Computerized Cognitive Remediation Therapy (CCRT): Investigating Change in the Psychosocial and Cognitive Function of Adolescent Psychiatric Patients

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Abstract

Cognitive rehabilitation therapy has been established as an efficacious treatment for adult psychotic disorders for over 40 years (McGurk, Twamley, Sitzer, McHugo, & Mueser, 2007). Research has shown that Computerized Cognitive Rehabilitation Therapy can reduce the impact that cognitive deficits associated with psychotic disorders and other serious and persistent mental illnesses when using the PSS Cognitive Rehabilitation software (Kurtz & Mueser, 2008). Few studies investigating the effects of CCRT in adolescent populations have been published. The current study analyzed extant data collected during the evaluation of a 27-week pilot, adolescent CCRT treatment program available within a state psychiatric hospital. Analysis and interpretation of available data suggest that two out of four participants experienced cognitive stability and three out of four participants experienced favorable changes in psychosocial function during CCRT. Limitations of the study include instrumentation and study design issues that could be improved during the next CCRT program implementation with increased administrative oversight.

Keywords: cognitive remediation therapy, adolescents, supported education program
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CHAPTER 1

The current chapter will review the national prevalence of serious mental illness and the associated cognitive and psychosocial dysfunction in adolescent and adult populations. It will also review treatment approaches for cognitive and psychosocial symptoms commonly associated with serious mental illness diagnoses. The significance of the current study and its specific research questions are presented at the end of the chapter.

Merikangas et al. (2010) found that one out of five adolescents in a nationally representative U.S. sample is diagnosed with a mental disorder that causes severe impairment and/or distress. Adolescents living with serious mental illness (SMI) experience lower levels of independence, poorer academic and vocational outcomes, and worse social development than adolescents without SMI (Nicolson et al., 2000; Urben, Pihet, Jaugey, Halfon, & Holzer, 2012). McLeod and Fettes (2007) reported that mental health problems from childhood (6 yrs.) through adolescence (22 yrs.) are associated with high school and college entry, two indicators of adult socioeconomic attainment and stability. Mild adolescent emotional disorders are strong predictors of adult mental, emotional, and behavioral disorders and can negatively influence different aspects of daily living without treatment (Kessler et al., 2012a).

Merikangas et al., (2010) reported adolescent mental health prevalence rates similar to a nationally representative sample of adults, suggesting that the majority of adult mental disorders emerge during childhood. Serious mental illness influences the development of identity, cognitive function, social skill acquisition, and emotional awareness, which affect an individual’s ability to pursue life goals, attain milestones, and successfully function day to day (Wykes et al., 2007). Prevention and early intervention treatment during childhood and adolescence can be protective factors against adult mental health disorders (McLeod & Fette, 2007).
Kessler et al. (2012a) define the term ‘serious emotional disturbance’ as diagnosable DSM-IV mental health problems and a rating of 50 or lower on the Children’s Global Assessment Scale (CGAS). A CGAS rating of 50 or lower indicates a moderate to severe impairment in a child’s ability to function socially, academically, and emotionally in their home, school, and community (Li, Green, Kessler, & Zaslavsky, 2010; Shaffer et al., 1983). Pratt, Mueser, Bartels, and Wolfe (2012) define the term “serious mental illness” as the presence of chronic symptoms of at least one major mental illness other than a substance use disorder for up to 12-months, with persistent impairments in several domains of adult (18 yrs. and older) life activities and functioning (Colpe, Epstein, Barker, & Gfroerer, 2009). This study uses the term ‘serious mental illness’ (SMI) to refer to both adolescent and adult populations.

SMI’s include major affective disorders (e.g., bi-polar I and II, depression), psychotic disorders (e.g., schizophrenia, schizo-affective) (Pratt et al., 2012), anxiety disorders (e.g., panic disorder with or without agoraphobia, agoraphobia without a history of panic disorder, social phobia, specific phobia, generalized anxiety disorder, post-traumatic stress disorder, separation anxiety disorder). SMI’s also include behavior disorders (attention-deficit/hyperactivity disorder, oppositional-defiant disorder, conduct disorder, intermittent explosive disorder, and eating disorders such as anorexia nervosa, bulimia nervosa, binge-eating disorder) (Li et al., 2010).

Adolescence is a crucial time of life for the development of an individual’s sense of self or identity. It is also a period of life when a teen is pursuing educational, vocational, and relational milestones. The onset of SMI can disrupt relationships, social skill development, self-care, self-esteem, and the attainment and maintenance of education and employment. Individuals with SMI who have difficulty completing and/or continuing their education could
have significantly lower economic prospects than those who do not (Mowbray, Collins, & Bybee, 1999). While it is important to treat psychiatric symptoms, it is equally as important to help both adults and adolescents with SMI identify and attain meaningful life goals and developmental milestones. Schools are a setting in which adolescents spend a significant amount of time. Since schools play an important role in shaping the present and future lives of teenagers, it is useful to understand and consider the treatment of SMI, cognitive function, and psycho-social skill development within the context of an academic setting (Kaplan & Flum 2012; Kidd, Bajwa, McKenzie, Ganguli, & Khamneh, 2012).

Individuals with SMI account for a significant percentage of the drop out population (Goudling, Chien, & Compton, 2010) and are more likely to drop out of school at an early age (Waghorn, Still, Chant, & Whiteford, 2004; Corrigan, Barr, Driscoll, & Boyle, 2008). They are less likely to complete or attempt post-secondary education and less likely to be employed compared to individuals in the general population (Waghorn et al., 2004; Corrigan et al., 2008). Goudling et al., (2010) reported that the manifestation of psychiatric symptoms could significantly delay normal social and emotional growth. According to Brauner and Stephens (2006) a child diagnosed with a SMI will also experience a substantial impairment in their ability to function in the community, home, and school or work environment.

**SMI, cognitive function, and psychosocial function**

Neurological structures that govern cognitive processes actively develop during childhood and adolescence (Nicolson et al., 2000; Censits, Ragland, Gur, & Gur, 1997). For example, as a child’s prefrontal cortex develops so does her/his memory and attention skills (Casey, Giedd, & Thomas, 2000). There is consistent evidence that SMI in adults is associated with cognitive deficits including, memory (e.g., working memory, global memory), psychomotor
ability, attention, speech comprehension and production, verbal fluency, and executive function processes, which affect a range of abilities and skills (Lewis, 2004; Greenwood, Landau, & Wykes, 2005; Tuulio-Henriksson, Partonen, Suvisaari, Haukkam & Lonnqvist, 2004; Lindenmayer et al., 2008; Hodge et al., 2008). Asarnow (1999) reported lower full scale IQ and reduced information processing capacity in adults with SMI. Other research found that children and adolescents with psychotic disorders have difficulty learning new information, engaging in active information processing, and utilizing executive processes (e.g., working memory and attention) necessary for organizing information (Bedwell et al., 1999).

There is a well-established relationship between psychiatric symptoms, cognitive deficits, and psychosocial dysfunction in individuals with serious mental illness (Fett et al., 2011; Pratt et al., 2012; McGurk et al., 2007). Improved cognitive functioning is associated with improved self-care, independent living and community involvement (Palmer et al., 2002), vocational skills (Velligan, Bow-Thomas, Mahurin, Alexander, & Halgunseth, 2000), social skills (Savilla, Kettler, & Galletley, 2008), and overall psychosocial function (McGurk et al., 2007). Elgamal, Mckinnon, Ramakrishnan, Joffe, and MacQueen (2007) argued that treatments targeting cognitive function before the manifestation of cognitive dysfunction might reduce the intensity and or severity of interrupted cognitive development for individuals diagnosed with serious mental illness. Kidd et al. (2012) argue that cognitive issues associated with SMI are especially inhibiting in work and school settings, which require individuals to utilize social skills, multitask, sustain attention, and recall material presented in a range of formats. “Given the central role of education and employment in the recovery of many persons with serve mental illness, there is a pressing need to identify effective treatments that address the challenges that can limit progress in these functional domains (Kidd et al., 2012).
Psychiatric Rehabilitation and Supported Education Programs (SED’s)

Psychiatric rehabilitation programs provide structured opportunities to learn, develop, and apply the cognitive skills needed to function safely and successfully in real world settings (Wykes, Huddy, Cellard, McGurk, & Czbor, 2011; Medalia & Saperstein, 2013). They are designed to supplement psychiatric treatment and support individuals diagnosed with SMI who are in the process of identifying, acquiring, and maintaining valued social roles (Farkas & Anthony, 2010). Impaired insight is a common cognitive phenomenon among individuals with serious mental illness. It can inhibit an individual’s perceived need to engage in treatment and willingness to work collaboratively with mental health providers (Ramsay et al., 2011). Though they vary in the way they are structured, they provide a combination of services in a variety of settings to improve an individual's awareness, emotion regulation and coping skill development, social skill development, and independent living skill utilization (Barrowclough et al., 2001; Glick, 2004). Farkas and Anthony (2010) reported that psychiatric rehabilitation programs are generally most helpful for individuals who have lived with mental illness for at least two years and have an impaired ability to function in residential, vocational, social, or educational roles.

Supported education programs (SED’s) are a type of psychiatric rehabilitation program. They integrate services that simultaneously target academic progress, psychiatric symptoms, and the psychosocial skills necessary to navigate an academic setting successfully (Hoffman & Mastrianni, 1993; Dixon et al., 2010; Kern, Glynn, Horan, & Marder, 2009; Farkas & Anthony, 2010). While there are a variety of ways that SED’s can be structured within various academic settings for a diverse client population (Mowbray & Collins, 2002) there are some general components found to make them successful. These include services that 1) coordinate an individual’s education and mental health treatment; 2) support coping skill development
necessary for success in academic settings; 3) provide mentorship and general personal support during enrollment in and completion of an educational program (e.g., library assistance, tutoring, other academic supports) (Waghorn et al., 2004).

Soydan (2004) argued that SED’s most effectively reduce the negative impact of early onset of SMI when tailored to the developmental and psychiatric needs of the individual. Hoffman and Mastrianni (1993) argued that despite variation in structure and setting, supported education programs are designed to protect and enhance an individual’s recovery of age-appropriate social functioning and independent living skills. Individuals SED’s show improved academic and vocational achievement, increased self-esteem (Soydan, 2004), sustained stronger identities, returned to college at higher rates, maintained higher academic aspirations, and have an easier transition from hospitals to the community (Hoffman & Mastrianni, 1993). Mowbray, Collins, and Bybee (1999) reported that supported education programs increase success in postsecondary education, improve self-esteem and social skill acquisition, and significantly increase college enrollment and competitive employment. Therefore, it is reasonable to expect that a supported education program can help reduce the negative impact of SMI and inpatient hospitalization on adolescent identity, academic engagement, attendance, and participation in pre-college academic achievement and employment.

**Cognitive remediation therapy (CRT)**

Cognitive remediation therapy (CRT) is a highly structured treatment that uses systematic instruction and mental exercises designed to facilitate improvement both fundamental and higher order cognitive skills across multiple domains of cognitive function, problem solving skills (Bracy et al., 1999), and information processing strategies (Kurtz, Seltzer, Shagan, Thime, & Wexler, 2007; Wykes et al., 2007; Elgamal et al., 2007), and reduce the impact, onset, and
progression of SMI over time (Lindenmayer et al., 2008; Marvel, Schwartz, & Isaccs, 2004). Medalia and Saperstien (2013) found that drill and practice, when combined with practical learning and coping skills utilization, consistently leads to improved psychosocial function. Cognitive rehabilitation treatment, cognitive rehabilitation therapy, or cognitive remediation treatment are terms used interchangeably in the literature when referring to CRT. This study will use the term CRT.

CRT is also associated with improved psychosocial function (Hogarty et al., 2004; Wykes et al., 2003; Bell, Bryson, Grieg, Cocoran, & Wexler, 2001), reduced symptoms of psychosis, improved daily function, and social interaction skills when combined with a psychiatric rehabilitation program (McGurk et al., 2007). There are computerized and non-computerized CRT training programs. Both kinds of CRT use curriculums which vary in design, length of exposure (e.g., overall and domain focused), program setting, target population, and target cognitive domains (e.g., attention and concentration, verbal learning, fluency, working memory, executive functioning, processing speed, visuospatial and motor skills, multiple aspects of language and conversation) (McGurk, et al., 2007; Kidd et al., 2012; Braff, 1993). Research has shown that CCRT can reduce the impact of cognitive deficits associated with SMI when using PSS (Kurtz & Mueser, 2008), COGPACK (Kidd et al., 2012), or other cognitive rehabilitation therapy software.

Research on adult CRT began over 40 years ago (McGurk et al., 2007), but research on the effect of CRT and CCRT on adolescent samples began within the last decade. Two studies of non-computerized CRT found immediate (Ueland & Rund, 2004) and sustained (Ueland & Rund, 2005) improvements in cognitive and psychosocial function for adolescent diagnosed with SMI. Another set of CRT studies found that adolescents diagnosed with serious mental illness
sustained improvements in executive function and memory up to 6-months after completing
treatment (Wykes, Newton, et al., 2007; Wykes, Reeder et al., 2007). One study found that
CCRT improved cognitive function in adolescents without mental illness (Bracy et al., 1999).
According to Dixon et al. (2010) CCRT is a promising practice and worth investigating further.

**Significance of the study**

There is evidence that cognitive impairment and deficits in psychosocial functioning are
consistently associated developmental precursors of SMI (Asarnow, 1999; Lewis, 2004). This
association makes sense given that complex social cognitive skills, important to psychosocial
function (e.g., empathy, perspective taking, reflection, appraisal of social contexts, planning, and
foresight), rely on the same neurological structures as cognitive abilities (e.g., problem solving,
learning, attention and concentration, working memory, and other aspects of executive
functioning, processing speed) and communication skills (Keshavan & Hogarty, 1999). There is
also significant evidence that the prognosis for an individual diagnosed with SMI is best
predicted by level of cognitive impairment and psychosocial functioning (Lewis & Lieberman,

Functional outcomes fall under two categories, competency and capacity. Functional
competence is the attainment of a sustainable level of functional ability in real world beyond
controlled treatment settings. Improved functional competence requires time and opportunity to
practice new skill sets in academic settings, vocational settings, and other settings that require
independent living skills. Functional capacity refers to an individual’s social skill performance,
measured in a controlled treatment setting but indicative of their potential to function in a
comparable and relevant, real world setting (Medalia & Saperstein, 2013). Increasingly, research
efforts have focused on how effectively CRT can alleviate psychiatric symptoms, enhance
cognition, and facilitate the transfer of treatment setting cognitive improvement to real-world functioning.

Individuals who continue to struggle with social function in real world settings despite access to and utilization of traditional, community, or school-based outpatient mental health treatment may benefit from more intense level of mental health treatment, available in a secure inpatient facility, that targets cognitive function, psycho-social function, and psychiatric symptoms simultaneously. Psychosocial and neurocognitive dysfunction can be problematic even when individuals are in remission from mood and psychotic symptoms (Simonsen et al., 2010). CRT is an effective strategy for addressing cognitive impairments and research has shown that individuals who receive cognitive rehabilitation treatment experience meaningful gains in social adjustment, vocational functioning, and other domains of social function (Eack, Greenwald, Hogarty, & Keshavan, 2010; Dixon et al., 2010; Medalia & Richardson, 2005).

CCRT combined with psychiatric rehabilitation programs improve cognitive function, psychosocial function, and symptoms of serious mental illness (Farkas & Anthony, 2010; Dixon et al., 2010). Since academic and mental health treatment settings are particularly influential with regard to the development and utilization of adolescent psychosocial functioning, it is reasonable to assume that there is an advantage to providing structured treatment of cognitive, psychosocial, and psychiatric symptoms of SMI simultaneously.

Research Questions

The current study explores the implementation of a pilot adolescent CCRT program within a long term, secure, psychiatric treatment facility. Cognitive function is operationalized and measured over time using extant data generated by the administrations of a neuropsychological assessment battery. Psychosocial function is operationalized and measured
over time, within an SED setting using extant data generated during both baseline and treatment phases of the pilot program. The nature of the data lends itself to a single subject, A-B design, frequently applied in clinical settings to assess the impact of an intervention. The current study will analyze and interpret available data to address the following questions pertaining to four participants:

1) Did participants in the pilot program show favorable change in cognitive function from Time 1 to Time 2?
2) Did participants in the pilot program show favorable change in psychosocial function in an SED setting from baseline to treatment phase?
Chapter 2
Review of the Literature

This chapter will review the literature relevant to the relationship between SMI, cognitive function, and psychosocial function within an academic setting. This chapter will also review the literature on treatment settings and the types of treatments used to improve psychosocial function and facilitate psychiatric recovery. The impact of CCRT and CRT on the psychosocial function of adults and adolescents will be a specific focus. CRT encompasses a range of programs designed to facilitate practice of cognitive tasks that help improve attention, memory, and problems solving ability (Kidd, et al., 2012). They are developed and evaluated to show they treat cognitive processes effectively in a variety of individuals across a range of settings (Wykes et al., 2011).

Prevalence of SMI

The National Comorbidity Survey Replication Adolescent Supplement (NCS-A) is a nationally representative face-to-face survey of 10,123 adolescents, ages 13 to 18, in the continental United States. It was the first national US survey of adolescents to assess a wide range of DSM-IV disorders using fully structured research diagnostic interviews. Extensive research has been done to describe the NCS-A’s sample design, measurements, validity of diagnostic assessments, and reported lifetime prevalence of DSM-IV disorders (Kessler, Avenevoli, Costello, Georgiades, et al., 2012a; Kessler, Avenevoli, Costello, Green, et al., 2012b). Data from the NCS-A estimate that 8% of individuals under the age of 18 in the United States are diagnosed with an SMI that lasts at least 12 months.

Kessler et al. (2012a) indicated that even a mild mental illness during adolescence is a strong predictor of serious mental illness during adulthood. Cognitive ability, social skills, and communication skills were found to be key predictors of how well a youth will function during
adulthood (Greenbaum et al., 1996; Wagner, Kutash, Duchnowsku, Epstien, & Sumi, 2005). The emergence of early emotional problems in young children is related to a variety of health and behavior problems in adolescence, juvenile delinquency, and school dropout (Brauner & Stephens, 2006). It is important to understand the onset, prognosis, and treatment of mental illness in youth because most adult mental illness begins in childhood or adolescence (Kessler et al, 2012a).

**SMI and Psychosocial Function**

Wagner et al. (2005) used data from the Special Education Elementary Longitudinal Study (SEELS) and the National Longitudinal Transition Study-2 (NLTS-2) to examine the academic and social obstacles that students diagnosed with a full range of developmental disabilities (e.g., physical, cognitive, and emotional) encountered in school settings. Wagner et al. found that SEELS ($N=1,081$) and NLTS-2 ($N=1,071$) samples are nationally representative of students served by special education programs. SEELS consisted of students ranging from 6-12 years old during the 1999-2000 school year. NLTS-2 consisted of students ranging from 13-16 years old during the 2000-2001 school year. The random sample of school districts in the SEELS study consisted of 245 school districts, including 30 schools that served only students with emotional disabilities and sensory impairments. The random sample of school districts in the NLTS-2 study consisted of 501 school districts, including 38 schools that only serve students with emotional disabilities and sensory impairments.

Children and youth with emotional disabilities have a wide range of psychiatric disorders (e.g., anxiety, behavior disorders, bipolar disorder, Tourette’s disorders, depression, obsessive-compulsive behaviors, oppositional behaviors, ADD/ADHD, and psychosis). Approximately 30% also have co-occurring learning disabilities, lower overall, social skill function (e.g., self-
control, assertion, and cooperation skills) compared to peers with and without other developmental disabilities. Students with emotional disabilities also have more difficulty utilizing cognitive skills used to manage everyday tasks that require reading, counting, and calculating. For example, they have more difficulty participating in a conversation because of difficulty paying attention to what someone is saying, comprehending what others say, and articulating their ideas (Wagner et al., 2005).

Wagner et al., (2005) reported that an average of seven out of 625 elementary/middle school students and 17 out of 1,310 students receiving special education services and supports also have a diagnosed emotional disability. Approximately 60% of students with emotional disabilities scored in the bottom quartile on a reading measure of academic achievement. Another 25% scored in the second quartile along with special education students receiving services and supports for mental retardation, autism, and other disabilities associated with significant cognitive limitations. Approximately 43% of students with an emotional disability scored in the bottom quartile on a math measure of academic achievement, along with students receiving services and supports for other disabilities associated with significant cognitive limitations.

Mild adolescent emotional disorders are strong predictors of adult mental, emotional, and behavioral disorders. Without treatment, children with SMI are likely experience reduced emotional control, develop fewer social cognitive abilities, struggle with aspects of daily living that make it difficult to maintain a safe level of independent living and functioning (Kessler et al., 2012a). They are also likely to less likely to participate in recreational community activities and social interactions, structured social skill and problem solving activities, and academic and vocational pursuits successfully (Simonsen et al., 2010). For example, 26.8% of
elementary/middle school students and 19.5% of high school students with a diagnosed emotional disability changed schools more frequently for disciplinary reasons compared to 8% and 3.1% of students receiving services and supports for other disabilities. Students with emotional disabilities were significantly more likely to be suspended, expelled, or held back because of academic performance, than students receiving services and supports for other disabilities or general population students. Fifty one percent of children with emotional, behavioral, or mental disorders eventually drop out of school (Wagner et al., 2005).

Wagner et al., (2005) argue that mental health treatment which takes into account a child’s level of function, educational history, and mental health history while targeting academic and behavioral needs will likely improve academic and social outcomes for both general population and special education students diagnosed with emotional and behavioral disorders. According to Teich, Robinson, and Weist’s (2007) review of national mental health services provided in schools from 2002 to 2003, public schools were making considerable attempts to respond to the mental health needs of their students, despite an ongoing and increasing need for mental health services, multiple administrative challenges, funding issues, and a lack of community based resources.

Hoagwood et al.’s (2007) research highlights the positive impact that school based mental health services have on academic and mental health outcomes for students. They identified 24 empirically based studies of school-based mental health interventions published between 1990 and 2006 that examined both mental health and educational outcomes. Fifteen of these studies found that an intervention had a positive impact on both mental health and academic outcomes; eight found that an intervention had a significantly positive impact on mental health outcomes; one found no statistically significant impact on either mental or
academic outcomes. However, those programs found to positively impact both academic and mental health outcomes only showed modest effects, despite intensive interventions aimed at multiple targets (e.g., teachers, parents, students, and systems). Hoagwood et al. argue that mental health needs to be reframed and integrated into the broader mission of schools. They found that the most effective school based mental health intervention programs used a multi-tiered approach, with varying levels of treatment intensity, for students identified as at risk as they progress through different grades. They argued that it might be helpful for future research to investigate both short term (e.g., academic engagement, disciplinary actions associated with conduct problems, classroom and school climate) and long-term (e.g., grades, attendance, test scores) outcome variables.

**SMI and Cognitive function**

The ability to utilize social cognitive abilities and manage emotional impulses (e.g. frustration, self-esteem, sadness, and anger) during social interactions is associated with the ability to demonstrate functional behaviors in community, work, and academic settings. How well an individual fulfills social roles and meets expectations relevant to their age and background is also an indication of their level of psycho-social function. Several researchers have noted that schizophrenia and to a lesser degree major affective disorders (e.g., bipolar disorder I and II and/or major depression) are associated with psychosocial dysfunction (McMurrich, et al., 2012) and cognitive impairment (Austin, Mitchell, & Goodwin, 2001; Paradiso, Lamberty, Garvey, & Robinson, 1997; Hammar & Ardal, 2009) in fundamental (Kurtz & Nichols’s, 2007; Kurtz, Seltzer, Fujimoto, Shagan, & Wexler, 2009) and higher order cognitive ability (Kurtz & Nichols’s, 2007). Those cognitive abilities include language and sensory-motor skills, social cue recognition associated with deficits in attention, impulsivity, and
inhibition; learning and memory; executive function, problem solving, decision making, and choice evaluation, consequence prediction and planning (Cataldo, Nobile, Lorusso, Battaglia, & Molteni, 2005; Gohier et al., 2009; Robinson et al., 2006; Fossati et al., 2004; Austin et al., 2001).

Kurtz and Nichols (2007) conducted a critical review of randomized, controlled trials focused on the rehabilitation of basic cognitive deficits and the development of skills that compensate for social cognitive deficits, which are characteristic of schizophrenia and other psychotic disorders. They found that neurocognitive deficits in schizophrenia explain dysfunction in variety of social domains including community function, social problem solving, and progress in skills training programs. They also found that neurocognitive deficits could be improved through a variety of CRT exercises that rely on drill-and-practice methods. Individuals with schizophrenia are able to learn and maintain more complex cognitive skills (e.g., emotion perception, affect recognition abilities), which rely on basic cognitive skills (e.g., executive functioning, memory, attention), and allow an individual to understand social cues and perspectives held by others (Kurtz & Nichols, 2007). Kurtz and Nichols also found that practicing cognitive exercises produced improvement on a variety of neuropsychological measures distinguishable from tasks used during training, but they acknowledge that it is unclear how well enhanced cognitive skills acquired in the laboratory setting translate into community functioning.

Individuals with SMI are likely to experience problems in interpersonal relationships, lower levels of social competence, and maladaptive functioning because of deficits in complex and basic cognitive skills (Combs, Tosheva, Wanner, & Basso, 2006). While the research indicates that those with major affective disorders are less likely to experience cognitive
dysfunction than those with psychotic disorders, affective disorders can also negatively impact social dysfunction (e.g., anger management, difficulty at work or school, difficulty getting around using public transportation, difficulty maintaining hygiene and other aspects of self-care, independent living skills, and social relationships) during both symptomatic and non-symptomatic phases of serious mental illness (Simonson et al., 2010; Pratt et al., 2012; Elgamal et al., 2007; Hogarty et al., 2004; Spaulding et al., 1999).

**Treatment for SMI, Psychosocial Function, and Cognitive Function**

Wykes et al. (2011) conducted a meta-analysis of 40 studies with data on over 2000 participants from randomized, controlled research trials. Each of the 40 CRT studies met five criteria for inclusion: 1) interventions met the standard Cognitive Remediation Experts Workshop definition for cognitive remediation; 2) 70% or more of the research participants are diagnosed with schizophrenia; 3) standard care, including appropriate medication for all participants; 4) a comparison group and allocation procedure; and 5) a cognitive or functional outcomes distinct from the trained tasks. They investigated the moderating effects of treatment type, patient characteristics, and the internal and external validity of the studies that reported treatment effects. Wykes et al. found that CRT has a moderately positive effect on global neurocognition (effect size=.45) regardless of the quality of trial methodology, cognitive improvement endures after treatment is complete (McGurk et al., 2007), and CRT provided in conjunction with psychiatric rehabilitation has a significantly greater impact on psychosocial functioning (effect size=.59) compared to cognitive remediation alone (effect size=.28). Wykes et al. also found that specific, explicit training strategies and transfer techniques are more important than the kind of CRT utilized. For example, better psychosocial outcomes are associated with CRT programs that combine drill and practice exercises with psycho-education groups that teach skill
application, address beliefs, and help individuals determine motivation for success (Medalia & Saperstein, 2013).

Medalia and Saperstein (2013) found that an independent meta-analysis of 19 studies with data on 692 participants, conducted by Kurtz and Richardson (2012), indicated that cognitive remediation had a moderate to large effect (.71) on improving ability to identify affect and a large effect (1.01) on improving affect discrimination ability. Overall, they found that cognitive remediation did not have an effect on an individual’s ability to interpret intentions or identify the nature of social interactions, but had a medium effect (.68) on reducing psychiatric symptoms, and a large effect (.78) on observer-rated measures of community and institutional functioning. Medalia and Saperstein also found that lack of opportunity to practice new cognitive skills, performance anxiety, self-competency beliefs, intrinsic motivation, and an environment that supports independent functioning and autonomy are a few potential obstacles that individuals face when learning to apply improved cognitive skills to psychosocial function.

McGurk et al., (2007) conducted a meta-analysis of 26 randomized controlled trials of cognitive rehabilitation that met four inclusion criteria: 1) randomized, controlled trial of psychosocial intervention designed to improve cognitive function; 2) an assessment of performance with at least one neuropsychological measure that could be generalized to broad cognitive function (vs. assessment of trained tasks); 3) data available on either group means and standard deviations for baseline and post-intervention cognitive tests of statistics from which effect sizes could be calculated; 4) minimum of 75% of the sample reported to have schizophrenia, schizoaffective disorder, or schizophreniform disorder. They confirmed findings from previous research showing a significant association between cognitive remediation, improved cognitive performance, and reduction in psychiatric symptoms. They also highlight a
variety of cognitive remediation strategies (e.g., drill and practice with and without teaching strategies, compensatory strategies, and group discussions) shown to improve cognitive ability. Overall, their results support arguments that CRT by itself leads to moderate improvements in cognitive function, and CRT combined with psychiatric rehabilitation leads to improvements in both psychosocial function and psychiatric symptoms.

However, McGurk et al., (2007) also found significant variability in the effect of CRT on psychosocial function. They reported that moderating variables (e.g., participant characteristics (age), setting (inpatient/outpatient), type of CRT program, type of control group, type of intervention, hours exposed to cognitive remediation treatment, hours of practice with exercises targeting specific cognitive domains vs. overall exposure to treatment) and provision of psychiatric rehabilitation impact the effect of CRT on psychosocial functioning. Specifically, they found that CRT combined with other psychiatric rehabilitation programs had a more positive impact on cognitive function than those that did not. They also found evidence that CRT combined with other psychiatric rehabilitation programs lead to greater improvements in hiring rates and success in competitive jobs, greater improvement in quality of and satisfaction with interpersonal relationships, and improved ability to solve personal problems (McGurk et al., 2007). Consistent with previous research their meta-analysis also found that cognitive impairments reduce an individual’s response to psychiatric rehabilitation programs and that improved cognitive function enables individuals to benefit more fully from psychiatric rehabilitation programs.

Medelia and Saperstein (2013) summarize that no recent studies exclusively utilizing CCRT found improved psychosocial function, but those that used CRT in conjunction with psychiatric rehabilitation did demonstrate a positive impact on psychosocial outcome. They also
show evidence that functional skill training provided through psychiatric rehabilitation programs is more effective when cognitive improvement lays the groundwork for improving functional skills, which in turn allows an individual to experience improved community functioning.

Overall, the literature shows that cognitive deficits are common for youth and adults with serious mental illness (Uleand & Rund, 2004; Uleand & Rund, 2005; Urben et al., 2012; McGurk et al., 2007; Wykes et al., 2011). Research also shows that cognitive deficits negatively influence multiple aspects of daily psychosocial functioning including treatment response, insight into illness, therapeutic alliance, academic functioning, vocational function and employment status, social relationships, independent living status and community functioning (Medalia & Richardson, 2005; Kurtz & Nichols, 2007; McGurk et al., 2007).

CRT combined with psychiatric rehabilitation services improves functional outcomes in social domains such as employment (McGurk, Mueser, DeRosa, & Wolfe, 2009), education (Kidd et al., 2012; Mowbray et al., 1999; Collins & Mowbray, 2010; Mowbray & Collins, 2005; Best, Still, & Cameron, 2008; Soydan, 2004), and measures of everyday functioning (Mausbach, Harvey, Goldman, Jeste, & Patterson, 2007). A variety of psychiatric rehabilitation treatment programs (e.g., social skills training, social perception training, supported employment, supported education, vocational rehabilitation, and vocational rehabilitation and social information processing groups), combined with a variety of CRT programs, showed significant improvements in cognitive functioning across patient conditions (McGurk et al., 2007) up to eight months (Wykes et al., 2011) after the completion of cognitive remediation. Wykes et al. (2011) note a small effect size of CRT on psychiatric symptom improvement. They argue that cognitive remediation has a limited impact on psychotic symptoms but believe that positive learning experiences leading to improved self-esteem and self-efficacy for achieving personal
goals during cognitive remediation and psychiatric rehabilitation can ultimately lead to an improvement of mood symptoms.

Kidd et al. (2012) found evidence that CRT integrated with functional skills training in SED settings can improve learning, concentration and executive functioning. Their intervention provided 16 participants with 10 weeks of bi-weekly CCRT sessions combined with weekly group discussions focused on the role of cognitive factors in academic performance, development of compensatory strategies for dealing with challenges in academic contexts, and strategies for managing psychosis symptoms in school settings. Group sessions were aligned with CCRT sessions when possible. For example, Kidd et al. found participants made significant improvements on Trail Making B test, verbal learning, a timed vigilance task, and general psychosis symptoms. They also indicated that 12 of 16 participants reported enjoying both computer and group sessions; that 13 participants described an improvement in memory and concentration that generalized to other areas of function, particularly in an academic setting. Participants reported that they found it rewarding and confidence building to experience the progress they made. While none of the participants reported having a negative impression or expressed serious reservations about having participated, three indicated that they were unsure of whether or not the cognitive remediation treatment had benefited them.

**Computerized Cognitive Remediation Therapy (CCRT)**

CCRT uses specially designed computer software that logically progresses individual users through a number of increasingly difficulty cognitive tasks, across multiple cognitive domains, to provide an individual with a user-friendly experience (Pilarc, 2000). According to Poletti et al. (2012), CCRT programs include different neurocognitive exercises that target specific cognitive domains known to be impaired in schizophrenia (e.g., verbal memory, verbal
fluency, psychomotor speed and coordination, executive function, working memory, attention). They also provide exercises that target broad cognitive domains, which influence function in areas like culture, language, and simple calculation skills. Most exercises have adjustable difficulty levels and can monitor the progress that participants make during individual sessions.

Eack et al. (2010) looked at how CRT combined with neurocognitive and social cognitive rehabilitation affects individuals with schizophrenia (N=38) and schizoaffective disorder (N=20). They compared an experimental cognitive enhancement therapy (CET) group (n=31) to an enriched supportive therapy (EST) control group (N=27). Fifty-eight participants were randomly assigned to the groups and treated. Forty-nine completed the full two years of treatment. Forty-two were available for the one-year post treatment follow up. The CET group received 60 hours of computer-based training in attention, memory, and problem solving and 45-90 minute sessions of group therapy designed to facilitate the development of higher-order social cognitive abilities (e.g., perspective taking, social context appraisal, and foresight). Participants worked together with a partner for approximately three months of CCRT focused on attention skills. After three months, three to four sets of partners were enrolled in a social cognitive therapy group for 21 months. EST is a psycho-education based approach to illness management that consists of two phases. During the first phase, participants received weekly, one-on-one sessions with a study clinician for basic psycho-education about schizophrenia and the effects of stress on the disorder. During the second phase participants received bi-weekly, one-on-one sessions with a study clinician to learn how to identify early warning signs of distress and the development and utilization of coping strategies (e.g., diaphragmatic breathing, passive and active relations strategies) to manage stressors, prevent relapse, and enhance social adjustment.
Eack et al., (2010) argued that targeting cognitive impairments early in the course of the disorder can result in significant functional benefits in employment, social functioning, and major role functioning. They reported functional improvements in participants assigned to both EST and CET conditions. CET participants maintained functional outcomes in the year following treatment completion and maintained high rates of employment post treatment. EST participants showed an increase in employment rates one-year post treatment. They argued that despite limitations, rater bias and modest sample size, their findings highlight the potential lasting benefits of early cognitive rehabilitation in schizophrenia for reducing psychosocial dysfunction in schizophrenia. Given the evidence of potential lasting impact on the early trajectory of the illness, they also argue that cognitive rehabilitation should be a key component of early intervention programs seeking to produce durable functional changes in the lives of individuals early in the course of their illness.

Poletti et al. (2010) assessed a sample of 100 adult patients, diagnosed with schizophrenia and receiving outpatient treatment, at six and twelve months. They were randomly assigned to either a CCRT group or a placebo training control group in addition to rehabilitation treatment as usual for three months. The experimental group had significant improvements in executive function, attention, psychomotor coordination, and daily functioning, which were maintained during the follow-up phase of the study. The control group showed no changes.

Elgamal et al. (2007) claim to be the first to successfully treat cognitive deficits associated with major depression using CCRT. They targeted memory, attention, executive function, and psychomotor speed in 12 outpatient participants diagnosed with major depressive disorder. As controls, they included a group of participants diagnosed with major depressive disorder \((N=12)\) and a group without a diagnosis of SMI \((N=12)\), neither of whom received
CCRT. They found that those participants treated with CCRT showed improvement on cognitive assessments of attention, verbal learning and memory, psychomotor speed, and executive function, which exceeded improvements shown by control groups. Symptoms of depression remained stable, indicating that improved cognitive function does not necessarily translate into improvements in psychiatric symptoms.

d’Amato et al. (2011) investigated 77 adult participants diagnosed with remitted schizophrenia. Participants were randomly assigned to either a control group (N=38) or 14 two hour sessions of CCRT over a seven week period (N=39) that targeted four domains of cognitive function involved in information processing (e.g., attention/concentration, working memory, logic, executive functions). They found that the treatment group significantly improved in areas of attention/vigilance, verbal working memory and verbal learning memory, and reasoning and problem solving. However they did not show improvement in non-verbal working memory and learning, speed of processing, or functional outcome measures (e.g., self-report quality of life for people with schizophrenia (SQoL), social autonomy scale (EAS)). d’Amato et al. concluded that their study used a larger sample to confirm the results reported in other studies that found specific and generalized cognitive improvement after treatment, not attributable to practice effects. They also advocated that future studies utilize longer follow-up periods in order to further evaluate the longer-term generalizable effects of cognitive improvement on functional outcome.

Murthy et al. (2012) conducted a study of 65 adult participants diagnosed with schizophrenia in multiple sites (e.g., treatment facilities and academic institutions), across two countries. Participants received up to 40 sessions of CCRT over 10 weeks. Sessions were at least an hour long and available up to five times a week. Murthy et al. did not utilize control
groups despite a sample size that was larger than the majority of those previously studied. Fifty-five participants completed the study and showed improvements in auditory processing, which did not generalize to outcomes beyond the CCRT tasks.

Rass et al. (2012) tested the effectiveness of biweekly training using CCRT programs on neuropsychological outcome measures. They recruited an adult outpatient sample and randomly assigned 48 participants to a CCRT group (n=21), an active control group (n=17), and a treatment as usual group (n=10). After 2 hours of treatment, two days a week for 10 weeks results indicated no differences in participant improvement. All groups improved on information processing, verbal memory and visual-spatial tasks but did not show generalized cognitive improvements. Rass et al. argued that further research exploring the effectiveness of CCRT on generalized cognitive improvements would be a logical and valuable next step.

There is considerably more research on the efficacy of CCRT with adults than adolescents. Early studies of adolescent CRT looked at the impact of CCRT in a non-clinical population of participants and the impact of CRT in adolescents with SMI. Bracy et al. (1999) investigated 80 middle school students (12-14 years old) without SMI diagnoses in a non-randomized nine-week study. Thirty-nine students enrolled in the CCRT group and 41 students enrolled in a study hall control group. They found that CCRT improved the cognitive/intellectual skills (e.g., attention, executive, visual-spatial and problem solving skills).

There are two studies that show evidence that CRT improved cognitive and psychosocial function in adolescents with SMI (Ueland & Rund, 2005; Ueland & Rund, 2004). Ueland and Rund (2004) investigated the effectiveness of CRT combined with a psycho-education treatment program for adolescents (ages 12-18) diagnosed with SMI and early onset symptoms of psychosis (schizophrenia, N=16; schizoaffective, N=3; bipolar, N =3; psychotic disorder NOS,
They randomly assigned 26 participants to a CRT \((N=14)\) group or a control group \((N=12)\) and assessed them using cognitive, clinical, psychosocial and behavioral measures. They reported a small sample size as a limitation and potential explanation for why they did not find a significant between group difference in pre and post treatment scores. They also conducted a within group analysis, which indicated the group receiving CRT plus psycho-education improved on five out of 10 cognitive measures and three out of five measures of functional outcomes. The control group improved on three out of 10 cognitive measures and one measure of functional outcome.

Ueland and Rund’s (2005) second study investigated the long-term impact of CRT on 25 inpatient participants one year after discharge from the initial study. When the CRT group \((N=14)\) was compared to a control group \((N=11)\) there was a significant between group difference in overall improvement for eight of ten cognitive measures and three of four outcome measures in the CRT group. After controlling for IQ, they also found that the CRT improved significantly more than the control group in early visual information processing from baseline to follow-up one year after discharge.

Urben et al. (2012) investigated the short-term outcomes of CCRT in outpatient adolescents diagnosed with psychotic disorders \((N=21)\) or at risk for psychosis \((N=11)\). Participants were randomly assigned to a treatment group \((N=18)\) or a control group \((N=14)\). 12 participants from the treatment condition and 10 from the control condition were available for follow up assessments of cognitive function six months after treatment. The results indicated improved executive functioning and reasoning skills in the treatment group. These findings are consistent with those from other randomized, control trials of adolescent CRT (ages 14 to 22
years old) in samples diagnosed with SMI that indicate long-term improvement in executive function and working memory (Wykes, Newton, et al., 2007; Wykes, Reeder et al., 2007).

The literature shows that CCRT and CRT can improve task specific, and in some cases generalized cognitive ability in adolescents and adults with SMI. The literature also shows mixed results pertaining to the impact that CCRT and CRT have on psychosocial functioning. There are consistent improvements in psychosocial function when CRT is combined with supported employment programs, but less research investigating the combination of CCRT and SED’s (Kidd et al., 2012). Given that the ability to multi-task, sustain attention, and recall visual, verbal, and auditory information are important to an individual's success in work and school settings and the role that education and employment play in the recovery of individuals with SMI and adolescents in general, it is reasonable to conclude that more research focused on CRT with adolescent populations are indicated. This study will analyze data collected during a pilot adolescent CCRT program.
Chapter 3

Methodology

This chapter describes the sample, participant recruitment and informed consent procedures. Procedures and tools used to administer treatment and collect data, analyze available data, and study methodology are also presented.

Procedures

Sample recruitment and demographics.

CCRT program records indicate that psychiatric and academic histories of potential program participants were reviewed, and treatment teams were consulted in order to compile a list of those students meeting the diagnostic, cognitive, and psychosocial criteria. Ten potential participants between the ages of 13 and 18 were informed of the opportunity for a treatment as usual CCRT program, available during their current hospital admission. They were not informed of the scope or content of data collection to increase the likelihood that their behaviors within the natural setting of the hospitals SED would not be altered to meet the expectations of the program administrators and reduce the internal validity concerns related to social desirability. Eight students agreed to participate, but there were only sufficient data available on four due to the amount of time the pilot program was operating. Because of the small sample size, other demographic data have been excluded to protect the confidentiality of the subjects. There were no gender, ethnic, or religious exclusionary criteria for participants.

To protect their rights and ensure their confidentiality participants were randomly assigned unique identification letters, which were used to label all records associated with the CCRT program. Hard copies of raw data were kept in a locked filing cabinet, in the locked office of program administrators. Raw data were entered into an excel spreadsheet master
database, which includes identifying information. The master database was maintained on a secure network server, and accessible only to program administrators. De-identification procedures described in Chapter 6, section VIII, Part A of the DMH Privacy Handbook were used to completely de-identify and prepare data made available for statistical analysis, presentation, or publication once approval was granted by the institutional review board.

**Intervention.**

**Research design.**

Records indicate that the adolescent CCRT program ran for 27 weeks using a single subject design (A-B), within a program evaluation framework. A program evaluation framework allowed for the systematic assessment of the CCRT programs’ (IV) everyday implementation and data collection procedures and participant outcomes, with regard to cognitive function (DV) and psychosocial within an SED setting (DV) and a CCRT setting (DV). The CCRT program replicated the single subject design, with multiple participants simultaneously in order to improve the study’s external validity and the general applicability of results to more heterogeneous populations. Participants served as their own pre-treatment control condition on four psychosocial function variables (i.e., attendance, participation, academic engagement, inattentive/overactive behavior). Prior to beginning treatment participants needed to show stable psychosocial function with the hospitals SED setting. A program administrator tasked with performing blind analyses of the data determined participant stability.

Visual analysis of data performed by someone blind to the source of the data (Ferron & Jones, 2006) was used to reduce the likelihood that false treatment effects are found (type I error). Once stability of baseline data is determined across participants, one was randomly chosen to begin the treatment phase by picking a slip of paper with their unique identifier out of
a hat. Blind analysis of all participant data continued until a treatment effect in the SED psychosocial function data was determined and another participant was randomly chosen to begin their treatment phase. The program administrator remained blind to the order in which participant(s) started their treatment phase throughout the course of the study.

**CCRT pilot program for adolescents.**

The CCRT program was housed in a room that was visible and central to the routines of hospital support staff, teachers, and treatment team members. It contained two desktop computer workstations and a laptop computer workstation with CCRT software. Each computer had headphones for modules with auditory tasks. To reduce the likelihood of social interaction and distraction workstations faced the walls opposite the door and each other. In order to maximize safety and privacy the door to the CCRT room was left open during sessions and a 2:1 participant to one staff ratio was maintained. Participant data (i.e., neurological assessment protocols, psychosocial data protocols, CCRT observation notes) were kept in a folder labeled with unique identifiers and locked in filing cabinet in the principal investigator’s locked office. Participant data folders also contained a pen, CCRT worksheets (completed and blank), and a labeled 3.5 inch computer disk used to document progress through CCRT modules. Blank worksheets, 3.5-inch computer disks, and data collection protocols were also kept in the same locked office.

Four pre-doctoral psychology interns and a staff neuropsychologist were recruited to be volunteer therapeutic coaches within the CCRT program. Participants were assigned to therapeutic coaches who were already a part of their treatment teams, familiar with treatment plan goals and objectives, and able to act as liaisons. Program administrators trained therapeutic coaches by familiarizing them with the CCRT curriculum and the tasks in each of the 13
modules. Therapeutic coaches were also trained to support participants by providing strategic prompts, reinforcing the development and utilization of learning strategies and coping skills, and adjusting their support and guidance during sessions as needed to facilitate independent participant functioning. Coaches were in a position to simultaneously build therapeutic rapport and act as active observers (Gay, Mills, & Airasian, 2006) of a participant’s mastery of CCRT tasks and their developing ability to learn and independently execute CCRT protocols. Program records indicate that their observations were documenting in session notes in line with hospital protocols governing the documentation of patient treatment records.

Participants received a standardized administration of a 12-module CCRT curriculum (Bracy, 1995) designed to support the development of cognitive processes associated with SMI. CCRT sessions were available three to five days weekly for approximately one-hour at a time in the adolescent CCRT room. In between CCRT sessions, participants were assigned homework designed to reinforce cognitive and psychosocial skills developed during treatment. Each participant began with modules designed to strengthen simple visual and auditory attention skills and progressed through modules that put increased demand on their visual-motor skills, attention skills, processing speed, and memory. CCRT modules utilized continuous movement, response/feedback tasks intended to strengthen the patient’s self-monitoring and self-correcting skills. Once participants met task specific qualitative and quantitative goals, they progressed to the next module in the treatment curriculum.

Prior to sessions, coaches checked participant folders to make sure they contained blank worksheets, a working pen, and participant computer disks. Once participants arrived, coaches would review and update homework assignments, session goals, and model efforts to inventory and organize the contents of their folders. During sessions, coaches modeled the setup and
shutdown of computers and treatment software, monitored and documented progress toward CCRT task goals and objectives, participant performance (e.g., hand eye coordination, attention and impulsivity, task mastery, cognitive fatigue, frustration tolerance and management of behavior and emotions), and social interactions (e.g., receptiveness to prompts, application of feedback). With approximately 15 minutes left in a session, therapeutic coaches modeled the review and documentation of participant progress, discussed and reflected on the session progress, established and documented goals for the next session, and determined the appropriateness and feasibility of homework to be completed before the next session. Therapeutic coaches then returned participants to their daily schedules, completed CCRT progress notes, and returned the participant file to the principal investigator's office.

**Supported education (SED) classrooms.**

The hospital’s SED program administrator worked closely with a patient's school district to deliver a treatment sensitive academic curriculum designed to meet the goals of each student's Individualized Education Plan. Hospital teachers and direct care staff provide therapeutic support and academic instruction six periods a day (e.g., math, science, social studies, English language arts, art, and gym/health), five days a week for the duration of a patient's admission period. During course of the pilot program, there were four weeks (21 days) for which no psychosocial data available from the SED program because of a combination of school vacations, teacher professional development days, and snow days.

The overall goal of the hospital’s SED was to provide an academic setting that will help patients maintain academic progress and prepare them to successfully transition from a hospital setting to their home school setting upon discharge. The SED’s operating procedures required direct care staff assigned to the classroom, to work as teachers’ aides. The role that teachers and
direct care staff played during class made them ideal candidates for recruitment as volunteer, privileged, active observers. They were able to watch what was happening during a period of instruction and make direct observations without compromising their primary role (Gay, Mills, & Airasian, 2006). Program records indicate that four teachers and eight direct care staff were recruited to collect psychosocial data as volunteer research assistants. At various points during the study, substitute teachers also volunteered to collect data.

**Teachers.**

Existing procedures required teachers to complete daily individual attendance and participation forms, which were used to assess student classroom functioning as a means for students to earn weekly points based incentives. Students have the potential to earn up to 20 points daily. One point for behavior during their morning and afternoon transitions between the residential unit and setting and 18 points per school day. Students who complete all assignments and earn more than 75 points weekly were eligible to participate in Friday afternoon activities. In addition, CCRT program administrators trained teachers to use the inattentive/overactive subscale of the IOWA-Connors teacher rating scale (IOWA-IO) to assess each participant’s level of inattention, impulsivity, and hyperactivity during class. Both instruments were used to assess the baseline and treatment phase psychosocial function of CCRT program participants in the SED. Records indicate that at the end of the program, teachers were asked to complete an anonymous, five-item survey that assessed overall understanding of the program and psychosocial instruments, and motivation to participate as volunteer research assistants.

**Direct care staff.**
CCRT administrators also created and trained direct care staff to use an observation form and pre-recorded time sampling procedure, to systematically assess the type and frequency of student academic engagement. Staff were asked to make observations during two different class periods, every day school was in session, during 15 minute observation periods. During observations, direct care staff used a discreet earpiece to listen to one of two MP3-player loaded with the same pre-recorded time sampling procedure. The recording rang twice every 15 seconds. The first ring signaled the beginning of a 10-second observation period and the second ring signaled the beginning of a five-second period used to record a student's level of academic engagement.

Records indicate that during the observation training period CCRT program administrators established inter-observer agreement with all eight direct care staff by explaining the coding system and given them an opportunity to ask clarifying questions. Afterwards, the principal investigator and the direct care staff listened to the same MP3-player while simultaneously making direct observations of academic engagement for students who did not meet criteria for participation in the CCRT. Training observations were made while direct care staff were off-shift so that upon completion of the observation they had a chance to compare their observations with the principal investigators and ask more clarifying questions. Shimabukuro, Prater, Jenkins, and Edelen-Smith (1999) suggested equation 1, the formula used to calculate inter-observer agreement.

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\frac{\text{(# of on-task behaviors simultaneously observed/the total number of observations)}}{100}. \quad (1)
\]

Once direct care staff were within 95% observation agreement for students who did not meet the criteria for CCRT program participation. The program administrator and direct care staff made simultaneous observations of student who volunteered to participate in CCRT. Direct
care staff were also asked to maintain inter-observer agreement by scheduling simultaneous observations of the same participant 40% of the time. CCRT administrators checked in with direct care staff and teachers throughout the week to answer questions, provide support, and make systematic observations of student academic engagement that could help maintain inter-observer agreement. CCRT administrators also periodically checked and changed the batteries for both MP3-players, provided blank observation forms and five item instruments at the beginning of each week, and collected and filed completed records at the end of the week. Records indicate that at the end of the program, direct care staff were asked to anonymously complete a five-item survey to assess their overall understanding of the program, psychosocial instruments, and motivation to participate as volunteer research assistants.

**Instruments**

**Measures of cognitive function.**

The CCRT neurocognitive assessment battery included nine assessments of cognitive function across four broad domains of ability (verbal, non-verbal, memory, executive function). Vocabulary, and Matrix Reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999; Keith, Powell, & Powell, in press; Lindskog & Smith, in press); the Digit Span, Vocabulary, and Matrix Reasoning subtests of the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003) and the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III; Wechsler, 1997), Fourth Edition (WAIS-IV; Wechsler, Coalson, & Raiford, 2008); the Wechsler Individual Achievement Test, Second Edition-Abbreviated (WIAT-II-A; Wechsler, 2002; Johnson & Smith, 2003); the Boston Naming Test-2 (BNT-2; Kaplan, Goodglass, & Weintraub, 2001); the Rey-Osterrieth Complex Figure Test (ROCF; Strauss, Sherman, & Spreen, 2006); and the Delis-Kaplan Executive Function
System (D-KEFS; Delis, Kaplan, & Kramer, 2001) Trail Making Test. The following sections describe the administration and scoring procedures, psychometric properties, and the data analysis plan for each instrument in the assessment battery.

**General intelligence.**

The Wechsler Abbreviated Scale of Intelligence (WASI) is an assessment of both verbal and nonverbal abilities that can be used to estimate the general intelligence of individuals aged 6-89. It is made up of four subtests (i.e., Vocabulary, Similarities, Matrix Reasoning, and Block Design) that assess various domains of cognitive function. Each of the four subtests is comparable to similarly named subtests that make up other Wechsler instruments. The WASI was developed to be a brief, but reliable instrument used in clinical, psycho-educational, and research settings. It takes approximately 30 minutes to administer all four subtest and 15 to administer the two subtest form (i.e., Vocabulary, Matrix Reasoning). During the first administration of neurocognitive assessments (T1), CCRT program administrators used the two subtest form to estimate verbal ability, nonverbal ability, and generate a full scale intelligence quotient composite score (FSIQ-2) that estimates overall general intelligence. During the second administration of neurocognitive assessments (T2), in order to determine if there had been any change in cognitive functioning during exposure to CCRT and reduce potential practice effects, program administrators assessed verbal and nonverbal ability using Vocabulary and Matrix Reasoning subtests from the WAIS-IV and the WISC-IV as alternate, parallel forms.

The Vocabulary subtest is one of the main assessments of word knowledge that contributes to the WASI, WAIS-IV, and WISC-IV’s Verbal Comprehension Index and Full scale IQ. It is used to assesses several factors (e.g., learning ability, fund of information, richness of ideas, memory, concept formation, expressive vocabulary, verbal knowledge, and language
development) closely related to an examinee's overall verbal ability and educational experiences. The WASI Vocabulary subtest is made up of 42-items, consisting of 4 pictures and 38 words (Wechsler, 1999). The WISC-IV Vocabulary subtest is made up of 36-items, consisting of 4 pictures and 32 verbal items (Wechsler, 2003). The WAIS-IV Vocabulary subtest is made up of 30-items, consisting of three pictures and 27 verbal items (Wechsler et al., 2008). The number of vocabulary words an individual can define reflects their ability to learn and to accumulate information. Test administrators read words aloud while examinees look at the words or a picture of the word. While examinees are giving a definition, administrators record their responses verbatim. Test administrators then compare examinee answers to a sample of responses provided in the administration manual and score them on a scale of zero to two points. In general, a two-point answer shows good understanding, a one point answer is deemed correct but lacks content, and a zero point answer shows no real understanding.

The Matrix Reasoning subtest is an untimed measure of nonverbal perceptual reasoning. It allows the examiner to assess an individual's ability to perceive and organize patterns and relationships between familiar objects (e.g., animals, clothing, food) and abstract visual stimuli (e.g., simple and complex geometric figures). It is also a measure of nonverbal reasoning, concentration, attention to detail, part to whole reasoning, and problem solving skills. Test administrators ask examinees to look at all aspects of an incomplete matrix or series of objects, identify the pattern(s) of relationships among the objects (e.g., pattern completion, classification, analogies, and serial reasoning), and apply that pattern by selecting the missing object from a list at the bottom of the page that contains four additional distractor items. The WASI Matrix Reasoning subtest is made up of 35 items; the WAIS-IV MR is made up of 26 items and only uses two types of items to maximize effective and efficient teaching
opportunities. Examiners follow explicit instructions that increase the chance that examinees will learn the problem solving strategies that lead to successful performance. The WISC-IV MR subtest is made up of 35 items. Four types of items were designed to provide a reliable measure of visual information processing and abstract reasoning skills. Examinees receive a raw score of zero for a correct answer and one for a correct answer.

WASI subtest raw scores are summed and converted to T-Scores ($M=50; S.D. =10$). T-Scores are summed by cognitive domain (i.e., verbal ability, nonverbal ability) and converted to standardized scores ($M=100, S.D. =15$) and percentile ranks to estimate FSIQ-2. WAIS-IV and WISC-IV subtest scores are summed and converted to scaled scores ($M=10; S.D. =3$). Scaled scores are then summed by cognitive domain (e.g., verbal ability, nonverbal ability) and converted to standard scores ($M=100, SD=15$) and percentile ranks for comparison using Strauss et al.’s (2006) conversion chart.

The WASI was independently normed on a nationally representative sample ($N=2245$), divided into 23 age groups with 75-100 persons per group, and stratified according to U.S. Census data on race/ethnicity, gender, and educational level (Strauss et al., 2006). All four subtests were selected from the pool of other Wechsler subtests because of research showing excellent reliability and correlation with overall FSIQ, verbal, and nonverbal domains of cognitive function (Wechsler, 1999). Keith, Powell, and Powell (in press) reported that WASI subtest items are new and distinct from previous versions. Split half reliability coefficients for FSIQ-2 (.93), Vocabulary (.86 to .93), and Matrix Reasoning (.86 to .96) were excellent for children ages 6-16 years old. Split half reliability coefficients for FSIQ-2 (.96), Vocabulary (.90-.98), and Matrix Reasoning (.88 to .96) were also excellent for and adult’s ages 17-89 years
old. Test-retest reliability coefficients for both children (.85) and adults (.88), tested at intervals of 2 to 12 weeks ($M = 31$ days), were also excellent (Strauss et al., 2006).

However, the WISC-III does not have a Matrix Reasoning subtest, research establishing the convergent validity between the WISC-III and WASI showed a statistically significant correlation between the Vocabulary subtests (.71) and FSIQ-2 (.81). Research establishing convergent validity between WAIS-III and WASI showed a significant correlation between the Vocabulary (.88) subtests, Matrix reasoning (.66) subtests, and FSIQ-2 (.87). Taken together the research indicates that the subtests and IQ scales of the WASI, WISC-III, and WAIS-III measure similar constructs (Wechsler, 1999). Research on the interchangeability of the subtests (i.e., for the assessment of change over time or serial assessment) suggests that a relatively brief, reliable, and valid assessment of FSIQ, verbal ability, and nonverbal ability can be obtained by substituting WASI subtest scores for corresponding subtests from either the WISC-III or WAIS-III (Goldstein, Beers, & Hersen, 2004).

Research establishing criterion related validity between the WISC-IV (which does include a Matrix Reasoning subtest) and the WASI showed a significant correlation between the Vocabulary (.79), Matrix Reasoning (.71) subtests, and FSIQ-2 (.83) (Wechsler, 2003). While concurrent validity studies were not conducted between the WASI and the WAIS-IV, research establishing criterion related validity between the WISC-IV and the WAIS-IV showed significant correlations between the Vocabulary (.82), Matrix Reasoning (.62) subtests, and FSIQ (.91) (Wechsler et al., 2008). These correlations are consistent with those found between the Vocabulary (.83), Matrix Reasoning (.59) subtests, and FSIQ (.89) of the WAIS-III and WISC-IV (Wechsler, 2003) as well correlation between the Vocabulary (.87), Matrix Reasoning (.71), and FSIQ (.94) of the WAIS-III and the WAIS-IV (Wechsler et al., 2008). Taken together the
research suggests that it is reasonable to expect that the WAIS-IV and the WASI measure similar constructs based on the research establishing the criterion related validity between earlier versions of the subtests.

**Academic achievement.**

The Wechsler Individual Achievement Test-Second Edition Abbreviated (WIAT-II-A) is a brief, individually administered achievement test that measures targeted academic skills in basic reading, math calculation, and written spelling. It is comprised of three subtests (i.e., Word Reading, Spelling, Numerical Operations) taken directly from the WIAT-II and generates a Total Achievement composite score (TA) that represents an individual's achievement of specific academic skills, which contribute their overall academic success. The Word Reading subtest is a standard measure of verbal ability. It assesses an individual's early literacy skills (e.g., letter identification, phonological awareness, letter sound awareness, word recognition and decoding) and ability to read single-words aloud, accurately and automatically. It contains 131 items that cover letter naming and matching, sound/phoneme discrimination and blending, sound-letter correspondence, and oral word reading.

The Spelling subtest is another standard measure of verbal ability that assesses an individual's capacity to listen to and write down a list of words dictated by the examiner. It contains 53 items that include name writing, letter and phoneme writing, and word dictation. The Numerical Operations subtest is a measure of nonverbal, quantitative reasoning and calculation, ability that requires individuals to solve written math calculation problems. It contains 54 items that include number identification, matching, and writing, counting pennies, and simple to complex computational math problems and geometry. Subtest raw scores are sums of correct responses, which are then converted to age-equivalent standard scores ($M=100$, $SD=15$).
SD=15) and percentile ranks. TA is the sum of subtest standard scores (M=100, SD=15), which is then converted into an age-equivalent standard score and percentile ranks. CCRT program administrators used the WIAT-II-A to provide a measure of overall achievement of specific academic skills at T1.

Each subtest reflects a thorough sampling of its relevant academic domain and the technical data show good reliability and sound validity for administration to individuals ages 6-85 (Johnson & Smith, 2003). Research establishing convergent validity between the WASI and the Wechsler Individual Achievement Test (Wechsler, 1992) showed moderate correlations between WASI FSIQ-2 and the Basic Reading (.61), Spelling (.64), and Numerical Operations (.60) subtests of the WIAT, which were predecessors of subtests that comprise the WIAT-II. Research establishing convergent validity between the WAIS-IV and the WIAT-II showed excellent correlation between FSIQ and the TA (.88), a low correlation between Matrix Reasoning and Numerical Operations (.48), and moderate correlations between Vocabulary and Word Reading (.63), Vocabulary and Spelling (.58), and FSIQ and Numerical Operations (.78), Word Reading (.65), and Spelling (.59) (Wechsler et al., 2008). Research establishing convergent validity between the WISC-IV and the WIAT-II show excellent correlation between FSIQ and the TA (.87) and moderate correlation between Matrix Reasoning and Numerical Operations (.53), Vocabulary and Word Reading (.69), Vocabulary and Spelling (.61), and FSIQ and Numerical Operations (.69), Word Reading (.74), and Spelling (.73). Taken together the research indicates that the subtests and IQ scales of the WASI, WISC-IV, and WAIS-IV related differentially to specific domains of achievement (Wechsler et al., 2008; Wechsler, 2003).

Verbal ability.
In addition to the Vocabulary, Word Reading, and Spelling subtests, the CCRT assessment battery also included another measure of verbal ability, the Boston Naming Test-second edition (BNT-2). It can be used to measure other aspects of verbal cognitive function (i.e., visual naming ability) in individuals ages 5-13 and 18 years and older. Items include 60 black and white drawings of objects that represent vocabulary words ranging from simple, high frequency words (e.g., *comb*) to rare words (e.g., *abacus*). The BNT-2 can be administered in 10-20 minutes. CCRT program administrators used the BNT-2 to provide a measure of verbal ability at T1 and T2. Examinees begin with item 30 (*harmonica*) and receive credit for every item named correctly within 20 seconds. If the examinee is not able to identify any of the first eight items administered correctly, then the examiner administers items backward, beginning at item 29, until eight of the preceding items are identified correctly, without stimulus or phonemic cues. Once eight items are consecutively identified, the examiner resumes the forward administration of items until the examinee reaches the discontinue criteria (i.e., eight consecutive incorrect answers). If an examinee misperceives the picture, the examiner provides a stimulus clue, which is bracket on the record form next to the item. A phonetic cue, the underlined portion of the item on the record form, is given after every incorrectly identified item. Correct responses provided after a phonemic clue are not included in the total score. The raw score is the sum of the number of correct responses given without any cues plus the number of correct responses given after stimulus cue. Raw score total were converted to standard scores \((M=100; SD=15)\) using normative data for 18-39 year olds provided by Spreen and Strauss (1991) as cited by Strauss et al. (2006).

Strauss et al. (2006) report that research with adults suggest that BNT-2 60 item form has excellent internal consistency (coefficient alpha between .78 and .96) and test-retest reliability.
over one to two week intervals (.91). Reliability data are not available for children (ages 5-17). Available validity data for adult samples show excellent correlation with the Visual Naming Test of the Multilingual Aphasia ($r = .76$ to $.86$) and a moderate correlation with verbal comprehension index of the WAIS-R, a predecessor of the WAIS-III (.61). In children, BNT-2 scores were moderately correlated with general intelligence ($r = .62$) as measured by the Standard Raven Progressive Matrices. Though reliability and validity data are not available for the most recent Wechsler IQ and academic achievement instruments, Strauss et al. report research suggesting that verbal ability, full scale IQ, and academic achievement are correlated with BNT-2 performance. However, Strauss et al. also recommend taking an individual's premorbid cognitive ability, verbal ability, and level of education into consideration when interpreting BNT-2 scores because most research available relied on a sample of highly educated ($M=13.79$ years, $SD=1.5$) adults (20-85 years old), with above average IQ’s ($M=116$, $SD=2.6$). This suggests that the test does not discriminate well at levels of performance that are average and higher, and individuals with limited vocabularies score below the mean. They also argue that since this instrument relies on pictures, visual-perceptual integrity should be taking into consideration during interpretation of results.

**Nonverbal ability.**

In addition to the Matrix Reasoning and Numerical Operations subtests, the ROCF is an instrument that can be used to measure other aspects of nonverbal cognitive function (e.g., visual perception and constructional ability), aspects of executive function (e.g., planning, organization, problem-solving), and visual memory (Cohen & Roman, 2001). There are multiple versions of the ROCF. Overall, the research that suggests alternate/parallel forms of the ROCF, the Rey figure (form A) and the Taylor figure (form B) are moderately correlated (Strauss et al., 2006)
and found to have acceptable validity in comparison to one another (Awad et al., 2004). CCRT program administrators used ROCF-forms A and B to provide a measure of visual spatial constructional skills and visual memory ability at time 1 and 2 to determine if there had been any change in cognitive functioning during treatment and reduce potential practice effects. Program records also indicate that the administration of the ROCF relied on an administration and scoring system described by Strauss et al. (2006).

The ROCF-copy condition is measure of complex visual-spatial perception and processing, constructional ability, and aspects of executive function (e.g., planning, organization). Research also suggests that the ROCF-copy condition has moderate internal consistency (split-half and alpha coefficients > .60), excellent inter/intra-scorer reliability total scores (> .80), and poor (.14) to excellent (.96) inter/intra-scorer reliability for the individual items. Correlation analysis indicates that scores on the ROCF-copy condition is moderately correlated with performance on visual-spatial subtests and composites of nonverbal ability on earlier editions of the Wechsler instruments tests. The ROCF-delayed recall condition can be used to measure visual spatial memory. After up to 30 minutes of interfering (non-constructional) activity, the examiner gives the examinee a blank piece of paper and asks them to draw the previously copied figure from memory. Research suggests that the ROCF-delayed recall condition has excellent internal consistency (split-half and alpha coefficients > .80), test-retest reliability (.89), and inter/intra scorer reliability (> .80), but ranged from poor (.14) to excellent (.96) for the 18 individual items. Correlation analysis indicates that scores on the ROCF-delay recall condition is moderately correlated with performance on visual-spatial subtests, composites of nonverbal ability on earlier editions of the Wechsler instruments tests, and Wechsler Memory Scales. Poor correlations were noted between ROCF-copy condition raw
scores and ROCF-delayed recall (.38) scores, which suggest a weaker relationship between the ability to copy the figure and the ability to draw the figure from memory (Strauss et al., 2006).

During both conditions, the examiner provides an examinee with a blank piece of paper, gives them the figure, and instructs them to copy the figure as accurately as possible. The examiner then scores 18 aspects of the ROCF on a scale of 0-2 for accuracy and placement. An item that is missing or not recognizable receives is scored zero. An item that is distorted or incomplete, but recognizable and inaccurately placed is scored half a point. An item that is either distorted or incomplete, but accurately placed or correctly drawn, but inaccurately placed is scored one point. An item that is correctly drawn and accurately placed is scored two points (Strauss et al., 2006). Given the lack of normative data available for individuals aged 14-18, raw scores for each of the 18 aspects are summed and total raw scores are converted to standard scores \((M=100; SD=15)\) using normative data for 20-29 year olds established by Spreen and Strauss (1991) and provided by Strauss et al., (2006). Program records also indicate that the amount of time that is allowed to lapse between ROCF-copy and ROCF-delayed recall conditions varied from 10 to 15 minutes, which does not affect overall recall performance (Strauss et al., 2006).

Memory.

In addition to the ROCF-recall condition, the Digit Span subtest of the Wechsler instruments can be used to measure aspects of short-term, auditory memory for unrelated strings of numbers, and the executive function skills (e.g., concentration, mental manipulation and sequencing skills) used to support memory function. Digit Span is one of two subtests that comprise the Working Memory Index of the WAIS-III, WAIS-IV, and WISC-IV (Sattler, 2001). CCRT program administrators used the Digit Span subtest from the WAIS-III at T1 and
the Digit Span subtest from either the WAIS-IV or WISC-IV (depending on the participant's age) as alternate, parallel forms at T2.

The Digit Span subtest from the WAIS-III and WISC-IV have two conditions (digits forward and digits backward) and Digit Span from the WAIS-IV has three conditions (digits forward, digits backward, and sequencing). Digits forward requires examinees to listen to the examiner read a list of numbers ranging from two to nine digits, and then repeat it back. The forward condition assesses rote learning, sequence processing, and short-term memory for simple strings of unrelated numbers. Digits backward requires examinees to listen to the examiner read a list of numbers two to eight digits long and repeat it back in reverse order. It assess a more complex combination of memory and organizational aspects of executive function ability, because participants must hold a mental image of the digit string in mind as they reverse the numbers prior to re-stating them. The sequencing condition requires examinees to listen to the examiner read a list of numbers two to eight digits long and repeat it back in numerical order. The sequencing condition also assess a more complex combination of memory and executive function, but it also taps into an examinees fundamental number sequencing skills. In each condition, participants can earn zero or one point for each item answered correctly. Raw score totals for each condition are added and converted to an overall scaled score ($M=10$, $SD=3$). Raw score totals for each condition of the WAIS-IV and the WISC-IV can also be converted to scaled scores. Overall Digit Span scaled scores and individual condition scaled scores are then and converted to standard scores ($M=100$, $SD=15$) and percentile ranks.

Research shows that the WISC-IV (.92), WAIS-III (.90), and WAIS-IV (.93) Digit Span subtests have excellent overall internal consistency. Validation studies show moderate correlation between WAIS-III and WISC-IV Digit Span (.73) and the WAIS-III and the WAIS-
IV Digit Span (.75). Taken together the research suggests that the subtest from all three instruments are reliable and valid measures of the similar constructs (Wechsler et al., 2008; Wechsler, 2003). While the WAIS-III Digit Span subtest does not have normative data that allows for raw score to scaled score conversions, its internal consistency and convergent validity allow for the conversion of each conditions raw score to a scaled score using the age based norms from either the WAIS-IV or the WISC-IV to compare assessment of cognitive function at T1 and T2.

*Executive function.*

Executive functions are the cognitive processes that regulate how an individual problem solves, executes tasks, manages their own behavior, and attends to their own progress. In addition to the ROCF-copy/recall conditions and Digit Span backward/sequencing conditions, the D-KEFS Trail Making Tests 1-5 can be used to assess executive function ability (e.g., problem solving, planning, flexibility of thinking, abstract thinking, creativity, attention, inhibition, impulse control, concept formation and organization). The Trail Making Tests are one of nine tasks that make up the D-KEFS. Each tasks was developed to be stand-alone assessment of different aspects of executive functioning in individuals aged 8 to 89 years old (Delis et al., 2001). The current study used the five Trail Making Tests to measure four fundamental executive function skills (i.e., visual scanning, number sequencing, letter sequencing, and motor speed) and a higher order executive function skill (e.g., cognitive flexibility or set shifting skills) that they support. CCRT program administrators used the D-KEFS Trail Making Tests (conditions one through five) to determine if there had been any change in fundamental and higher-level executive function skills T1 to T2.
Condition one is a visual scanning and cancellation task in which the examinee has to look over a sheet of paper filled with letter and numbers and mark the number three\(^{(3)}\). Condition 2 is a number-sequence task, in which the examinee has to visually scan two pages of numbers and letters and connect the numbers on the page in ascending order. Condition 3 is a letter-sequence task, in which the examinee has to visually scan two pages of numbers and letters and connect the letters in alphabetical order. Condition 4 is a number-letter switching task, in which the examinee has to visually scan two pages of numbers and letters and connect both in order, alternating between numbers and letters. Condition 5 is a motor speed task, in which the examinee has to trace over a dotted line that connects dots as quickly as possible\(^{(Delis et al., 2001)}\).

Each task's completion-time is the raw score, which is converted to age-based scaled scores\((M=10; SD=3)\). Scaled scores are then be converted to standardized scores\((M=100; SD=15)\) and percentile ranks. Contrast scores can be used to determine an examinee's area(s) of relative weakness by comparing their performance of higher order executive function skills to that of fundamental skills. In addition to completion-time percentile ranks, completion accuracy percentage scores for each condition can also help determine the degree to which an individual's performance on the higher-level switching task (condition four) may be related to their performance of one or more underlying fundamental skills. Equation 2 was used to calculate completion accuracy percentage scores.

\[
\frac{[\text{total # of targets} - \# \text{ of targets a line passes by}]}{\text{total # of targets}}. \tag{2}
\]

According to Strauss et al.\((2006)\) reliability studies reported Delis et al.\((2001)\) show internal consistency correlations that range from moderate\((<.59)\) on conditions 1-4, to excellent\((.70-.79)\)
on the combined number and letter sequencing composite. Research also show excellent (.70-.79) test-retest reliability on all condition 5.

**Measures of psychosocial function.**

Psychosocial data available for analysis and interpretation can be divided across two phases of the CCRT program: baseline and treatment. Three instruments were used to monitor psychosocial function in the supported education classroom during each phase. There were 21 days during the course of the program for which no data were available. Direct care staff used an observation form and time sampling procedure created by CCRT administrators to record systematic, direct observations of frequency and type of academic engagement for each participant. Teachers used the IOWA-IO to assess the level of inattentive/overactive behaviors displayed by students during class. Teachers also used the daily attendance and classroom participation form. Instrument descriptions, psychometric properties, and data analysis plans are presented and discussed in the following sections.

**Attendance and participation.**

SED program procedures required teachers to document each student’s daily general classroom behavior using an attendance and participation form. The CCRT’s program administrators used attendance and participation records during the recruitment phase to determine if a student met the program's criteria for attendance and behavioral stability. Once students agreed to participate in the program their attendance and participation forms were used as a measure SED attendance and participation during baseline and treatment phases of the study. To determine a participant's attendance they were counted as present for the day if they attended at least one (of six) available classes. Absences were classified as unexcused if a participant refused to attend a class or was not permitted in class because they were
Absences were classified as excused if students had permission to miss class because of reasons related to mental health, weather, or appointments (e.g., medical, psychiatric, family). Based on the subjective evaluation of behavior, teachers awarded students zero to three participation points and provided corresponding written comments for each class attended. Students could earn up to 18 points daily and zero points for absences (excused or unexcused). Mean weekly student attendance, unexcused absences, and participation were calculated using the Equations 3-5:

$$\% \text{ attendance} = \left( \frac{\# \text{ classes attended}}{\# \text{ classes offered} - \# \text{ unexcused classes}} \right) \times 100.$$  
(3)

$$\% \text{ unexcused absences} = \left( \frac{\# \text{ classes offered weekly}}{\# \text{ unexcused classes}} \right) \times 100.$$  
(4)

$$\% \text{ participation} = \left( \frac{\# \text{ of points}}{\# \text{ classes attended}} \right) + \left( \frac{\# \text{ unexcused absences} \times 3}{\# \text{ classes attended}} \right) \times 100.$$  
(5)

Mean scores and standard deviations in all three variables (student attendance, unexcused absences, and classroom participation percentages) were analyzed for trends and performance variability during baseline and treatment phases. A simple regression analysis and standard deviation calculations were performed with Microsoft excel software. The current study also required a minimum of three data points to establish a trend.

**Academic engagement.**

The observation form direct care staff used to record academic engagement (see Appendix B) operationalizes it by distinguishing between behaviors that are actively (AET) or passively (PET) on task or off task during instructional activities (Junod, DuPaul, Jitendra, Volpe, & Cleary, 2006). On-task behaviors were defined as verbal or motor behaviors within classroom rules and appropriate to the activity. Active on task behaviors were defined as writing, reading aloud, or talking to a teacher or peer about topics appropriate to the task. Passive on task behaviors were defined as listening to a lecture, looking at a worksheet, or
reading silently. Off-task behaviors were defined as motor, verbal, and passive behaviors that were not appropriate to the classroom activity. Off-task motor behaviors were defined as any type of motor activity that strays from or interfered with attention to or completion of the academic task. Off-task verbal behaviors were defined as any audible verbalizations that are not permitted and/or not related to the classroom activity (e.g., humming, talking to peers about topics appropriate to the tasks). Off-task passive behaviors were defined as passive inattention (e.g., spacing out) or engagement in classroom activities, for a period of at least three consecutive seconds. Frequency of participant academic engagement was calculated using Equation 6:

\[
\% \text{ on-task} = \left(\frac{\# \text{ off-task observations}}{\text{total observations}}\right) \times 100.
\]

(6)

Mean scores and standard deviation of academic engagement were analyzed for trends and performance variability during baseline and treatment phases. A simple regression analysis and standard deviation calculations were performed with Microsoft excel software. The current study also required a minimum of three data points to establish a trend.

A program administrator made simultaneous observations with all eight direct care staff over the course of the pilot program. Inter-observer agreement data suggest that agreement was established between the principal investigator and the direct care staff, but were insufficient to determine if it had been maintained. Data were also insufficient to determine if inter-observer agreement had been established or maintained amongst direct care staff. Table 3.1 presents available inter-observer agreement data available by unique numerical, staff identifiers (i.e, 1-8) and program phase (i.e., baseline, treatment), and percentage of agreement.
Table 3.1

available inter-observer agreement data by staff identifier, program phase, and agreement percentage

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<th>Agreement %</th>
<th># Treatment obs</th>
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<td>100</td>
<td>1</td>
</tr>
</tbody>
</table>

Inattentive/overactive behavior.

The IOWA-IO (IO) is a five-item subscale of the IOWA-Connors Teacher Rating Scale used to assess the level of inattentive/overactive behaviors demonstrated by students in class. It measures the level of fidgeting, verbalizations, excitability/impulsiveness, inattention/distractibility, and task completion. Reid, Casat, Norton, Anastopoulos, and Temple (2001) reported that the IO has excellent internal (.87) and test-retest reliability (.87). At the end of every class teachers were asked to rate each item on a scale of zero (i.e., no behaviors indicated) to three (i.e., behaviors disrupted participant psychosocial function and classroom environment). Raw score totals for each of the five items were summed. Higher scores indicated lower levels of psychosocial function (i.e., more inattentive/hyperactive behaviors). A minimum of three data points was required to establish a trend. No norms were available for
individuals aged 13-18 participant inattention/over activity percentage scores were calculated using the Equation 7:

\[ \% \text{ IO behaviors} = \left( \frac{\text{raw score}}{15} \right) \times 100. \]  

(7)

Available data.

According to Weiss (1998) any process or outcomes (i.e., expected or unexpected) data collected during a program’s implementation can be used to inform administrators about procedural adjustments that could improve the program's overall efficiency and effectiveness. To that end, current study will analyze available process and outcomes data to determine if adolescent CCRT is a cost-efficient psychiatric rehabilitation program worthy of replication, and further study, with a larger sample from the same population. Records indicate that the studies 27-week duration was long enough for four of the eight students recruited to generate baseline and treatment data sufficient for analysis and interpretation. Program records indicate that neurocognitive assessment data were originally reported in various psychometric forms (e.g., T-scores, scaled scores, standard scores, percentiles, and raw scores). All available forms of quantitative and qualitative data were analyzed and interpreted in order to develop each participants overall cognitive profile. In order to determine whether the difference in assessed cognitive function at T1 and T2 could be attributed to more than chance, all neurocognitive assessment data were converted into standard scores (\( M=100, SD=15 \)) and percentile ranks (\( M=50^{th} \text{ percentile}, SD 34 \)) using instrument specific normative data closest to each participant's age demographic, a conversion chart from Strauss et al. (2006), and Equation 8:

\[ \text{Standard score} = \left( \frac{\text{raw score} - M}{\text{standard deviation}} \right) \times 15 + 100. \]  

(8)

Program records contain sufficient cognitive data to develop a cognitive profile on all four participants, however only enough data on two participants to analysis change in cognitive
function from T1 to T2. Program records contain sufficient psychosocial data on all four
participants to analysis change in function from baseline to treatment. Tables 3.2-3.3 summarize
data available for each participant. Table 3.2 summarizes data available on each participant's
exposure to CCRT (weeks) and dose of CCRT (total # of modules/total # hours in which the
modules were administered). Table 3.3 summarizes psychosocial data available for each
participant by phase (baseline, treatment) and variable.

Table 3.2
Exposure to treatment and assessment of cognitive function (Time 1 and 2) over time

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>E</th>
<th>H</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>1.5 weeks</td>
<td>5 weeks</td>
<td>9 weeks</td>
<td>3.5 weeks</td>
</tr>
<tr>
<td>#2</td>
<td>1.5 weeks</td>
<td>4 weeks</td>
<td>4 weeks</td>
<td>NA</td>
</tr>
<tr>
<td>Dose #1</td>
<td>13 modules/7 hours</td>
<td>13 modules/9 hours</td>
<td>13 modules/10 hours</td>
<td>6 modules/3 hours</td>
</tr>
<tr>
<td>Dose strength</td>
<td>1.9 modules/hour</td>
<td>1.4 modules/hour</td>
<td>1.3 modules/hour</td>
<td>2 modules/hour</td>
</tr>
<tr>
<td>Dose #2</td>
<td>9 modules/3 hours</td>
<td>11 modules/9 hours</td>
<td>9 modules/6 hours</td>
<td>NA</td>
</tr>
<tr>
<td>Dose strength</td>
<td>3 modules/hour</td>
<td>1.2 modules/hour</td>
<td>1.5 modules/hour</td>
<td>NA</td>
</tr>
<tr>
<td>Total exposure</td>
<td>3 weeks</td>
<td>9 weeks</td>
<td>13 weeks</td>
<td>3.5 weeks</td>
</tr>
<tr>
<td>Total dose</td>
<td>22 modules/10 hours</td>
<td>24 modules/18 hours</td>
<td>22 modules/16 hours</td>
<td>6 modules/3 hours</td>
</tr>
<tr>
<td>Total strength</td>
<td>2.2 modules/hour</td>
<td>1.4 modules/hour</td>
<td>1.4 modules/hour</td>
<td>2 modules/hour</td>
</tr>
</tbody>
</table>

Table 3.3
Number of data points for each psychosocial function variable by participant and phase

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>E</th>
<th>H</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>8 weeks</td>
<td>4 weeks</td>
<td>16 weeks</td>
<td>13 weeks</td>
</tr>
<tr>
<td>Treatment</td>
<td>34 (1)</td>
<td>3 (2)</td>
<td>50 (2)</td>
<td>27 (1)</td>
</tr>
<tr>
<td>Academic Engagement</td>
<td>34 (3)</td>
<td>11 (9)</td>
<td>26 (8)</td>
<td>6 (1)</td>
</tr>
<tr>
<td>Baseline</td>
<td>21 weeks</td>
<td>5 weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>60 (1)</td>
<td>13 (1)</td>
<td>99 (2)</td>
<td>41 (3)</td>
</tr>
<tr>
<td>Modified Iowa</td>
<td>88 (2)</td>
<td>38 (3)</td>
<td>89 (7)</td>
<td>32</td>
</tr>
<tr>
<td>Baseline</td>
<td>216 (1)</td>
<td>66 (1)</td>
<td>396 (2)</td>
<td>168 (6)</td>
</tr>
<tr>
<td>Treatment</td>
<td>276 (2)</td>
<td>228 (7)</td>
<td>507 (3)</td>
<td>18 (5)</td>
</tr>
</tbody>
</table>

Note: Missing data = (total # of weeks for which there are no data)
This chapter provides a summary of the sample, methods, instruments, procedures, and data available for analysis in this study. The next chapter presents the results and goes into detail regarding the results of the analysis.
Chapter 4
Results

This chapter describes the changes in the cognitive and psychosocial functioning of four participants enrolled in the 27-week pilot CCRT program. The analyses and interpretations are based on the four participants for whom sufficient data were available. Data were coded using unique participant identification letters (A, E, H, J), and electronically stored in Microsoft excel. No additions or subtractions could be made to the data set once the Commonwealth or Massachusetts Central Office Research Review Committee (COCCR) and Northeastern University’s Office of Human Subject Research Protection (HSRC) released it for analysis following IRB approval.

Lezak (2004) and Strauss et al. (2006) suggest a conservative approach to the analysis and interpretation of neurocognitive assessment. Their standard interprets a difference of one to two standard deviations as a trend, a difference of two or more standard deviations as a significant change, and scores falling one standard deviation below the mean as a potential area of relative cognitive weakness. A minimum of three data points was required to establish a trend in psychosocial function data. The question of whether cognitive function improved will be addressed by presenting a cognitive profile for each participant and graphing comparisons of converted assessment score percentile ranks ($M=50^{th}$ percentile, $SD=34$) at T1 and T2. The question of whether a participant’s baseline psychosocial function improved during CCRT will be addressed by graphing comparisons of mean weekly percentage scores and standard deviations, analyzed for trends and changes in performance variability over the course of each participant's enrollment the CCRT program. A simple regression analysis and standard deviation of mean scores were calculated and graphed using Microsoft excel.
Participant A

Cognitive profile.

General intelligence.

At T1 participant A’s WASI FSIQ-2 performance estimates an overall general intelligence within the average range (39th percentile). A’s Vocabulary (34th percentile) and Matrix Reasoning (47th percentile) subtest scores, which comprise the WASI FSIQ-2, also fell within the average range. Program records indicate that Participant A persevered despite a general awareness of, and frustration with, limitations. Records also indicate that A utilized a variety of learning, memory, and problem solving strategies (e.g., information chunking, verbal mediation when reasoning, contextualization) inconsistently. Given A’s demonstrated sense of purpose, persistence, and engagement at T1 and T2, the available data are considered to be a valid estimation of A’s cognitive functioning.

Academic achievement.

Participant A’s WIAT-II-A Total Achievement composite score (TA) fell within the average range (61st percentile) of overall academic achievement, however the three individual subtest standardized scores that comprise the TA range from average (34th percentile) to high average (79th percentile). This suggests that A’s TA score may not be the single best indication of academic achievement, and subtest scores should be considered separately. For example, participant A’s Word Reading subtest score fell within the average range (70th percentile), but was equivalent to that of someone approximately 12 months younger. This suggests that A’s fundamental reading skills are age delayed compared to same age peers with a comparable FSIQ. A’s Numerical Operations subtest score was at the low end of the average range (34th percentile), equivalent to that of someone approximately 36 months younger. This suggests that
A’s fundamental mathematics skills are age delayed compared to same age peers with a comparable FSIQ. A’s Spelling subtest score was within the high average range (79th percentile), equivalent to someone between 1-24 months older. This indicates that A’s fundamental spelling skills are age-appropriate to age advanced compared to same age peers with a comparable FSIQ. Figure 4.1 shows participants A’s cognitive profile represented by subtest scores at T1.

Figure 4.1: participants A’s cognitive profile by subtest scores at T1

![Participant A cognitive profile](image)

**Change in cognitive function.**

**Verbal ability.**

The Vocabulary subtest measures an individual's retention of acquired general knowledge, ability to retrieve it from storage, expressive vocabulary, and verbal concept formation. Participant A’s performance on the Vocabulary improved from T1 (34th percentile) to T2 (63rd percentile), but was not statistically significant. The Boston Naming Test (BNT-2) is a measure of visual naming ability using black and white drawings of objects that represent increasingly difficult vocabulary words that range from common high frequency items (e.g., *comb*) to rare (e.g., *abacus*). A’s performance on the Boston Naming Test (BNT-2) improved
from T1 (16th percentile) to T2 (23rd percentile), but was not statistically significant. Another indication of improved performance included a decrease in the number of phonetic cues needed at T1 (3) and T2 (1). Figure 4.2 shows the change in Participant A’s verbal scores from T1 to T2.

Figure 4.2: Change in Participant A’s verbal ability scores from T1 to T2.

Non-verbal ability.

The Matrix Reasoning subtest is a measure of an individual's non-verbal reasoning skills. It requires an individual to look at an incomplete matrix or series of objects, identify the pattern(s) (e.g., pattern completion, classification, analogies, and serial reasoning), and apply that pattern by selecting the missing object from a list containing four distractor items. Participant A’s Matrix Reasoning scores improved from T1 (47th percentile) to T2 (63rd percentile), but were not statistically significant. A’s performance on the copy condition of the Rey-Osterrieth Complex Figure Test (ROCF) at T1 (79th percentile) suggests a solid understanding of the figures overall gestalt, though A demonstrated relative difficulty when required to recreate aspects of the figure that required overlap and integration (e.g., intersection lines through a circle
inside a square). A only utilized half of the blank piece of paper provided to copy the figure, which indicates a good sense of visual planning and organization. A’s ROCF-copy score decreased from T1 (79th percentile) to T2 (14th percentile). The change was not statistically significant, but did reflect a negative trend in function (i.e., a change of one to two standard deviations). This suggests a reduced understanding of the figures gestalt, as evidenced by an increase in missing or inaccurately drawn components. Program records also indicate an increase in cognitive fatigue, effort, and a marked decrease in the neatness and precision of A’s handwriting, which makes the T2 construction appear rushed. However, it is also notable that the distribution of the ROCF-copy scores within the standardization sample are overly sensitive to small difference in raw scores at T1 (35/36) and T2 (32/36) given A’s high level of performance at T1 and T2. Figure 4.3 shows the change in Participant A’s non-verbal scores from T1 to T2.

**Figure 4.3: Change in Participant A’s non-verbal scores from T1 to T2.**

<table>
<thead>
<tr>
<th></th>
<th>T1=4 hours CCRT</th>
<th>T2=8 hours of CCRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR</td>
<td>47</td>
<td>63</td>
</tr>
<tr>
<td>Rey-Copy</td>
<td>79</td>
<td>14</td>
</tr>
</tbody>
</table>

Memory.

The delayed recall condition of the ROCF is a measure of visual memory, constructional ability, and aspects of executive function (e.g., planning, organization). Participant A’s ability to
recall the ROCF figure approximately 15 minutes after initially copying it at T1 (82\textsuperscript{nd} percentile) suggests consolidation of the material over time and a solid understanding of its gestalt. A demonstrated relative difficulty when reproducing aspects of the figure requiring overlap and integration (e.g., intersection lines through a circle inside a square). At T2 (37\textsuperscript{th} percentile) A’s ROCF-delayed performance decreased. While the change was not statistically significant, it does suggest a negative trend in function. Multiple details of the reproduction were missing, inaccurately drawn, or inaccurately placed.

The Digit Span subtest measures short-term, auditory memory and sequencing skills for arrays of simple information. A’s WISC-IV Digit Span subtest scores improved from T1 (50\textsuperscript{th} percentile) to T2 (63\textsuperscript{rd} percentile), but the increase was not statistically significant or suggest a positive trend in overall function. On the digits forward condition, A’s ability to accurately recall a string of numbers improved from six digits at T1 (25\textsuperscript{th} percentile) to eight digits at T2 (75\textsuperscript{th} percentile), which suggests a positive trend in function. On the digits backward condition, A’s ability to accurately recall and reorder a string of numbers decreased from five digits at T1 (75\textsuperscript{th} percentile) to four digits (37\textsuperscript{th} percentile) at T2, which suggests a negative trend in function. A could generally recall all the digits read by the examiner successfully, but not always in the correct order. A appeared to have as much difficulty holding digits in memory as reordering them accurately, as the volume of information increased across conditions. Figure 4.4 shows the change in Participant A’s memory scores from T1 to T2 and 4.5 shows the change in A’s memory and organization scores.
Figure 4.4: Change in Participant A’s memory scores from T1 to T2

![Participant A memory scores graph]

<table>
<thead>
<tr>
<th></th>
<th>T1=4 hours CCRT</th>
<th>T2=8 hours CCRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rey-Recall</td>
<td>82</td>
<td>37</td>
</tr>
<tr>
<td>Digit Span</td>
<td>50</td>
<td>63</td>
</tr>
</tbody>
</table>

- Rey-Recall = ROCF-delayed recall condition

Figure 4.5: Change in Participant A’s memory and organization scores from T1 to T2.

![Participant A memory and organization scores graph]

- DSf = Digit Span subtest-forward condition
- DSb = Digit Span subtest-backward condition
- DSs = Digit Span subtest-sequencing condition
Executive function.

D-KEFS Trail Making Test measure fundamental executive function skills (i.e., visual scanning, number and letter sequencing, and motor speed) and a higher order executive function ability (i.e., cognitive flexibility or set shifting) supported by those fundamental skills. It is important to consider completion-time percentile ranks, errors, contrast scores, and completion accuracy percentage scores for each task to determine the degree to which an individual's performance on the higher-level switching task (condition four) may be related to their performance of one or more underlying fundamental skills. It is also informative to compare data available at T1 and T2 to determine if treatment impacted the consistency with which A utilizes executive function skills.

Participant A’s performance on the visual scanning and attention (98th percentile) and motor speed (84th percentile) tasks at T1 suggest that those fundamental cognitive skills are within an age advanced range. A’s score on the number sequencing task (2nd percentile) at T1 suggests that those fundamental skills are significantly age delayed. However, given the age appropriate Numerical Operations subtest score (37th percentile) and age advanced number-letter switching contrast score (98th percentile), it is reasonable to assume that A has good basic numerical knowledge and processing ability. This suggests that the significant decrease in performance from condition one (98th percentile) to condition two (2nd percentile) (i.e., a difference of two or more SD’s) is likely related to the combined impact of shifting task complexity and increasing cognitive demands. Thus, it may well be that overloaded cognitive resources led to a significant decrease in performance on the second condition at T1.

A’s performance improved significantly on conditions three (63rd percentile) and five (84th percentile), and indicated a positive trend in function on condition four (37th percentile),
compared to condition two (2nd percentile). Taken together the data suggest that A’s performance from condition one (visual scanning) to condition two (number sequencing) was temporary and once expectations were established, A was able to perform similar tasks at an age appropriate to age advanced level. For example, A’s performance on condition three (63rd percentile) only required a shift from number sequencing to letter sequencing. A’s decrease in performance on condition four (37th percentile) also suggest difficulty shifting to tasks that are more complex (i.e., drawing a line that alternates between letter and number sequencing). While A’s increase in performance on condition five (84th percentile) suggest relative ease shifting to a task that was less complex (i.e., required visual scanning and connecting the dots).

A’s completion accuracy scores at T1 also decreased across conditions. For example, A had a 100% completion accuracy on conditions 1 through 3, 98% completion accuracy on condition 4 (the most complex task utilizing the most executive skills), and 73% completion accuracy on condition 5 (the least complex task requiring the fewest executive skills). This suggests a potential relationship between A’s completion accuracy scores at T1 and the cumulative amount of cognitive energy required to perform increasingly complex executive function tasks. Figure 4.6 shows the decrease in A’s completion accuracy scores across conditions as they relate to the completion time scores, which trend upwards across conditions.
Participant A’s T2 D-KEFS data indicate a statistically significant decrease in motor speed performance (16th percentile; 73% completion accuracy) and a negative trend in visual scanning and attention performance (63rd percentile; 90% completion accuracy) from T1 (see figure 4.9). Data also indicate a decrease in letter sequencing performance (37th percentile; 81% accuracy rate) and increases in performance on number sequencing (25th percentile; 95% accuracy rate) and number-letter switching tasks (63rd percentile; 95% accuracy rate) at T2, which do not reach statistical significance of trends in function. The negative trend in performance from the visual scanning and attention task (63rd percentile) to the number sequencing (25th percentile) task at T2, was similar to the decrease at T1 though not as significant. Overall, there appears to be a negative trend in task performance and completion accuracy scores across conditions at T2. Figure 4.7 shows A’s T2 D-KEFS completion accuracy and completion-time scores.
When considered together, A’s D-KEFS scores at T1 and T2 suggest an age delayed to age advanced ability to perform fundamental executive function skills (e.g., visual scanning and attention and sequencing), which are impacted by the complexity of a task. The data also suggest an inverse relationship between the number of consecutive tasks A is required to perform and the accuracy with which A completed each task. This suggests that A’s ability to utilize executive skills decreases in relation to the volume of work required. However, the data also suggest A consistently performed age appropriate higher order executive function skills (i.e., cognitive flexibility) at T1 (37th percentile; 98% completion accuracy) and T2 (63rd percentile; 95% completion accuracy). Figure 4.8 shows the increase in A’s number-letter switching scores from T1 to T2. Figure 4.9 shows A’s D-KEF scores across all five conditions at T1 and T2.
Figure 4.8: A’s condition four completion-time and completion accuracy scores at T1 to T2.

<table>
<thead>
<tr>
<th></th>
<th>T1=4 hours CCRT</th>
<th>T2=8 hours of CCRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completion time</td>
<td>37</td>
<td>63</td>
</tr>
<tr>
<td>Completion accuracy</td>
<td>98</td>
<td>95</td>
</tr>
</tbody>
</table>

Figure 4.9: A’s D-KEFS scores on all five conditions at T1 and T2

Summary of change in cognitive function from T1 to T2.

Overall, Table 4.1 gives a summary of A’s change in cognitive function from T1 to T2, after four hours of CCRT.
### Table 4.1

**Summary of A cognitive function at T1 and T2**

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Matrix Reasoning</strong></td>
<td>SS 99</td>
<td>% 47</td>
<td>SS 105</td>
</tr>
<tr>
<td><strong>Vocabulary</strong></td>
<td>94b</td>
<td>34th</td>
<td>105</td>
</tr>
<tr>
<td><strong>BNT-2</strong></td>
<td>85c</td>
<td>16th</td>
<td>89c</td>
</tr>
<tr>
<td><strong>Digit Span</strong></td>
<td>100a</td>
<td>50th</td>
<td>105a</td>
</tr>
<tr>
<td><strong>DS-forward</strong></td>
<td>90d</td>
<td>25th</td>
<td>105d</td>
</tr>
<tr>
<td><strong>DS-backward</strong></td>
<td>110d</td>
<td>75th</td>
<td>95d</td>
</tr>
<tr>
<td><strong>Rey-Recall</strong></td>
<td>114c</td>
<td>82nd</td>
<td>96c</td>
</tr>
<tr>
<td><strong>Rey-Copy</strong></td>
<td>112c</td>
<td>79th</td>
<td>84c</td>
</tr>
<tr>
<td><strong>DKEFS-VS</strong></td>
<td>130</td>
<td>98th</td>
<td>105</td>
</tr>
<tr>
<td><strong>DKEFS-NS</strong></td>
<td>70</td>
<td>2nd</td>
<td>90</td>
</tr>
<tr>
<td><strong>DKEFS-LS</strong></td>
<td>105</td>
<td>63rd</td>
<td>95</td>
</tr>
<tr>
<td><strong>DKEFS-NLS</strong></td>
<td>95</td>
<td>37th</td>
<td>105</td>
</tr>
<tr>
<td><strong>DKEFS-MS</strong></td>
<td>115</td>
<td>84th</td>
<td>85</td>
</tr>
</tbody>
</table>

**Note:** *boldface* types indicates statistically significant change; *boldface* indicates a trend in performance that suggests a change in function.

a. Converted from raw scores to scaled scores ($M=10; SD=3$) to standard scores ($M=100; SD=15$) and percentile ranks ($Mean=50^{th} \text{ percentile}; SD=34$) (Strauss et al., 2006).

b. Converted from age corrected T-scores ($M=50; SD=10$) to standard scores ($M=100; SD=15$) and percentile ranks ($Mean=50^{th} \text{ percentile}; SD=34$) (Strauss et al., 2006).

c. Converted from raw scores to standard scores ($M=100, SD=15$) and percentile ranks $Mean=50^{th} \text{ percentile}; SD=34$ (Strauss et al., 2006).

d. Converted from raw scores to age normed scaled scores ($M=10, SD=3$) to standard scores ($M=100l, SD=15$) and percentile ranks ($Mean=50^{th} \text{ percentile}; SD=34$) (Strauss et al., 2006).

**Change in psychosocial function.**
Psychosocial function data available for Participant A are unequally distributed across the phases of the study rendering systematic analysis difficult. Figure 4.10 shows the number of psychosocial data points available and missing over the course of the study by variable and study phase.

**Figure 4.10 Participant A’s available psychosocial function data by variable and study phase**

![Graph showing Participant A's available psychosocial data](image)

- **Note:** Missing data = (# weeks for which there are no data)
- **a:** one data point for every class offered
- **b:** one data point for every class attended
- **c:** one data point for every observations made
- **d:** one data point for every IOWA form collected

**Attendance and participation.**

Baseline data show A attended an average of 89.9 % (12.8%) of the classes offered weekly. 5.5 % (8.7%) of the classes A missed weekly were unexcused. When in class, A participated an average of 84.2% (17.9%) weekly. Treatment phase data show an average weekly attendance of 100 %. When in class, A participated an average of 98.3 % (2.9 %) weekly. Figures 4.11 to 4.13 show a simple regression analysis of A’s attendance, participation, and unexcused absences overtime performed using Microsoft excel. Improved scores and
reduced variability in scores suggest an increase in the overall stability of psychosocial function in an SED setting over time.

Figure 4.11 mean weekly percent of attendance over time

Figure 4.12 mean weekly percent of participation over time

Note: week’s 5 and 12 are school vacation weeks
Figure 4.13 mean weekly percent of unexcused absences over time

Note: week’s 5 and 12 are school vacation weeks

**Academic engagement.**

Baseline data show an 88.5% (10.4%) mean weekly percent of academic engagement and a 97.6% (1.1%) weekly mean during the treatment phase. A’s academic engagement scores showed a positive trend during the baseline phase and suggest improvement during the treatment phase, but there were insufficient data (i.e., three data points) to establish a trend as there were no academic engagement data the last week A was in enrolled in the study. There was 100% agreement about observations of task engagement during simultaneous observations, however only six of the 37 observations made during the baseline phase were conducted simultaneously and none of the three observations made during the treatment phase were simultaneous, which is insufficient to establish inter-observer agreement. Figure 4.14 shows a simple regression analysis of A’s weekly academic engagement over time performed using Microsoft excel.
Figure 4.14 A’s mean weekly percent of academic engagement over time

![Graph showing mean weekly percent of academic engagement over time.](image)

Note: week’s 5 and 12 are school vacation weeks; data missing at week 11

**Inattentive/overactive behavior.**

Baseline data show a 3.8% (4.4%) mean weekly percent of inattentive and overactive behaviors and a 1.1% (.96%) weekly mean during the treatment phase. Figure 4.15 shows a simple regression analysis of A’s weekly inattentive/overactive behavior ratings over time performed using Microsoft excel. Decreasing scores and reduced variability in scores suggests an increase in the overall stability of psychosocial function over time.
Summary of change in psychosocial function from baseline to treatment.

Analysis of psychosocial data indicate an increase in Participant A’s attendance, classroom participation, and academic engagement frequency over time. Data also indicate a decrease in unexcused absences, teacher rated inattention/over activity, and the standard deviation (SD) of psychosocial scores over time. Taken together the data suggests that A’s psychosocial function in an SED setting improved over the course of the study. However, improved functioning appears to precede the beginning of the treatment phase (i.e., weeks 9-11) and cannot be attributed to treatment. Table 4.2 presents A’s mean weekly psychosocial function scores and their standard deviations at baseline and treatment.
Table 4.2

<table>
<thead>
<tr>
<th></th>
<th>Baseline (8 weeks)</th>
<th>Treatment (4 weeks)</th>
<th>Change over time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Attendance</td>
<td>89.9% (12.8%)</td>
<td>100% (0)</td>
<td>10.1% (-12.8%)</td>
</tr>
<tr>
<td>Participation</td>
<td>84.3% (17.9%)</td>
<td>98.3% (2.9%)</td>
<td>14% (-14.9%)</td>
</tr>
<tr>
<td>Unexcused absences</td>
<td>5.6% (8.7%)</td>
<td>0 (0)</td>
<td>-5.6% (-8.7%)</td>
</tr>
<tr>
<td>Academic engagement</td>
<td>88.5% (10.4%)</td>
<td>97.6% (1.1%)</td>
<td>9.1% (-9.3%)</td>
</tr>
<tr>
<td>Inattention/over activity</td>
<td>3.8% (4.4%)</td>
<td>1.1% (.96%)</td>
<td>-2.6% (-3.4%)</td>
</tr>
</tbody>
</table>

Note: a plus or minus sign denote an increase and decrease respectively

**Participant E.**

**Cognitive profile.**

**General intelligence.**

At T1 participant E’s WASI FSIQ-2 performance estimates an overall general intelligence within the average range (34th percentile). E’s Vocabulary (16th percentile) was one standard deviation below the mean ($M=50^{th}$ percentile, $SD=34$), which indicates that E’s verbal comprehension skills are an area of relative weakness compared to more age appropriate nonverbal, perceptual reasoning skills. Program records indicate that E was engaged with the examiner, likable, and frequently utilized a variety of coping strategies (e.g., counting to ten, breathing, taking “time outs”) with variable success, to manage frustrations related to the content and context of the testing situation. Records also indicate that one of E’s primary triggers was related to cognitive limitations and academic achievement. E seemed knowledgeable of triggers and coping strategies and was generally comfortable talking about them, which suggests E invested a significant amount of time and energy learning to identify and articulate the
relationships between triggers, emotions, thoughts, behaviors, and practicing de-escalation techniques. E frequently used verbal mediation to talk through the coping process, while staying engaged with the task. Given E’s effort, persistence, and engagement despite frequent frustration during both administrations of neurocognitive assessments, the available data are considered a valid estimation of Participant E’s cognitive functioning at T1 and T2. However, the notable discrepancy between the two subtests that comprise the FSIQ-2 indicate that it may not be the most accurate representation of overall cognitive ability.

Academic achievement.

Participant E’s WIAT-II-A TA score fell within the extremely low range (3rd percentile) of overall academic achievement. However, E’s TA score may not be the single best indication of academic achievement. For example, E’s performance on the Word Reading (27th percentile) subtest was within a standard deviation of the mean. However, E’s performance on the Spelling (2nd percentile) and Numerical Operations (<1st percentile) performance were significantly lower than the mean (M=50th percentile, SD=34). Taken together the data suggest that within the verbal domain of cognitive function, E has more developed basic reading skills than spelling ability. This also suggests that E’s basic math skills are an area of academic weakness, despite the age appropriate nonverbal, perceptual reasoning abilities at the higher end of the average range indicated by E’s Matrix Reasoning performance at T1 (62nd percentile). E’s raw scores for all three academic achievement subtests fell within the age-delayed range, which suggests fundamental academic skills that are age delayed compared to same age peers. Figure 4.16 shows participants E’s cognitive profile represented by subtest scores at T1.
Figure 4.16: participants E’s cognitive profile by subtest scores

![Participant E cognitive profile graph](image)

**Change in cognitive function.**

**Verbal ability.**

Participant E’s Vocabulary subtest score fell stayed the same (16th percentile) at T1 and T2. Program records indicate that E was engaged, but bored and often frustrated with limitations. However, records also indicate that E was appropriately funny and utilized coping skills (e.g., breathing) with prompts from the therapeutic coach. For example, at T1 when asked to define the word “police” E exclaimed, “Run! (laughs to self). Helps people.” E’s BNT-2 performance improved from T1 (4th percentile) to T2 (10th percentile), but did not reach statistical significance or reflect a positive trend in function. However, E was able to name more items quickly at T2, which suggests that E’s capacity for verbal memory and learning may have been bolstered by cueing at T2. It is notable that E’s range of BNT-2 scores at T1 and T2 are commensurate with the Vocabulary and Spelling subtests, which measure different aspects of verbal ability. Figure 4.17 shows Participant E’s verbal ability scores at T1 and T2.
Figure 4.17: Change in Participant E’s verbal ability scores from T1 to T2

<table>
<thead>
<tr>
<th></th>
<th>T1=3 hours CCRT</th>
<th>T2=15 hours of CCRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>BNT-2</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

a. BNT-2 = The Boston Naming Test, 2nd edition

**Non-verbal ability.**

Participant E’s performance on the both the Matrix Reasoning (T1=62nd percentile; T2=37th percentile) and the ROCF-copy (T1=14th percentile; T2= >1st percentile) decreased from T1 to T2, but were not statistically significant or reflective of a negative trend in function. Records indicate that E demonstrated relative difficulty reproducing specific details of the ROCF (e.g., specific number of dots or lines), straight and wavy lines, and angles and had difficulty with visual planning and organization at T1 and T2. There was also a decrease in the precision of E’s penmanship from T1 to T2. Records also indicate that E put forth the “best effort” possible, but was “in a bad space” after a poor performance on a previous subtest. This suggests that E’s emotions may affect visual planning (i.e., attention to and processing of details), organization (i.e., reproduction of details), and possibly motor function. Figure 4.18 shows the change in Participant E’s non-verbal abilities from T1 to T2.
Figure 4.18: Change in Participant E’s non-verbal ability scores from T1 to T2

![Graph showing Participant E's non-verbal ability scores]

<table>
<thead>
<tr>
<th></th>
<th>T1=3 hours CCRT</th>
<th>T2=15 hours of CCRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR 62</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Rey-copy 14</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

a. MR= Matrix Reasoning Subtest of the Wechsler instruments

**Memory.**

Participant E’s T1 (81st percentile) performance on the ROCF-delayed recall task, suggest that E’s planning and organization are better when drawing from memory, as evidenced by neater, more precise penmanship. E demonstrated relative difficulty reproducing overlapping or integrated aspects of the figure (e.g., intersecting lines that pass through a circle embedded within a square) similar to the copy condition performance. However, E’s ability to recall the figure after approximately 20 minutes suggests consolidation of the material over time and a solid understanding of the figures gestalt. E’s T2 (87th percentile) performance on the ROCF-delayed recall task (87th percentile) also suggests consolidation of material over time and a better sense of planning and organization when drawing from memory. Taken together, the data suggest that the utilization of coping skills during the ROCF-copy condition may have benefitted E’s ability to consolidate visual information in memory, while enduring a period of emotional turmoil that disrupted function in the moment. Overall, participant E’s ROCF-delayed recall...
performance improved from T1 (81st percentile) to T2 (82nd percentile), but did not reflect a statistically significant change or a positive trend in function.

Participant E’s WAIS-III Digit Span subtest performance improved from T1 (25th percentile) to T2 (50th percentile), but was not statistically significant or indicative of a positive trend in function. On the digits forward condition, E was able to recall a string of numbers up to seven digits long at T1 (37th percentile) and T2 (75th percentile). It is notable that the standard score performance (compared to the raw score performance) reflects a positive trend in function from T1 to T2. This suggest that the WAIS-II and WISC-IV DS subtest, forward condition may not be ideal alternative forms of assessment. On the digits backward condition, E’s ability to recall a string of numbers improved from three digits (2nd percentile) at T1 to five digits (25th percentile) at T2, but was not statistically significant and did not reflect a positive trend in function. Taken together, the data suggest that E had more difficulty organizing the digits than recalling digits as the volume of information increased. Records indicate that E actively utilized strategies to facilitate focus and concentration (e.g., picked an object to concentrate on while listening to the examiner read the strings of digits) during the task. Figure 4.19 shows the change in Participant E’s memory scores and organization scores at T1 and T2.
Figure 4.19: Change in Participant E’s memory scores from T1 to T2

Executive function.

Participant E’s visual scanning and attention task performance decreased from T1 (9\textsuperscript{th} percentile; 100\% completion accuracy) to T2 (2\textsuperscript{nd} percentile; 100\% completion accuracy), though not significantly. E’s motor speed task performance decreased significantly from T1 (63\textsuperscript{rd} percentile) to T2 (16\textsuperscript{th} percentile). Records indicate that during the T2 administration of the motor speed task E, “was upset with (E’s) performance” on condition 4 (i.e., number-letter switching task), and did not utilize coping skills (i.e., declined a break) when prompted by the therapeutic coach. Records also indicate E made “negative comments” and expressed “self-doubt” with regard to overall ability. This suggests that the decrease in E’s motor speed task performance is related to an increase in emotional intensity and a possible decrease in attention to the task. E’s performance on the number sequencing (T1=37\textsuperscript{th} percentile, 100\% completion accuracy; T2=16\textsuperscript{th} percentile, 100\% completion accuracy), letter sequencing (T1=50\textsuperscript{th} percentile, 100\% completion accuracy; T2=37\textsuperscript{th} percentile, 100\% completion accuracy), and number-letter switching tasks (T1=25\textsuperscript{th} percentile, 85\% completion accuracy; T2=5\textsuperscript{th} percentile, 85\% completion accuracy).
completion accuracy) all deceased from T1 to T2, but the changes were not statistically significant and did not reflect a negative trend in function.

When considered together, D-KEFS data at T1 and T2 suggest that E’s fundamental (e.g., visual scanning and attention, letter-number sequencing, drawing a line) and higher level (e.g., multitasking) executive function skills range from age delayed to age appropriate. Data also suggest that E’s visual attention skills are relatively weaker than sequencing skills, motor function, and processing ability; and that simultaneous engagement in multiple simple tasks, perseveration about performance on previous tests, perceived limitations, and an increased emotional state can negatively affect performance of fundamental and higher order executive function tasks. Figure 4.20 and 4.21 show that Participant E’s completion accuracy scores as they relate to the time-completion percentile ranks at T1 and T2. Table 4.3 gives a summary of E’s change in cognitive function from T1 to T2.

Figure 4.20 E’s D-KEFS completion-time percentile ranks and completion accuracy at T1
Figure 4.21 E’s D-KEFS completion-time percentile ranks and completion accuracy at T2
Summary of change in cognitive function from T1 to T2.

Overall, Table 4.3 gives a summary of E’s change in cognitive function from T1 to T2, after four hours of CCRT.

**Table 4.3**

Summary of E’s cognitive function at T1 and T2

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th></th>
<th>T2</th>
<th></th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>%</td>
<td>SS</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Matrix Reasoning</td>
<td>105&lt;sub&gt;b&lt;/sub&gt;</td>
<td>62&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>95&lt;sub&gt;b&lt;/sub&gt;</td>
<td>37&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-25</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>85&lt;sub&gt;b&lt;/sub&gt;</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>85&lt;sub&gt;a&lt;/sub&gt;</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>0</td>
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<tr>
<td>BNT-2</td>
<td>73&lt;sub&gt;c&lt;/sub&gt;</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
<td>81&lt;sub&gt;c&lt;/sub&gt;</td>
<td>10&lt;sup&gt;th&lt;/sup&gt;</td>
<td>+6</td>
</tr>
<tr>
<td>Digit Span</td>
<td>90&lt;sub&gt;a&lt;/sub&gt;</td>
<td>25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>100&lt;sub&gt;a&lt;/sub&gt;</td>
<td>50&lt;sup&gt;th&lt;/sup&gt;</td>
<td>+25</td>
</tr>
<tr>
<td>DS-forward</td>
<td>95&lt;sub&gt;d&lt;/sub&gt;</td>
<td>37&lt;sup&gt;th&lt;/sup&gt;</td>
<td>100&lt;sub&gt;d&lt;/sub&gt;</td>
<td>75&lt;sup&gt;th&lt;/sup&gt;</td>
<td>+38</td>
</tr>
<tr>
<td>DS-backward</td>
<td>70&lt;sub&gt;d&lt;/sub&gt;</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>90&lt;sub&gt;d&lt;/sub&gt;</td>
<td>25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>+23</td>
</tr>
<tr>
<td>Rey-Recall</td>
<td>113&lt;sub&gt;c&lt;/sub&gt;</td>
<td>81&lt;sup&gt;st&lt;/sup&gt;</td>
<td>117&lt;sub&gt;c&lt;/sub&gt;</td>
<td>87&lt;sup&gt;th&lt;/sup&gt;</td>
<td>+6</td>
</tr>
<tr>
<td>Rey-Copy</td>
<td>84&lt;sub&gt;c&lt;/sub&gt;</td>
<td>14&lt;sup&gt;th&lt;/sup&gt;</td>
<td>13</td>
<td>&gt;1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>-13</td>
</tr>
<tr>
<td>DKEFS-VS</td>
<td>80</td>
<td>9&lt;sup&gt;th&lt;/sup&gt;</td>
<td>70</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
<td>-7</td>
</tr>
<tr>
<td>DKEFS-NS</td>
<td>95</td>
<td>37&lt;sup&gt;th&lt;/sup&gt;</td>
<td>85</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-21</td>
</tr>
<tr>
<td>DKEFS-LS</td>
<td>100</td>
<td>50&lt;sup&gt;th&lt;/sup&gt;</td>
<td>95</td>
<td>37&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-13</td>
</tr>
<tr>
<td>DKEFS-NLS</td>
<td>90</td>
<td>25&lt;sup&gt;th&lt;/sup&gt;</td>
<td>65</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>-24</td>
</tr>
<tr>
<td>DKEFS-MS</td>
<td>105</td>
<td>63&lt;sup&gt;rd&lt;/sup&gt;</td>
<td>85</td>
<td>16&lt;sup&gt;th&lt;/sup&gt;</td>
<td>-47</td>
</tr>
</tbody>
</table>

Note: **boldface types** indicates statistically significant change; **boldface** indicates a trend in performance that suggests a change in function.

a. Converted from raw scores to scaled scores ($M=10$; $SD=3$) to standard scores ($M=100$; $SD=15$) and percentile ranks ($Mean=50^{th}$ percentile; $SD=34$) (Strauss et al., 2006).
b. Converted from age corrected T-scores ($M=50$; $SD=10$) to standard scores ($M=100$; $SD=15$) and percentile ranks $Mean=50^{th}$ percentile; $SD=34$ (Strauss et al., 2006).
c. Converted from raw scores to standard scores ($M=100$, $SD=15$) and percentile ranks $Mean=50^{th}$ percentile; $SD=34$ (Strauss et al., 2006).
d. converted from raw scores to age normed scaled scores ($M=10$, $SD=3$) to standard scores ($M=100$, $SD=15$) and percentile ranks $Mean=50^{th}$ percentile; $SD=34$ (Strauss et al., 2006).
Change in psychosocial function.

Psychosocial function data available for Participant E are unequally distributed across the phases of the study rendering systematic analysis difficult. Figure 4.22 shows the number of psychosocial data points available and missing over the course of the study by variable and study phase.

Figure 4.22 Participant E’s available psychosocial function data by variable and study phase

![Participant E's Available Psychosocial data](image)

Note: Missing data= (# week for which there are no data)

- a. one data point for every class offered
- b. one data point for every class attended
- c. one data point for every observation made
- d. one data point for every IOWA form collected

**Attendance and participation.**

Baseline phase data show E attended an average of 76.7% (16.8%) of the classes offered weekly. 22.4% (16.7%) of the classes E missed weekly were excused. When in class, E participated an average of 67.2% (21%) weekly. Treatment phase data show an average weekly attendance of 81.3% (14.3%). 17 % (12.9%) of the classes E missed during the treatment phase were unexcused. When in class E participated an average of 72.9% (18.9%) weekly. Improved scores and reduced variability in scores suggest an increase in the overall stability of E’s
psychosocial function within an SED setting over time. Figures 4.23 to 4.25 show a simple regression analysis of E’s attendance, participation, and unexcused absences overtime performed using Microsoft excel.

Figure 4.23 mean weekly percent of attendance over time

![Mean Weekly Percent of Classes Attended Over Time](image1)

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 23-27

Figure 4.24 mean weekly percent of participation over time

![Mean Weekly Percent of Participation Over Time](image2)

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 23-27
Academic engagement.

A simple regression analysis of E’s academic engagement data during baseline 85.7% (14.6%) and treatment phases, show a slight positive trend over time (Figure 4.25). There was 100% agreement during simultaneous observations, however only six of the 50 observations made during the baseline phase and four of the 27 observations made during the treatment phase were conducted simultaneously, which is insufficient to establish inter-observer agreement. Taken together the data indicate that E’s mean weekly academic engagement score and performance variability scores (SD) improved from baseline to treatment. Figures 4.26 show a simple regression analysis of E’s mean weekly academic engagement over time performed using Microsoft excel.
Inattentive/overactive behavior.

Baseline data show a 12.5% (10.2 %) mean weekly percent of inattentive and overactive behaviors and an 18.7% (7.4 %) weekly mean during the treatment phase. Figure 4.27 shows a simple regression analysis of E’s mean weekly inattentive/overactive behavior ratings over time performed using Microsoft excel. Increased scores and reduced variability suggest a decrease in psychosocial function.
Summary of change in psychosocial function from baseline to treatment.

Analysis of psychosocial data indicate an increase in Participant E’s attendance, classroom participation, and academic engagement frequency over time. Data also indicate a decrease in unexcused absences, teacher rated inattention/over activity, and the standard deviation of psychosocial function scores over time. Taken together the data suggest that E’s classroom psychosocial function improved over the course of the study, however it cannot be attributed to treatment as it appears to precede the beginning of treatment (i.e., weeks 17-27). Table 4.4 presents E’s mean weekly psychosocial function scores and their standard deviations at baseline and treatment.

*Table 4.4*

| Change in average psychosocial function and performance variability over time |
|---|---|---|
| | Baseline (16 weeks) | Treatment (11 weeks) | Change over time |
| Mean (SD) | Mean (SD) | Mean (SD) |
| Attendance | 76.7% (16.8%) | 81.3% (14.3%) | 4.7% (-2.5%) |
| Participation | 67.2% (21%) | 72.9% (18.9%) | 5.7% (-2.1%) |
| Unexcused absences | 22.4% (16.7%) | 17% (12.9%) | -5.4% (-3.7%) |
| Academic engagement | 85.7% (14.6%) | 94% (6.3%) | 8.3% (-8.4%) |
| Inattention/over activity | 12.5% (10.2%) | 18.7% (7.4%) | 6.2% (-2.8%) |

Note: a plus or minus sign denote an increase and decrease respectively

**Participant J.**

**Cognitive profile.**

**General intelligence.**

At T1 participant J’s WASI FSIQ-2 performance estimates an overall intellectual ability within the average range (27th percentile). J’s Vocabulary subtest score (19th percentile) was in one to two standard deviations below the mean ($M=100$, $SD=15$). This indicates that J’s verbal
comprehension skills are an area of relative cognitive vulnerability compared to the age appropriate nonverbal, perceptual reasoning skills measured by the Matrix Reasoning subtest score (47th percentile).

**Academic achievement.**

Participant J’s WIAT-II-A TA score fell within the low average range (19th percentile) TA score, which is generally commensurate with a low average range (19th percentile) FSIQ-2 score. J’s academic achievement subtest scores ranged from age-delayed to age-appropriate. This suggests that J’s academic achievement is potentially more variable than would be predicted based on cognitive ability. For example, J’s Word Reading score (45th percentile) was equivalent to that of someone approximately 36 months younger, which suggests that J’s fundamental reading skills are age delayed compared to same age peers with a comparable FSIQ. J’s Numerical Operations subtest score (6th percentile) was one to two standard deviations below the mean (M=50th, SD=34), which indicates that J’s fundamental mathematics skills are age delayed compared to same age peers with a comparable FSIQ. J’s Spelling subtest score (34th percentile) was equivalent to someone between 12-36 months younger, which suggests age-delayed fundamental spelling skills compared to same age peers with a comparable FSIQ. Figure 4.28 shows participants J’s cognitive profile represented by subtest scores at T1.
Verbal ability.

J’s BNT-2 scores fell within the very low range (4th percentile), which was one to two standard deviations below the mean (M=50th, SD=34), indicating an area of weakness within the verbal domain of cognitive functioning compared to J’s Vocabulary (19th percentile), Word Reading (45th percentile), and Spelling (37th percentile) subtests. Figure 4.29 shows Participant J’s verbal ability scores.
Non-verbal ability.

J’s extremely low ROCF-copy condition score (> 1st percentile) suggests limited understanding of the figures gestalt, and poor visual planning and organization ability. It was one to two standard deviations below the mean \( (M=50th, SD=34) \), indicating an area of weakness within the non-verbal domain of cognitive function compared to the Matrix Reasoning (47th percentile) and Numerical Operations (6th percentile) subtests. Figure 4.30 shows Participant J’s non-verbal ability scores at T1.
Figure 4.30: Participant J’s non-verbal ability scores at T1

- **MR**: Matrix Reasoning
- **NO**: Numerical Operations
- **Rey-C**: ROCF-copy condition

### Memory.

J’s ROCF-delayed recall condition score fell within the average range (37th percentile) at T1, which suggests consolidation of the figures details over time despite a limited understanding of the figures overall gestalt. Records indicate that J seemed to have a better sense of visual planning and organization when drawing the figure from memory. J’s penmanship was also neater and more precise on the delayed recall condition than it was on the copy condition.

J’s WAIS-III Digit Span score fell within the average range (25th percentile). On the digits forward condition, J’s ability to recall a string of numbers up to seven digits long fell within the low average range (16th percentile). On the digits backward condition, J’s ability to recall a string of up to four digits in mind and accurately reorder them also fell within the low average range (16th percentile). Participant J met a clear discontinue point and could not hold onto all the digits in the string of numbers as the volume of information increased over both conditions. Overall, J’s ROCF-copy (37th percentile) and Digit Span (25th percentile) scores
suggest average range function in the memory domain. Figure 4.31 shows Participant J’s memory scores and memory based organization scores at T1.

**Figure 4.31: Participant J’s memory and memory based organization scores at T1**

![Graph showing Participant J's memory and organization scores](image)

- **DSf**: Digits Span subtest, forward condition
- **DSb**: Digits Span subtest, backward condition
- **Rey-Recall**: ROCF-delayed recall condition

**Executive function.**

Participant J’s scores on the visual scanning and attention (75<sup>th</sup> percentile; 100% completion accuracy) and motor speed (75<sup>th</sup> percentile; 95% completion accuracy) tasks suggest that those fundamental cognitive skills are within an age advanced range. J’s number sequencing (37<sup>th</sup> percentile; 95% completion accuracy) and letter sequencing (37<sup>th</sup> percentile; 95% completion accuracy) task scores suggest that those fundamental skills are within an age appropriate range. J’s performance on the number letter switching task (9<sup>th</sup> percentile; 85% completion accuracy) included a set loss error (i.e., did not switch from numbers to letters) with capture stimuli (i.e., pairs of consecutive numbers/letters in close proximity) and a sequencing error (i.e., switched from numbers to the wrong letter). This indicates that J’s set shifting skills
are a cognitive deficit (i.e., a difference of one SD) compared to the letter sequencing and number sequencing skills. J’s set shifting skills are also significantly (i.e., a difference of two or more SD) less developed than the visual scanning and motor skills. Taken together the data suggest that J’s cognitive flexibility is less developed than the fundamental executive function skills that support it. It is also notable that J’s completion accuracy scores indicate a negative trend appears to decrease as the task complexity increases. Figure 4.32 shows J’s completion time scores as they relate to the decrease in J’s completion accuracy scores, which trend downward across conditions.

Figure 4.32: D-KEFS completion-time and completion accuracy scores at T1

Change in psychosocial function.

Psychosocial function data available for Participant J are unequally distributed across the phases of the study rendering systematic analysis difficult. Figure 4.33 shows the number of psychosocial data points available and missing over the course of the study by variable and study phase.
Figure 4.33 Participant J’s available psychosocial function data by variable and study phase

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline</th>
<th>Treatment</th>
<th>Missing</th>
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</thead>
<tbody>
<tr>
<td>Attendance forms</td>
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<td>393</td>
<td>18</td>
</tr>
<tr>
<td>Class participation</td>
<td>18</td>
<td>15</td>
<td>8</td>
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<tr>
<td>Academic Engagement</td>
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<td>6</td>
<td>9</td>
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<td>IOWA forms</td>
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<td>32</td>
<td>7</td>
</tr>
</tbody>
</table>

*Note: Missing data= (# week for which there are no data)*

a: one data point for every class offered  
b: one data point for every class attended  
c: one data point for every observations made  
d: one data point for every IOWA form collected

**Attendance and participation.**

Due to the uneven distribution of available data across the phases of the study, J’s daily classroom participation and attendance scores were analyzed for trends. Baseline phase data show J attended an average of 86.6 % (19.2%) of the classes offered daily. 7.2 % (14.8%) of the classes J missed weekly were unexcused. When in class, J participated an average of 92.1% (16.2%) daily. Treatment phase data show an average weekly attendance of 91.1% (15.4%). 5.6% (9.6%) of the classes J missed were unexcused during the treatment phase. When in class J participated an average of 93.3% (11.5%) daily. Figures 4.34 to 4.36 show simple regression analysis of J’s attendance, participation, and unexcused absences overtime, performed using Microsoft excel. Improved scores and reduced variability in scores suggest an increase in the overall stability of psychosocial function over time.
Figure 4.34 mean daily percent of attendance over time

![Graph showing mean daily percent of classes attended over time.]

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 23-26

Figure 4.35 mean daily percent of participation over time

![Graph showing mean daily percent of participation over time.]

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 23-26
Figure 4.36 mean daily percent of unexcused absences over time

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 23-26

**Academic engagement.**

Baseline data show a 77.4% (22.7%) mean weekly percent of academic engagement and an 85.2% (11.1%) weekly mean during the treatment phase. J’s academic engagement scores showed a positive trend during the baseline and treatment phases. There was 100% agreement during simultaneous observations, however only four of the 26 observations made during the baseline phase and two of the six made during the treatment phase were simultaneous observations, which is insufficient to establish inter-observer agreement. Figure 4.37 shows a simple regression analysis of J’s mean weekly academic engagement over time, performed using Microsoft excel.
Inattentive/overactive behavior.

Baseline data show a 5.8% (5%) mean weekly percent of inattentive and overactive behaviors and a 4.6% (2.9%) weekly mean during the treatment phase. There is an upward trend in scores during J’s baseline phase, which suggest an increase in inattentive and overactive behavior over time. However, J’s treatment phase scores show a downward trend and reduced variability from baseline to treatment (-2.1%), which suggests stable improvement in psychosocial function in an SED setting over time. Figure 4.38 shows simple regression analysis of J’s mean weekly inattentive/overactive behavior ratings over time performed using Microsoft excel.
Figure 4.38 mean weekly percent of inattention/over activity over time

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 13-15, and 19

**Summary of change in psychosocial function from baseline to treatment.**

Analysis of psychosocial data indicate an increase in Participant J’s attendance, participation, and academic engagement over time. Data also indicate a decrease in unexcused absences, inattentive/overactive behaviors, and the standard deviation of psychosocial variable scores over time. Taken together the data suggest that J’s psychosocial function in an SED setting improved over the course of the pilot program. However, it cannot be attributed to treatment, as it appears to precede the beginning of the treatment phase (i.e., week 13-week 27). Table 4.5 presents J’s mean weekly psychosocial function scores and their standard deviations at baseline and treatment.
Table 4.5

*change in average psychosocial function and performance variability over time*

<table>
<thead>
<tr>
<th></th>
<th>Baseline (16 weeks)</th>
<th>Treatment (11 weeks)</th>
<th>Change over time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Attendance</td>
<td>86.6 % (19.2 %)</td>
<td>91.1 % (15.4 %)</td>
<td>4.5 % (-3.8 %)</td>
</tr>
<tr>
<td>Participation</td>
<td>92.1 % (16.2 %)</td>
<td>93.3 % (11.5 %)</td>
<td>1.2 % (-4.7 %)</td>
</tr>
<tr>
<td>Unexcused absences</td>
<td>7.2 % (14.8 %)</td>
<td>5.6 % (9.6 %)</td>
<td>-1.6 % (-5.2 %)</td>
</tr>
<tr>
<td>Academic engagement</td>
<td>77.4 % (22.7 %)</td>
<td>85.2 % (11.1 %)</td>
<td>7.8 % (-11.7 %)</td>
</tr>
<tr>
<td>Inattention/over activity</td>
<td>5.8 % (5 %)</td>
<td>4.6 % (2.9 %)</td>
<td>-1.2 % (-2.1 %)</td>
</tr>
</tbody>
</table>

a. An increase and decrease are denoted by a plus or minus sign respectively
b. daily means and standard deviations
c. scores represent weekly means and standard deviations

Participant H.

*Cognitive profile.*

*General intelligence.*

Participant H refused to provide assessment of neurocognitive assessment data during CCRT program enrollment. However, records indicate that program administrators relied on updated neurocognitive assessment scores to determine that H met the cognitive criteria for CCRT recruitment. Recruitment records indicate that H’s WASI FSIQ-2 estimate an overall general intelligence within the low average range (6th percentile). H scored within the average range (47th percentile) on the Vocabulary subtest and the very low range (4th percentile) on Matrix Reasoning subtests. Program records also indicate that H valued a good performance and exerted good effort, but showed signs of frustration (e.g., defensive comments, refusal to continue, self-deprecating comments). Records also indicate that H responded well to positive encouragement, but given H’s frequent frustration and consistent refusal to complete associated tasks, the available data were considered an underestimate of H’s potential cognitive function.
**Academic achievement.**

Data available pertaining to participant H’s academic achievement included two WIAT-II-A subtests. Participant H scored in the low average range (10\textsuperscript{th} percentile) on the Word Reading subtest and the average range (27\textsuperscript{th}) on the Numerical Operations subtest. Figure 4.39 shows participants H’s cognitive profile represented by composite scores and subtest scores.

Figure 4.39: participants H’s cognitive profile by subtest scores

![Participant H's cognitive profile](image)

a. Voc=Vocabulary  
b. MR=Matrix reasoning  
c. NO=Numerical Operations  
d. WR=Word Reading

**Other available cognitive data.**

In addition to the Matrix Reasoning and Numerical Operations subtests, another measure of nonverbal ability included a ROCF-copy condition score in the extremely low range (<1\textsuperscript{st} percentile). Records indicate that H omitted or distorted many components of the figure and did not have a strong sense of the figures overall gestalt. H drew the figure by combining multiple geometric components in a disorganized manner. Data also included memory and executive function scores. H had a Digit Span-forward condition score in the average range (39\textsuperscript{th})
percentile) and a digit span-backward condition score in the extremely low range (2nd percentile). This suggests that H has relative difficulty holding information in mind while reorganizing it compared to rote, short-term auditory memory for strings of digits up seven numbers long.

Available D-KEFS Trail Making Test scores for conditions 1-5 fell with the extremely low (<1st percentile) to very low (5th percentile) ranges. H’s extremely low range (<1st percentile) score on the visual scanning and attention, motor speed, and letter sequencing tasks suggest that those fundamental executive functioning skills are a relative cognitive weakness compared to same age peers (i.e., more than 1 SD below the mean). H’s very low range (5th percentile) score on the number-sequencing task also appears to be a relative weakness compared to same age peers. H’s extremely low range (>1st percentile) performance on the number-letter switching task suggests higher order set shifting skills and cognitive flexibility are also relative weaknesses compared to same age peers. Records indicate that low scores were due to the amount of time H needed to complete tasks (i.e., motor slowing), sequencing errors on the number letter switching task, difficulty attending to verbal directions (i.e., needed multiple instances of corrective feedback during the sample task), and managing frustrations that arose during task performance. Figure 4.40 represents H’s cognitive profile by subtest scores and domain.

Figure 4.40: participants H’s cognitive profile by subtest scores and domain
Change in psychosocial function.

Psychosocial function data available for Participant H are unequally distributed across the phases of the study rendering systematic analysis difficult. Program records indicate that H was inconsistently engaged with CCRT after beginning the treatment phase (i.e. one to three week gaps). Figure 4.41 shows the number of psychosocial data points available and missing over the course of the study by variable and study phase.

Legend:
- Voc = Vocabulary
- MR = Matrix reasoning
- NO = Numerical Operations
- WR = Word Reading
- DS-f = Digit Span subtest-forward condition
- DS-b = Digit Span subtest-backward condition
- DKEFS-NLS = Number letter sequencing condition.
Attendance and participation.

Baseline data show H attended an average of 94.1% (10.9%) of the classes offered weekly. 5.5% (10.2%) of the classes H missed weekly were unexcused. When in class, H participated an average of 85.5% (16.8%) weekly. Treatment phase data show an average weekly attendance of 54.9% (30.5%). When in class, H participated an average of 42.5% (31.4%) weekly. H showed negative trends in teacher ratings of attendance and classroom participation, positive trends in unexcused absences, and increased variability of scores. Taken together the data suggest a decline in the overall stability of psychosocial function in an SED setting over time. Figures 4.42 to 4.44 show a simple regression analysis of H’s attendance, participation, and unexcused absences over time using Microsoft excel.
Figure 4.42 mean weekly percent of attendance over time

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 13, 23-27

Figure 4.43 mean weekly percent of participation over time

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 13, 23-27
**Academic engagement.**

Baseline data show an 84.8% (6.3%) mean weekly percent of academic engagement and a 93.2% (11.7%) weekly mean during the treatment phase. H’s academic engagement scores showed a negative trend during the baseline phase and a positive trend during the treatment phase. There was 100% agreement during simultaneous observations, however only eight of the 34 observations made during the baseline phase were conducted simultaneously and none of the 11 observations made during the treatment phase were simultaneous, which is insufficient to establish inter-observer agreement. Figure 4.45 shows a simple regression analysis of H’s mean weekly academic engagement over time, performed with Microsoft excel.
Figure 4.45 weekly percent of academic engagement over time

Note: weeks 5, 12, and 21 are school vacation weeks; data missing weeks 11, 13, 16, 18, 19, 23-25, 27.

**Inattentive/overactive behavior.**

Though scores seem to trend upward during baseline and downward during treatment, H demonstrated a slight increase weekly inattentive and overactive behavior scores from baseline (M=27.8%; SD=11.6%) to treatment (M=29%; SD=6%). The variability in H’s scores decreased from baseline to treatment, which suggest increased stability psychosocial function in an SED setting over time. Figure 4.46 shows a simple regression analysis of H’s mean weekly inattentive/overactive behavior ratings over time, performed using Microsoft excel.
Figure 4.46 mean weekly percent of inattention/over activity over time

![Graph](image.png)

Note: weeks 5, 12, and 21 are school vacation weeks; data are missing at weeks 17 and 27

**Summary of change in psychosocial function from baseline to treatment.**

Analysis of psychosocial data indicate a decrease in Participant H’s attendance, classroom participation, and frequency of academic engagement over time. Data also indicate an increase in unexcused absences and teacher rated inattention/over activity. However, the data also seem to suggest that when in class H showed an increase in academic engagement and increased stability of inattentive/overactive behaviors. Taken together the data suggest that H’s overall psychosocial function in an SED setting declined over the course of the study. Table 4.6 presents H’s mean weekly psychosocial function scores and their standard deviations at baseline and treatment.
Table 4.6

change in average psychosocial function and performance variability over time

<table>
<thead>
<tr>
<th></th>
<th>Baseline (13 weeks)</th>
<th>Treatment (14 weeks)</th>
<th>Change over time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Attendance</td>
<td>94.1 % (10.9 %)</td>
<td>54.9 % (30.5 %)</td>
<td>-39.2 % (19.6 %)</td>
</tr>
<tr>
<td>Participation</td>
<td>85.5 % (16.8%)</td>
<td>42.5 % (31.4%)</td>
<td>-43 % (14.6%)</td>
</tr>
<tr>
<td>Unexcused absences</td>
<td>5.5 % (10.2 %)</td>
<td>46.7 % (32 %)</td>
<td>41.2 % (21.8 %)</td>
</tr>
<tr>
<td>Academic engagement</td>
<td>84.8 % (6.3 %)</td>
<td>93.2 % (11.7 %)</td>
<td>8.3 % (5.3 %)</td>
</tr>
<tr>
<td>Inattention/over activity</td>
<td>27.8 % (11.6 %)</td>
<td>29 % (6 %)</td>
<td>1.2 % (-5.6 %)</td>
</tr>
</tbody>
</table>

Note: A plus or minus sign denote an increase and decrease respectively

Overall summary of results.

Overall, both A and E showed evidence of positive changes in cognitive function and A, E, and J all showed evidence of positive change in psychosocial function. However, changes in psychosocial function appeared to begin prior to the treatment phase for each participant. Participant J withdrew from the program after 3 hours of CCRT, and refused a cognitive assessment at T2. Participant H refused cognitive assessments at both T1 and T2 and showed evidence of decreasing psychosocial function, which co-occurred with a 4-week period of voluntary disengagement from CCRT sessions during the middle of the program. Upon re-engaging with CCRT, H’s psychosocial function improved for the duration of the program. There were not enough data points to generate the statistical power necessary to determine if functional improvements were statistically significant. However, each participant's case study provides results that align with those of other research in which participants experience stability in or improvement of overall cognitive ability and practical psychosocial function (Wykes et al., 2011; McGurk et al., 2007) following some version of CRT. Table 4.7 shows the changes in
cognitive function over time by participant. Table 4.8 shows the changes in psychosocial function over time by participant.

**Table 4.7**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Participant A</th>
<th>Participant E</th>
<th>Change (4hrs)</th>
<th>Change (12 hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSIQ-2</td>
<td>39th</td>
<td>NA</td>
<td>NA</td>
<td>34th</td>
</tr>
<tr>
<td>TA</td>
<td>61st</td>
<td>NA</td>
<td>NA</td>
<td>3rd</td>
</tr>
<tr>
<td>Matrix Reasoning</td>
<td>47th</td>
<td>63rd</td>
<td>+16</td>
<td>62nd</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>34th</td>
<td>63rd</td>
<td>+29</td>
<td>16th</td>
</tr>
<tr>
<td>BNT-2</td>
<td>16th</td>
<td>23rd</td>
<td>+7</td>
<td>4th</td>
</tr>
<tr>
<td>Digit Span</td>
<td>50th</td>
<td>63rd</td>
<td>+13</td>
<td>25th</td>
</tr>
<tr>
<td>Digits forward</td>
<td>25th</td>
<td>63rd</td>
<td>+38</td>
<td>37th</td>
</tr>
<tr>
<td>Digits backward</td>
<td>75th</td>
<td>37th</td>
<td>-38</td>
<td>2nd</td>
</tr>
<tr>
<td>ROCF-Recall</td>
<td>82nd</td>
<td>39th</td>
<td>-43</td>
<td>81st</td>
</tr>
<tr>
<td>ROCF-Copy</td>
<td>79th</td>
<td>14th</td>
<td>-65</td>
<td>14th</td>
</tr>
<tr>
<td>D-KEFS-number-letter</td>
<td>37th</td>
<td>63rd</td>
<td>-26</td>
<td>25th</td>
</tr>
<tr>
<td>Switching</td>
<td></td>
<td></td>
<td></td>
<td>1st</td>
</tr>
</tbody>
</table>

Note: 34 percentile points=1 standard deviation
Table 4.8

change in average psychosocial function and performance variability over time

<table>
<thead>
<tr>
<th>Variable</th>
<th>A</th>
<th>E</th>
<th>J</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>10.1% (-12.8%)</td>
<td>4.7% (-2.5%)</td>
<td>4.5% (-3.8%)</td>
<td>-39.2% (19.6%)</td>
</tr>
<tr>
<td>Participation</td>
<td>14% (-14.9%)</td>
<td>5.7% (-2.1%)</td>
<td>1.2% (-4.7%)</td>
<td>-43% (14.6%)</td>
</tr>
<tr>
<td>Unexcused absences</td>
<td>-5.6% (-8.7%)</td>
<td>-5.4% (-3.7%)</td>
<td>-1.6% (-5.2%)</td>
<td>41.2% (21.8%)</td>
</tr>
<tr>
<td>Academic engagement</td>
<td>9.1% (-9.3%)</td>
<td>8.3% (-8.4%)</td>
<td>7.8% (-11.7%)</td>
<td>8.3% (5.3%)</td>
</tr>
<tr>
<td>Inattention/overactivity</td>
<td>-2.6% (-3.4%)</td>
<td>6.2% (-2.8%)</td>
<td>-1.2% (-2.1%)</td>
<td>1.2% (-5.6%)</td>
</tr>
</tbody>
</table>
Chapter 5

Discussion

The following chapter will present a discussion about the implications of the study’s results, limitations, and suggestions for future research. The primary goals of the current study were to determine if pilot program participants showed changes in cognitive function and classroom based psychosocial function during CCRT treatment.

Implications of the Results

The current study found that participants exhibited improvements in psychosocial function within an SED setting over the course of their time in the pilot program. However, improved function appears to take place prior to the beginning of CCRT and are likely related to each participant’s individual situation. For example, three of the four participants were scheduled for discharge from the hospital by their treatment teams within a week of completing CCRT. It is also possible that adolescent CCRT participants showed improvements in function because they were receiving an increase in positive, structured attention from direct care staff and therapeutic coaches who worked with them to develop coping skills and learning strategies in addition to treatment as usual. To determine if the adolescent CCRT program is clinically effective, simultaneous, single subject, multiple baseline studies of more individual patients are required. In order to establish a more generalizable body of knowledge on the effectiveness of adolescent CCRT, research should use more rigorous experimental designs that compare groups of participants.

It is possible that the longitudinal study of a larger sample of the adolescent population, with more rigorous data collection procedures, and a higher level of experimental control would yield a clearer picture of the relationship between CCRT (IV), cognitive function (DV), and
psychosocial function (DV). It would also be informative to follow participants upon discharge to monitor their mental health treatment and stability, and related cognitive and psychosocial function as they pursue educational, vocational, and relational goals. Given the central role of education and employment in the recovery of many persons with SMI (Kidd et al., 2012), it is reasonable to suggest that future research investigate the efficacy of CCRT for inpatient and outpatient SED settings.

**Programmatic implications.**

The data available for analysis were collected within a state hospital. Hospital administrators, treatment providers, teachers, direct care staff, and pre-doctoral interns were supportive of the adolescent CCRT pilot program. However, the institution and its employees prioritized their primary duties, which were in line with Waghorn et al’s (2004) findings about the general components of a successful SED (i.e., coordination of education and mental health treatment; supported practical utilization of coping skills within an academic setting; provided personal support to facilitate academic success).

Similar to Phillips (2009) the current study encountered some programmatic barriers that may be endemic to research in a psychiatric setting. For example, the priority of research is secondary to duties more directly related to care and safety of patients. Program records suggest that teachers and direct care staff were motivated to volunteer as research assistants but were only able to follow through on their volunteer duties as consistently as their paid duties and responsibilities would allow. All direct care staff reported they understood the goals and objectives of the pilot program well enough to performing volunteer duties. Two of the six direct care staff reported they felt comfortable answering questions asked by other volunteers
and four out of six reported they felt the program administrator was accessible and available to answer any questions that arose.

Taken together the porousness of participant SED outcome data suggests the reasons they are inconsistent may be related to the availability of paid CCRT program staff. If the program administrator and direct care staff were able to be more consistently involved in the pilot program, it is probable that the number of participants would have increased, yielding more data (baseline, treatment, and post-treatment) and clearer results.

**Study Limitations**

**Methodological concerns.**

An external validity threat of the current study includes a limited ability to replicate the study with different participant groups in different settings (Cozby & Bates, 2015). Three other major methodological areas that limited the external validity of the current study: the population, instrumentation, and the research design. It is difficult to get teens diagnosed with SMI, within a secure treatment facility, to participate in a research study consistently. For example, two of the four participants withdrew from the study prior to the programs last week. One of those two re-enrolled. It is also worth noting that an inpatient facility is a more secure setting than that of a school or an outpatient treatment facility and the population is a more captive audience with a routine daily schedule and the support of many staff members. The inconsistency of participation within a secure, highly structured facility setting could have had an impact on the performance data.

**Instrumentation.**

Assessment of cognitive and psychosocial function was inconsistently administered over the course of the study. For example, there were baseline cognitive data available for only one
participant; the other three were assessed after different doses of treatment occurred. This allows for an analysis of cognitive function during exposure to CCRT, but does not allow for an analysis of the potential effect that the initial dose of treatment have on cognitive function. For example, it is possible that a person who receives 15 hours of CCRT a week for four weeks would show a measurable improvement but a person who receives one hour a week for four weeks would not. It is also possible that a person who receives four hours of treatment before a T1 assessment has already experienced a change in cognitive function that will not be captured at T2. Though historical cognitive function data were used to recruit potential participants, baseline function should have been established prior to treatment.

Instrumentation was not consistent throughout the study in that some cognitive instruments relied on alternative/parallel forms for which convergent validity is reasonably assumed, but for which no confirmatory data were available. Other instruments with moderate to excellent test-retest reliability, were administered at T1 and T2, but raw scores were interpreted using norms (i.e., means and SD) based on an age group closest to the participant age (i.e., BNT-2 norms used were for individuals 18-39 years old; Rey-copy/recall norms used were for 20-29 year olds) to calculate standard scores and percentile ranks were. In addition, Strauss et al. (2006) point out that individuals in the standardization sample have high mean vocabulary and education scores. This means that the BNT-2 does not discriminate well at the average range of a normal bell curve or higher and those with limited vocabularies generally score well below the mean, because most scores in the standardization sample cluster in the higher range. Strauss et al. also argue that the sensitivity of test retest reliability of the ROCF-Form A is artificially reduced by the fact that the majority of individuals in the standardization group obtained the maximum or near maximum scores on the copy condition. Taken together, analysis and interpretation of data
collected from individuals within the appropriate age ranges require consideration because small deviations from the mean will have a large impact on standard scores.

There were four regular teachers and as many as five substitutes in the pilot program’s 27-week duration, which affects the consistency and objectivity of the teacher participation and IOWA-IO ratings. Though inter-observer agreement was established between the program administrator and the direct care staff, there were no procedures in place to oversee inter-observer agreement amongst direct care staff or to maintain inter-observer agreement between the program administrator and direct care staff.

Mental health problems in children and adolescents are associated with mental health issues in adulthood that can negatively affect high school and college success (Kessler et al., 2012; McLeod & Fettes, 2007) without treatment. Treatment goals in a secure psychiatric facility include academic progress in line with their IEP’s, coping skill development, and preparation for vocational and educational opportunities later in life. Treatment goals also aim to facilitate an increase in SED psychosocial function. An individual who pursues and reaches these goals may transition into regular secondary and postsecondary programs at the high school and college levels and entry level in employment and vocational training programs (Kidd et al., 2012) with a transferable set of academic skills and self-efficacy that bolsters the improvement of psychosocial function in community.

Cognitive stability, improved cognitive function, and improved psychosocial function within an academic setting could contribute to a positive sense of self. When teens are aware of their capacity to develop and utilize the study skills, goal setting strategies, and coping strategies necessary to overcome mental health and academic challenges in secure SED settings, they are also positioned to experience increase self confidence in the utilization of those same skills and
strategies (Kidd et al., 2012). It would be helpful if future studies include measures of participant’s self-concept and self-efficacy to investigate changes across baseline to treatment phases.

**Research design.**

A single subject, multiple baseline, simultaneous replication, case study design was attempted, but not completely implemented for reasons already discussed, within a program evaluation framework to evaluate the effectiveness of the CCRT pilot program. The small number of participants for which data were available and the inconsistency of the data available hampered the analysis and interpretations that could be made. Results were generally favorable in these areas, but the magnitude of effect was small. The current study utilized an interpretive approach that relies on a program evaluation framework and social behavioral perspective. Confidentiality laws and professional ethics limited the presentation of details pertaining to the settings and participants. Generalizability of the interpretations should be considered on the basis of the reader's perspective and experience. In the present study, the intention was to treat each participant as his or her own control by generating baseline and treatment phase data. A more traditional research design, using a pre-test/post-test methodology would lend itself to an investigation of whether or not there were statistically significant changes in participant scores following exposure to CCRT. Additionally, a comparison group of pre-treatment participants, and participants receiving a different CCRT intervention would improve the study's ability to argue that changes realized after CCRT participation were not associated with confounding factors (e.g., maturation, history).

**Future Research**
Similar to Eack et al. (2010), to establish a clearer understanding of how the therapeutic alliance is related to participant psychosocial function, future research could also modify the role of a therapeutic coach to include the provision of psycho-education (e.g., in groups or individually) focused on SMI, academic stress and its effects on SMI, identification of early warning signs of emotional distress, the development and utilization of coping strategies (e.g., diaphragmatic breathing, passive and active relations strategies) to manage stress. At that point, it would be possible to conduct a directed content analysis on the treatment notes kept by therapeutic coaches to identify themes related to psychosocial function in the CCRT settings.

The current study was intended to inform future study of adolescent CCRT interventions, embedded within SED programs to establish their efficacy as a practical, cost-efficient, supplementary mode of inpatient and outpatient psychiatric rehabilitation. In order to make the study more informative, future studies should be designed to include more participants within multiple treatment settings. It will also be important to look more closely at the operational definitions of variables that showed the desirable effects and the instruments used to measure them. It will be beneficial to consider multiple versions of CCRT software to avoid the notion that there is a “one size fits all” treatment to address the cognitive and psychosocial function of adolescents diagnosed with SMI.

While it is encouraging to find data that support the improvement of participants’ functional capacity or social skill performance, measured in a controlled treatment setting (Medialia & Sapperstein, 2013), the current study does little to suggest that participants showed improved functional competence, or the attainment of a sustainable level of functional ability (Hoagwood et al., 2007) in the real world beyond controlled treatment settings (Medialia & Sapperstein, 2013; Kurtz & Nichols, 2007, McGurk et al., 2007). In addition to improving the
processes and procedures of adolescent CCRT programs, future studies should consider investigating the sustainability and transferability of treatment setting cognitive and psychosocial improvements to real-world functioning by looking at the long-term impact of CCRT embedded within and SED, across the continuum of care that bridges inpatient and outpatient psychiatric rehabilitation treatment.

One approach to investigating the sustained impact of CCRT on adolescent cognitive and psychosocial functioning includes the utilization of online interventions that provide individually tailored social supports in the form of mental health coping strategies. This approach is similar to those that target physical activity (Cavallo et al., 2012), smoking cessation (Wang & Etter, 2004), and sexual health (Bull et al., 2012), in that participants are monitored electronically. When participant vital information reaches a predetermined threshold (i.e., increased heart rate, mild respiratory distress) support is provided (e.g., via phone call, text message) and an individual is prompted to utilize coping skills (e.g., meditation, diaphragmatic breathing) learned during individual CCRT sessions with their therapeutic coaches.

As research efforts within the field of psychology continue to investigate the efficacy of cost-efficient, developmentally appropriate treatment options for adolescents diagnosed with or at risk for developing SMI, pilot programs can provide both outcomes and process level data that inform efforts to improve the quality of individuals psychiatric and academic experiences. The current study attempted to contribute to the existing literature by piloting a program designed to help adolescents develop and utilize a transferable set of positive psychosocial skills. Though there was a lack of consistent outcome data, process data may be helpful for refining the procedures of future psychiatric rehabilitation programs that combine CCRT and SED programs in inpatient and outpatient settings. This could inform efforts to improve the continuum of care
that helps the adolescent psychiatric healing process, while simultaneously making available resources they can use to build academic and vocational skillsets.
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DSM-IV disorders in the National Comorbidity Survey Replication Adolescent

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69(4), 381-389.

remediation for individuals with psychosis in a supported education setting: a pilot study.
*Rehabilitation Research and Practice*, 1-5.

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Kurtz, M.M. & Richardson, C.L., (2012). Social cognitive training for schizophrenia: a Meta-

assisted cognitive remediation in schizophrenia: What is the active ingredient?

change in like skills in schizophrenia after cognitive remediation. *Schizophrenia
Research*, 107, 267-274.


APPENDIX A:
ADOLESCENT COMPUTERIZED COGNITIVE THERAPY CURRICULUM

Foundations I

1) Visual tracking I
Directions: the screen will turn red. A black line will move across the screen step-by-step in one of four possibly directions (check the modify options). Keep your eyes focused on the end of the line. Whenever a yellow block appears, press the appropriate mouse button as quickly as you can. If you hear the ‘ta da’ sound you were fast enough but if you hear the ‘wrong’ chord you were too slow. You can modify the line movement, speed and mouse button options.

2) Track and target
Directions: The screen will turn black. A home base square will display at the bottom center of the screen. When you click the mouse arrow on this button as directed, a red circular target will appear on the screen. Move the mouse arrow to the target as quickly as you can and click. When an accurate click is made the target will disappear. Repeat this whole procedure for each of the 15 trials. Move as quickly as possible as you reaction will be timed.

Foundations II

3) Simultaneous multiple attention
Directions: there will be four lines of parallel window frames extending across the screen. In the center of the screen there will be a frame labeled ‘target.” The target frame will hold the color for which you will monitor the screen. At first only the line labeled “1” will be in play. Colors will march across the screen from left to right. Within each line, the center frame sits apart from the others. Your job is to watch for target colors to march across the screen until they get to the centered frame. Before it moves out of the frame put the mouse arrow on it and click. As you progress more lines will get involved and you will have to monitor them all at the same time. When the bottom line (4) joins in it will march from right to left, just opposite the other three. Try not to let any target colors get by without you clicking on them.

4) Detecting differences (alpha 1/graphic1)
Directions: for large frames will appear on the screen. Depending upon the mode you select from the modify screen) the frames will fill with either an alphabet character or small graphic blocks. The four frames will be identical except for one very small detail in one frame. Detect the frame containing the difference as quickly as possible and click the mouse on it. You will be timed each trial.

Memory I

5) Spatial memory
Directions: It’s a nightmare. You find yourself lost in a huge house with room after room and no hallways. Every time you go through a door you enter a room exactly like the one you just left. Worse yet, if you try to open a wrong door the floor opens up and somehow drops you back into the very first room where this all started. Luckily, the correct pathway stays the same so you can
retrace your steps to where you went wrong. Your job is just to keep going until you find success! The number of rooms to be traveled can be adjusted through using the modify screen.

6) **Sequenced recall (digits {visual})**
Directions: you will be presented a series of numbers one at a time. Your job is to memorize the numbers in the order they are presented. After the last number clears, you must click on the numbered command buttons so that you duplicate the sequence that you memorized. Each trial ends either when you have input the entire sequence of when you make an error. See the modify screen for parameters that can be altered.

7) **Sequenced recall (graphics {visual})**
Directions: you will be presented a series of graphic figures one at a time. Your job is to memorize the graphics in the order they are presented. After the last graphic clears, you must click on the graphics pictures buttons so that you duplicate the sequence that you memorized. Each trial ends either when you have input the entire sequence of when you make an error. See the modify screen for parameters that can be altered.

8) **Sequenced recall reversed (digits {visual})**
Directions: you will be presented a series of numbers one at a time. Your job is to memorize the numbers in the order they are presented. After the last number clears, you must click on the numbered command buttons in reverse order so that you duplicate the sequence IN REVERSE that you memorized. Each trial ends either when you have input the entire sequence or when you make an error. See the modify screen for parameters that can be altered.

9) **Sequenced recall reversed (graphic {visual})**
Directions: you will be presented a series of graphic figures one at a time. Your job is to memorize the graphics in the order they are presented. After the last graphic clears, you must click on the graphics pictures buttons in reverse order so that you duplicate the sequence IN REVERSE that you memorized. Each trial ends either when you have input the entire sequence or when you make an error. See the modify screen for parameters that can be altered.

10) **Sequenced recall (digits {auditory})**
Directions: you will be presented a series of numbers one at a time orally. Your job is to memorize the numbers in the order they are presented. After the last number is spoken, you must click on the numbered command buttons so that you duplicate the sequence that you memorized. Each trial ends either when you have input the entire sequence or when you make an error. See the modify screen for parameters that can be altered.

11) **Sequenced recall reversed (digits {auditory})**
Directions: you will be presented a series of numbers one at a time orally. You job is to memorize the numbers in the order they are presented. After the last number is spoken, you must click on the numbered command buttons in reverse order so that you duplicate the sequence IN REVERSE that you memorized. Each trial ends either when you have input the entire sequence or when you make an error. See the modify screen for parameters that can be altered.

**Problem solving I**
12) Checker exchange
Directions: This checker game is a little different from what you might have played before. You job here is to move all the blue checkers to the top and all of the green checkers to the bottom. If you are successful in completely exchanging the two sets, you can earn a top score of 24. There is a catch. You cannot make any jumps. Therefore, in order to move the two sets past each other you will really have to develop a strategy and plan. If you are stuck and cannot make a move (and you will) just press the quit button and then start over and try again. It is possible so keep at it.
## APPENDIX B.

### Academic Engagement Observation form

<table>
<thead>
<tr>
<th>subject #</th>
<th>classroom task type</th>
<th>AET</th>
<th>PET</th>
<th>OFT-M</th>
<th>OFT-V</th>
<th>OFT-P</th>
<th>AET: Active On task</th>
</tr>
</thead>
<tbody>
<tr>
<td>ob 1</td>
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<td>Ex:</td>
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<tr>
<td>ob 2</td>
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<td></td>
<td></td>
<td>Reading</td>
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<tr>
<td>ob 3</td>
<td></td>
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<td></td>
<td></td>
<td>Writing</td>
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<tr>
<td>ob 4</td>
<td></td>
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<td></td>
<td></td>
<td>Discussion of academic topic with teacher or classmate</td>
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<tr>
<td>ob 5</td>
<td></td>
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<tr>
<td>ob 7</td>
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<td></td>
<td>PET: Passive On Task</td>
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<tr>
<td>ob 8</td>
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<td>Ex:</td>
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<tr>
<td>ob 9</td>
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<td></td>
<td>Listening to lecture</td>
</tr>
<tr>
<td>ob 10</td>
<td></td>
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<td>completing worksheet</td>
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<td></td>
<td></td>
<td>reading silently</td>
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<td>ob 2</td>
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<td></td>
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<tr>
<td>ob 3</td>
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<td></td>
<td></td>
<td>OFT-M: Off Task Motor</td>
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<td>ob 4</td>
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<td></td>
<td></td>
<td>Ex:</td>
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<tr>
<td>ob 5</td>
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<td></td>
<td>Any motor activity that distracts Students from academic task</td>
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<td>ob 6</td>
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<tr>
<td>ob 7</td>
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<tr>
<td>ob 8</td>
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<td>OFT-V: Off Task Verbal</td>
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<td>ob 9</td>
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<td>Ex:</td>
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<tr>
<td>ob 10</td>
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<td></td>
<td>Any verbal activity not related to, or Which distracts students from academic tasks</td>
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<tr>
<td>ob 1</td>
<td></td>
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<tr>
<td>ob 2</td>
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<td></td>
<td></td>
<td>OFT-P: Off Task Passive</td>
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<td>ob 3</td>
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<td></td>
<td></td>
<td>Ex: Passive inattention (day dreaming) for at least 3 consecutive seconds</td>
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<tr>
<td>ob 4</td>
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<tr>
<td>ob 5</td>
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<td>ob 6</td>
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<tr>
<td>ob 7</td>
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<tr>
<td>ob 8</td>
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**APPENDIX C: HYPERACTIVITY INSTRUMENT, MODIFIED IOWA CONNERS (IO subscale)**

<table>
<thead>
<tr>
<th></th>
<th>0 (not at all)</th>
<th>1 (just a little)</th>
<th>2 (pretty much)</th>
<th>3 (very much)</th>
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<tbody>
<tr>
<td>1</td>
<td>Fidgeting</td>
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<tr>
<td>2</td>
<td>Hums and makes other noise</td>
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<tr>
<td>3</td>
<td>Excitable, impulsive</td>
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<td>4</td>
<td>Inattentive, easily distracted</td>
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<tr>
<td>5</td>
<td>Fails to finish things (short attention span)</td>
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APPENDIX D:
Attendance and Class Participation Form (side one)

<table>
<thead>
<tr>
<th>Student Credit Sheet</th>
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<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
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<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
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<tbody>
<tr>
<td>Transition</td>
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<tr>
<td>8:30-9:15</td>
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<td>9:15-10:00</td>
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<td>10:30-11:15</td>
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<tr>
<td>11:15-12:00</td>
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</tr>
<tr>
<td>Lunch</td>
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<td>12:45-1:30</td>
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<td>1:30-2:45</td>
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<tr>
<td>Transition</td>
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All students must complete all of their classroom academic assignments. Students earn credits when there is a holiday/snow day.

Students who earn more than 75 credits during any week of school are eligible to participate in Friday afternoon activities. This includes all activities. Students who earn less than 75 credits can participate in Friday afternoon activity; however, you must make up all missed assignments.
<table>
<thead>
<tr>
<th>Name:</th>
<th>Group:</th>
<th>Team:</th>
<th>Week of:</th>
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<th></th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
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<th>5</th>
<th>6</th>
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</table>

Blank — Present for at least half of class
M — Medical
TX — Therapy, Clinician
L — Legal, court, lawyer
A — Appointment, home visit, family visit
U — Unexcused — Student refused to attend