IMPROVING EVERYDAY ACTION IN SCHIZOPHRENIA THROUGH ENVIRONMENTAL INTERVENTIONS

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ABSTRACT
Improving Everyday Action in Schizophrenia through Environmental Interventions
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Cognitive functioning, particularly executive functioning, is a strong predictor of everyday action impairments in schizophrenia. However, it is unclear if remediating cognitive deficits can lead to meaningful gains in adaptive functioning. Approaches that attempt to improve everyday action performance through bypassing or compensating for cognitive deficits are promising ways to address functional impairments. This study examined whether standardized environmental interventions can compensate for cognitive difficulties and improve action performance in schizophrenia. Forty two individuals were administered two versions of the Naturalistic Action Test (NAT)—a standard version (ST-NAT), and a user-centered version (UC-NAT) that incorporated interventions aimed at streamlining action performance. Individuals with schizophrenia demonstrated enhanced performance on the UC-NAT, demonstrating the beneficial effects of environmental interventions on everyday action. Results indicated that the interventions likely exerted their effect through compensating for global cognitive dysfunction. Additionally, the NAT's reliability and validity for schizophrenia populations, as well as the UC-NAT's utility for addressing the cognitive impairments of a variety of neurological populations were examined.

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DEDICATION

I would like to dedicate this dissertation thesis to Jon, my rock, my best friend, and my greatest love; and to Lila, the light of my life and without a doubt my greatest achievement.

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CHAPTER 1

INTRODUCTION

Functional Impairments in Schizophrenia

Schizophrenia affects approximately 1% of the general population and is associated with both functional and cognitive impairments (Harvey, Green, Keefe, & Velligan, 2004; Sevy & Davidson, 1995). The functional deficits in schizophrenia are diverse, debilitating, and contribute to the high cost of the disorder. Schizophrenia is one of the top five causes of disability in developed countries (Harvey et al., 2004). The yearly cost of schizophrenia in the United States is estimated to be $62.7 billion, with $22.7 billion in direct healthcare costs, $7.6 in direct non-healthcare costs, and $32.4 in indirect costs (Wu et al., 2005). The majority of individuals with schizophrenia are unable to live independently and be self-sufficient in their daily lives, a factor that greatly contributes to the cost of the disorder. More than 80% of individuals with schizophrenia live in supported housing arrangements (Harvey et al., 2004). Independent living capabilities deteriorate soon after the onset of schizophrenia, and 50% of individuals with schizophrenia receive disability payments and live in supported housing within six months of their first episode (Ho, Andreasen, & Flaum, 1997). Moreover, schizophrenia is far more prevalent in homeless populations than in the general population, indicating that independent living skills are often grossly deficient (Folsom & Jeste, 2002).

The ability to perform activities of daily living and instrumental activities of daily living (ADL/IADL) is crucial for successful independent living, and numerous studies have demonstrated that individuals with schizophrenia are impaired at performing such

tasks (Evans et al., 2003; Kessler, Giovannetti, & MacMullen, 2007; Klapow et al., 1997; Patterson et al., 1998; Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001; Semkovska, Bedard, Godbout, Limoge, & Stip, 2004; Semkovska, Stip, Godbout, Paquet, & Bedard, 2002; Velligan et al., 2007). Studies that used performance-based measures to assess everyday action found that individuals with schizophrenia were impaired at performing daily activities in several domains that include household chores, grooming, communication, shopping, finance, transportation, and planning recreational activities (Evans et al., 2003; Klapow et al., 1997; Patterson et al., 1998, 2001; Velligan et al., 2007). Semkovska and colleagues (2002; 2004) demonstrated that individuals with schizophrenia were significantly impaired at performing everyday tasks that included planning a meal, shopping for ingredients, and cooking four dishes. When performing these everyday activities, the schizophrenia participants committed more errors than healthy controls and took almost three times as long to finish the tasks.

Velligan and colleagues (2007) examined everyday action performance using the Test of Adaptive Behavior in Schizophrenia (TABS), a performance-based measure specifically designed to assess initiation and the ability to identify problems that occur during the course of daily activities. They found that compared to healthy controls, individuals with schizophrenia demonstrated significantly worse medication management, shopping skills, and dressing skills. Scores reflecting overall performance on the TABS were four standard deviations lower for schizophrenia participants compared to healthy controls.

Kessler, Giovannetti, and MacMullen (2007) demonstrated that schizophrenia inpatients show impaired performance on the Naturalistic Action Test (NAT; Schwartz, Buxbaum, Ferraro, Veramonti, & Segal, 2003), a performance-based measure of action that involves three everyday tasks. This study was the first to thoroughly examine all aspects of task performance including accomplishment, overall error rate, and error patterns using a published, standardized, and validated measure. This research demonstrated that compared to healthy controls, individuals with schizophrenia accomplished significantly fewer steps of the NAT tasks and committed more errors, although error rate was a more sensitive measure of impairment. Specifically, 79% of the schizophrenia participants exhibited overall errors rates that fell in the deficient range whereas only 35% of the participants exhibited deficient NAT accomplishment.

The schizophrenia participants' performance was also compared to that of individuals with dementia, a population with known action impairments. When the schizophrenia group was compared to individuals with dementia who had equivalent levels of global cognitive impairment, they demonstrated significantly higher rates of accomplishment but similar total error rates on the NAT. Additionally, a correlation analysis demonstrated that errors of commission (i.e. all non-omission errors) and NAT accomplishment were independent aspects of task performance for the schizophrenia group, but not the dementia participants. That is, for the dementia participants, lower levels of accomplishment were associated with higher error rates, whereas these two aspects of performance were unrelated in the schizophrenia group.

This research also looked at the types of errors that people with schizophrenia commit while performing everyday tasks. Prior to this work, only two studies had examined and classified the types of errors made during everyday tasks (Semkovska et al., 2002, 2004). Semkovska and colleagues (2002) examined the performance of 17 participants while cooking a meal; errors were classified as omissions (forgetting a task step), repetitions (repeating a task step), macro-sequencing (preparing the four dishes in a suboptimal order), and micro-sequencing errors (misordering the task steps within each dish). The schizophrenia group committed more omissions, repetitions, and macro-sequencing errors than healthy controls. Another study by Semkovska et al. (2004) examined task performance of 27 schizophrenia participants and 27 healthy controls during three IADL—choosing a menu, shopping for missing ingredients, and cooking a meal. The schizophrenia participants performed significantly worse than controls, committing more omissions, repetitions, and sequencing errors.

The Kessler, Giovannetti, and MacMullen (2007) study added to this previous work by coding errors according to a more thorough taxonomy and by comparing error patterns to those of another cognitively impaired population (i.e. individuals with dementia). In this study, errors were classified as omissions, sequencing errors, perseverations, action-additions, substitutions, and other errors, according to an established NAT coding system (for definitions and examples of all NAT errors, see Table 1). The schizophrenia group's error pattern was distinct from that of the dementia group, in that it contained a significantly lower proportion of omissions and significantly higher proportions of perseverations and action-additions. Importantly, the dementia

Table 1. Definitions and Examples of NAT Errors

Error Type	Definitions	Examples From Toast and Coffee and Present Tasks
Omission	a step or subtask is not performed	does not add sugar to coffee
Substitution	semantically related or perceptually similar alternate object used in place of target object	spreads butter on toast with spoon instead of knife
Anticipation-Omission	anticipation of a step which entails a subsequent omission	applies butter on bread, without first toasting bread
Reversal	steps or subtasks are performed in reverse order	applies jelly on bread, then applies butter
Perseveration	a step or subtask is performed more than once; an action is performed repetitively or for an excessive amount of time	toasts more than one slice of bread
Action-Addition	performance of an action not readily interpreted as a task step	eats toast; drinks coffee
Quality	task performance is grossly inadequate	pours too much cream into coffee so that the cup overflows
Gesture Substitution	correct object is used, but with an inappropriate gesture	grasps knife incorrectly
Spatial Misorientation	object is misoriented relative to the participant's hand or another object	misorients wrapping paper with respect to the gift
Spatial Misestimation	the spatial relationship between objects is incorrect	cuts too small a piece of wrapping paper
Tool Omission	action is performed without the appropriate object	rips wrapping paper (i.e. does not use scissors)

group's pattern is virtually identical to those of other previously studied populations that include closed head injury (CHI), left cerebral vascular accident (LCVA), and right cerebral vascular accident (RCVA) groups (see Giovannetti, Libon, Buxbaum, & Schwartz, 2002 for comparison across groups). Thus, this work demonstrated that individuals with schizophrenia exhibit a distinct pattern of impaired action performance characterized by mildly deficient task accomplishment with unusually high rates of perseveration and off-task behaviors.

The Relationship between Adaptive Functioning and Cognition

Importantly, treatment with antipsychotic medication most often does not lead to dramatic improvements in functional domains such as self-care and everyday action performance (Harvey et al., 2004). That is, everyday action difficulties persist even when positive symptoms remit. In fact, relevant reviews have found no significant relationship between positive symptoms and functional outcomes in schizophrenia (Green, 1996; Green, Kern, Braff, & Mintz, 2000). Thus, the psychotic features of the disorder are likely not the cause of functional deficits.

Research has implicated cognitive deficits as one of the primary predictors of functional outcomes in individuals with schizophrenia (Sharma & Antonova, 2003). It has been estimated that 70-80% of individuals with schizophrenia demonstrate cognitive impairments relative to the general population (Medalia & Choi, 2009). Reviews indicate that cognitive impairments account for 20-60% of the variance in functional outcomes including community, social and work functioning (Green et al., 2000; Green, Kern, & Heaton, 2004). Cognitive deficits are considered to be an integral feature of

schizophrenia (Heinrichs, 2005) and impairments have been noted in multiple domains including verbal memory, attention, motor speed, and executive functioning (Harvey, Green, Keefe, & Velligan, 2004). Problems with cognition are not merely the byproduct of medication use or of repeat hospitalization, as deficits are often present in first episode, antipsychotic naïve individuals (Addington, Brooks, & Addington, 2003; Bilder et al, 2000; Hoff, Riordan, O'Donnell, Morris, & DeLisi, 1992; Saykin et al., 1994). Cognitive impairments are present throughout the course of the disorder and are found in adolescent, adult, and elderly populations (Dickerson, Boronow, Ringel, & Parente, 1996; Harvey, Sukhodolsky, Parrella, White, & Davidson, 1997; Ueland, Ole, Inge-Landro, & Rund, 2004). Importantly, cognitive impairments can precede both negative and positive symptoms, and are more strongly associated with functional impairments than are clinical symptoms (Sharma & Antonova, 2003; Velligan et al., 1997). Cognitive functioning is a robust predictor of response to psychosocial rehabilitation in schizophrenia, (McGurk, Twamley, Sitzer, McHugo, & Mueser, 2007) and has been shown to predict changes in functional outcomes following outpatient rehabilitation to a greater degree than symptoms (Kurtz, Wexler, Fujimoto, Shagan, & Seltzer, 2008). Given that these deficits are so strongly related to adaptive functioning in schizophrenia, many have argued that cognitive dysfunction is a major contributor to the cost of the disorder (Sevy & Davidson, 1995).

Previous work has focused on the relationships between *specific* aspects of adaptive functioning and *specific* cognitive domains. In a review by Green, Kern, Braff, and Mintz (2000), community functioning and ADL/IADL outcomes were associated

with executive functioning. Executive functioning deficits are common in schizophrenia—anywhere from 40-95% of individuals with schizophrenia exhibit deficient executive functioning (Velligan & Bow-Thomas, 1999). Executive impairments are diverse and have been demonstrated on tests of forward planning, cognitive flexibility, inhibition, working memory, and action initiation (Velligan & Bow-Thomas, 1999). Importantly, executive impairments in schizophrenia can exist in the absence of generalized cognitive impairment (Velligan & Bow-Thomas, 1999).

Several studies have provided further support for the association between executive functioning and everyday action. Velligan, Ritch, Sui, DiCocco, and Huntzinger (2002) determined that higher levels of executive dysfunction were correlated with lower scores on a performance-based measure of adaptive functioning. Semkovska et al. (2002, 2004) and Velligan et al. (2007) also demonstrated relationships between everyday action performance and neuropsychological measures of executive functioning. In a study of 24 schizophrenia participants, several measures of executive dysfunction were significantly correlated with a measure of problems in daily life functioning (Krabbendam, de Vugt, Derix & Jolles, 1999). Additionally, executive functioning has been shown to predict the level of care and supervision required by individuals with schizophrenia (Royall et al., 1993; Wykes, Sturt, & Katz, 1990).

The Kessler et al study (2007) also provided some support for the link between executive functioning and everyday action performance in schizophrenia. In addition to describing the NAT performance of individuals with schizophrenia, this work also attempted to explicate the cognitive underpinnings of action deficits in this population.

More specifically, the study aimed to determine if action deficits were the result of global cognitive limitations, a tenet supported by the resource theory (Schwartz et al., 1998), or the byproduct of executive dysfunction.

The pattern of NAT performance demonstrated by the schizophrenia group tentatively supported both theories. The executive account was supported by the fact that the schizophrenia group committed higher proportions of executive errors such as perseverations and action additions (i.e. off-task behaviors), than did other populations. Additionally, in the schizophrenia group, total error rates were significantly negatively associated with measures of executive functioning, such that better executive functioning was associated with fewer errors on the NAT. Additionally, as mentioned previously, the most striking aspect of the schizophrenia group's action impairment was their high total error rates. In contrast, task accomplishment was affected to a lesser degree, although it was still impaired when compared to controls. This pattern of performance indicates that the schizophrenia group possessed relatively intact knowledge of the task goals and steps; their primary difficulty with the NAT was with achieving the tasks in an organized and efficient manner. This ability depends on intact executive functioning, for such mechanisms provide the top-down cognitive control that is crucial for the execution of everyday actions.

Notably, everyday action studies with dementia, CHI, LCVA, and RCVA groups have all provided support for the resource theory, which purports that action difficulties are due to limitations in global cognitive capacity. The Kessler et al. study (2007) is not totally at odds with this previous work, as it too provided some support for the resource

theory. In this study, NAT accomplishment for the schizophrenia group was associated with, and only with, a measure of global cognitive functioning. This may suggest that this particular aspect of NAT performance (i.e. accomplishment) is best explained by a global limitation in cognitive capacity, even if executive dysfunction accounts for other aspects of action performance in schizophrenia. Because the study demonstrated that accomplishment and commission errors are distinct and dissociable aspects of action performance in schizophrenia, it is conceivable that each domain could be driven by a different cognitive process.

In sum, the Kessler et al (2007) study suggests that for individuals with schizophrenia, NAT accomplishment may be explained by global cognitive resources, whereas NAT errors are likely explained by executive dysfunction. However, given that total error rates are the predominant action impairment in this population, an essentially executive account of action deficits is likely more appropriate for this particular population. Thus, this study also supported the notion that executive functioning is associated with everyday action and ADL/IADL performance.

That impaired executive functioning affects everyday action performance is not surprising, as the construct executive functioning describes a host of processes (e.g. forward and strategic planning, initiation of purposeful action, self-monitoring, inhibition, and the ability to think abstractly and flexibly) that are crucial to the initiation and successful execution of goal-oriented behaviors. Even basic everyday tasks require a great deal of planning as well as the capacity to properly sequence actions, and to inhibit

inappropriate responses and behaviors. Consequently, it is logical that executive dysfunction could lead to disruptions in everyday action performance.

For example, cooking a meal, even a simple one, is a cognitively complex activity that places a great demand on executive capabilities. In order to cook a meal, particular ingredients must be selected and added together in a specific sequence. These components of cooking depend on executive functions such as forward planning and the ability to sequentially order actions. Some additional planning, like preheating an oven, might be helpful, or even necessary, for the successful completion of the task. Cognitive flexibility is also essential for everyday tasks such as cooking; in real life, recipes may need to be doubled or halved, or alternate ingredients may need to be substituted when a recipe calls for an item that a person does not own. These minor complications require the capacity to think flexibly and creatively in order to devise solutions to unexpected problems. If a person's executive functioning is deficient, even a trivial complication can entirely disrupt the performance of a basic task. Furthermore, executive functioning regulates a person's ability to stay on task, to ignore irrelevant stimuli, and to inhibit inappropriate and perseverative actions. Impaired executive functioning can therefore derail the performance of a very basic daily activity.

Remediating Cognitive Deficits

Given that cognitive deficits have been shown to predict functional outcomes in schizophrenia, it is possible that improving cognition could lead to better adaptive functioning. As such, the reduction or elimination of cognitive deficits in schizophrenia is considered a crucial goal for treatment of the disorder. Although some atypical anti-

psychotics do improve particular aspects of cognition in schizophrenia, such medications do not eradicate these deficits (Harvey et al., 2004; Rund & Borg, 1999). As a result, much research has attempted to elucidate whether or not the cognitive deficits associated with schizophrenia can be remediated via non-pharmacological interventions.

The terms "cognitive rehabilitation," "cognitive training," and "cognitive remediation" have been used to describe a myriad of diverse techniques and treatments designed to improve cognitive functioning and functional outcomes in schizophrenia. There have been numerous studies and reviews of cognitive rehabilitation in schizophrenia, including six meta-analyses (Krabbendam & Aleman, 2003; Kurtz, Moberg, Gur, & Gur, 2001; Mcgurk et al., 2007; Pilling et al., 2002; Suslow et al., 2001; Twamley, Jeste, & Bellack, 2003). Of the six, five have found moderate to large effects sizes with respect to improvements in cognition or functional outcomes (Medalia & Choi, 2009). A thorough review of the entire cognitive remediation literature is beyond the scope of this study (for comprehensive reviews and meta-analyses see Medalia & Choi, 2009; Mcgurk et al., 2007; Velligan, Kern, & Gold, 2006). Because this study focuses specifically on executive functioning, only studies of cognitive rehabilitation that addressed changes in executive functioning will be reviewed. However, it is important to note that many of these studies examined the remediation of, and changes in, a host of cognitive domains—not solely executive functioning.

With respect to executive functioning in particular, it has been demonstrated that individuals with schizophrenia can improve their performance on neuropsychological tests of executive functioning, such as the Wisconsin Card Sorting Test (WCST; Heaton

et al., 1993), with the aid of various strategies and techniques that are practiced during training sessions (Kurtz, Moberg, Gur, & Gur, 2001). However, because the training and outcome measures used in these studies are often one and the same, it is not clear that improvements are due to remediated executive functioning and are not the result of training or practice effects.

Studies that have examined the impact of cognitive training on independent outcome measures of executive functioning have yielded generally positive results. One such cognitive rehabilitation program is a component of a larger clinical treatment program for schizophrenia, Integrated Psychological Therapy (IPT; Brenner et al., 1994). One subcomponent of IPT focuses on rehabilitating basic cognitive deficits, including executive functioning, via group activities that utilize strategy use and training. For example, a sample task involves discussing strategies that can be used on a sorting task.

Studies on IPT have demonstrated improvements in executive functioning (Brenner et al., 1994; Rund & Borg, 1999). One problem with some of these studies, however, is that it is not clear that the cognitive subprograms, and not the other psychosocial subprograms of IPT, are responsible for the resulting improvements in cognition (Wykes & van der Gaag, 2001). A study by Spaulding, Reed, Sullivan, Richardson, and Weiler (1999) attempted to tease apart the effects of the cognitive subprograms from the effects of the other subprograms of IPT. This study was conducted with 90 inpatients, and a supportive group therapy condition acted as the control. The results of this study indicated that the experimental group showed significant improvement on a measure of executive function. Other IPT-like programs have also

demonstrated that the cognitive subprograms of IPT are successful in improving executive functioning in schizophrenia (Penades et al. 2003; van der Gaag, 1992).

Computerized cognitive rehabilitation has also been shown to produce beneficial results with respect to executive functioning. In a study by Bell, Bryson, Tamasine, Corcoran, and Wexler (2001), Neurocognitive Enhancement Therapy (NET), a program which included repeated practice on computerized tests of attention, memory, and executive function, led to improvements on measures of working memory and executive function. Moreover, these gains persisted for six months (Bell, Bryson, & Wexler, 2003). The positive effects of NET on executive functioning, as well as other cognitive domains, have been replicated (Greig, Zito, Wexler, Fiszdon, & Bell, 2007). However, other computerized cognitive rehabilitation programs have failed to improve executive functioning in individuals with schizophrenia (Bellucci, Glaberman, & Haslam, 2002; Lindenmayer et al., 2008; Vauth et al., 2005).

Other more individualized cognitive rehabilitation approaches have been shown to improve executive functioning in schizophrenia. Wykes, Reeder, Corner, Williams, and Everitt (1999) compared a cognitive rehabilitation approach (Cognitive Remediation Therapy; CRT) to traditional occupational therapy. Participants were assigned to one of two groups, which were matched for therapist contact and length of treatment (i.e., individual sessions over 40 days). The CRT sessions utilized paper and pencil exercises and targeted three executive functions: flexibility, planning, and working memory. In each session, a variety of tasks were presented that addressed the individual component

processes that are involved in these executive functions. Such component processes included perceptual, motor, and conceptual skills.

Results indicated that the CRT group evidenced significant improvement in all three of the executive domains when compared to the occupational therapy group. Moreover, the improvements in working memory were sustained over a six month follow up period, although improvements in the other two domains were not maintained (Wykes et al., 2003). A later study that compared CRT to treatment as usual found that CRT led to improvements in working memory immediately following treatment; after a six month follow up period, improvements in both working memory and cognitive flexibility were present (Wykes, Reeder et al., 2007). CRT has also been shown to improve cognitive flexibility in young, early-onset individuals with schizophrenia (Wykes, Newton et al., 2007).

Additionally, Wykes et al. (2002) utilized functional magnetic resonance imaging (fMRI) in a subset of participants to examine whether or not there were changes in brain activation that were associated with CRT. They demonstrated that the individuals who exhibited the most benefit from rehabilitation evidenced increased activation in frontocortical regions, brain areas typically associated with working memory and executive functions. However, the occupational therapy control group also demonstrated increased brain activation, indicating a potentially non-specific effect of treatment in general. Nonetheless, taken together, these results suggest that CRT can yield beneficial effects on cognition, specifically executive functioning, that are durable and may be associated with alterations in brain activation. Other individualized cognitive

rehabilitation techniques have also been shown to improve executive functioning in schizophrenia (van der Gaag, Kern, van den Bosch, & Liberman, 2002)

Despite the fact that several studies have demonstrated that cognitive training can lead to improvements in executive functioning, it is unclear if this remediation translates into long-lasting meaningful gains in adaptive functioning. It is possible that performance on executive functioning measures may improve with no corresponding functionally and clinically significant improvements. For example, enhanced performance on the WCST may not translate into participants demonstrating more cognitive flexibility in the real world. Several studies have looked at changes in adaptive functioning following the remediation of executive functioning.

NET in combination with vocational rehabilitation has been shown to improve work outcomes more so than vocational rehabilitation alone (Bell, Zito, Greig, & Wexler, 2008). Participants who received NET worked more total hours, had better rates of competitive employment, and had more competitive work hours than those who received vocational rehabilitation alone; these gains persisted for a year after the intervention ended (Bell et al., 2008). Studies that have examined the impact of cognitive training on symptom measures and social functioning have yielded inconclusive results, with some studies finding improvements (Penades et al., 2003; Spaulding et al., 1999; Wykes et al., 2007) and others failing to find such results (Wykes et al., 1999; Wykes, Newton et al., 2007). However, many of the studies that did find such improvements included comprehensive training programs that were not limited to the rehabilitation of executive

capabilities. Thus, it is quite plausible that executive gains were not solely responsible for the improvements in symptom levels or social functioning.

Additionally, other studies have failed to find a link between executive functioning remediation and everyday action outcomes. In a study of computerized cognitive rehabilitation, Kurtz et al. (2007) found that changes in verbal learning, but not executive functioning, predicted gains on a performance-based measure of everyday function, the UCSD Performance-Based Skills Assessment (UPSA; Patterson, Goldman, McKibbin, Hughs, & Jestes, 2001). In fact, no studies have demonstrated improvements in everyday action performance following the remediation of executive deficits. At present, there is no evidence to suggest that remediating executive deficits through restorative techniques can lead to improved everyday action and ADL/IADL performance.

Compensatory and Environmental Approaches to Cognitive Training

All of the above described rehabilitation approaches aim to directly improve or restore executive functioning. However, some have suggested that efforts to restore cognitive functioning may not be appropriate for individuals with schizophrenia (Bellack, 2004). Cognitive deficits may be present in schizophrenia from a relatively very young age, and the disorder is generally considered to be neurodevelopmental in nature (Bellack 2004; McGrath, Feron, Burne, Mackay-Sim, & Eyles, 2003; Wykes & van der Gaag, 2001). As such, it may not be possible to use practice or strategy-learning to achieve a

degree of cognitive functioning that never previously existed. Additionally, cognitive remediation programs are costly, time-intensive and require participant insight and motivation.

There are two alternative approaches to restorative cognitive training—compensatory techniques and environmental strategies. Compensatory techniques teach strategies that rely on intact cognitive functions to bypass cognitive deficits in memory, executive function, and attention. Environmental adaptations aim order to circumvent cognitive deficits by structuring or reorganizing the person's environment or living space.

Compensatory techniques include errorless learning, which has been shown to improve WCST performance in schizophrenia (Kern, Wallace, Hellman, Womack, & Green, 1996). Errorless learning is compensatory in that it attempts to minimize the demands placed on impaired cognitive processes (i.e. declarative memory) by recruiting intact functions (i.e. procedural memory, habit learning) to circumvent deficits. Participants start with very simple tasks whose difficulty is gradually increased. At each stage, participants meet criteria for mastery by completing the tasks without error. Because participants begin with very easy tasks whose demands are gradually increased, they do not experience failure which can derail task performance. Also, as tasks are mastered, they become automatic and do not place high demands on working and declarative memory, cognitive domains that are often impaired in schizophrenia. Other compensatory strategies include using visual imagery to remember information and self-talk to compensate for difficulties with attention (Meichenbaum & Cameron, 1973).

In a pilot study, Twamley, Savla, Zurhellen, Heaton, and Jeste (2008) examined the effects of a compensatory cognitive training intervention on cognitive functioning, performance of everyday activities, symptoms, quality of life, and a measure of self-reported cognitive difficulties. This intervention focused on four cognitive domains—prospective memory, attention and vigilance, verbal learning and memory, and executive functioning; it included ideas and materials from several sources including previous studies of cognitive rehabilitation in people with traumatic brain injury and schizophrenia. The intervention is unique in that it utilized both compensatory techniques (e.g. using self-talk, errorless learning) and environmental interventions, such as using calendars or writing down important information.

Twamley et al. (2008) found that following the intervention, participants demonstrated improvement in several cognitive domains including executive functioning. There were also moderate effects on everyday functioning and quality of life, and large effects on negative symptoms, although this gain was not maintained at a six month follow up. This study has several drawbacks including a relatively small sample size (14 individuals completed the cognitive training intervention) and a mixed-diagnosis population, including individuals diagnosed with depression with psychotic features. These limitations notwithstanding, the study demonstrates that a combination of compensatory and environmental strategies can improve executive functioning as well as everyday activities in schizophrenia.

Like compensatory approaches, environmental adaptations aim to circumvent cognitive deficits to improve functioning. However, with environmental interventions,

deficits are addressed by restructuring or organizing the person's environment. Environmental strategies also include the use of external aids such as calendars, alarms, or notepads to write down information. Although some make the distinction between compensatory and environmental approaches (Twamley et al., 2008), environmental interventions are essentially compensatory in nature in that they do not aim to improve cognitive functioning per se; rather, they utilize the environment to bypass deficits and teach new ways of meeting cognitive demands.

The only well researched environmental intervention for individuals with schizophrenia is Velligan and colleagues' Cognitive Adaptation Training (CAT; Draper, Stutes, Maples, & Velligan, 2009; Maples & Velligan, 2008; Velligan et al., 2000). CAT utilizes environmental adaptations to circumvent executive dysfunction and improve adaptive functioning, a technique that has been successfully used in populations with head injuries and mental retardation. CAT is extremely individualized, as the interventions are custom-tailored to suit every individual's behavior, level of impairment, and cognitive needs.

CAT begins with a comprehensive assessment of the treated individual. The person's behavioral functioning is evaluated with respect to the presence and degree of disinhibited behavior and apathy. Cognitive functioning in the domains of attention, memory, and executive function is also assessed, and the person's impairments in ADL/IADL are evaluated. Finally, an environmental assessment is conducted in the participant's home to identify safety hazards and triggers of maladaptive behavior, as well as to assess the person's organization and the availability of necessary supplies.

Importantly, treatment plans take executive functioning heavily into account, including participants' levels of apathy and disinhibition. Apathy is targeted by providing prompting and cuing tools that promote the initiation of steps in a given task. Such environmental adaptations include using checklists, labels, electronic devices and strategically placed signs to cue and sequence behavior. To target disinhibition, distracting stimuli are removed and objects are organized to minimize inappropriate use. For example clothing might be organized so that complete outfits are placed in different bins. Such an adaptation may reduce the likelihood of a disinhibited individual putting on multiple layers of clothing. Other executive functioning deficits are targeted through providing greater structure, assistance, and more obvious environmental cues. These interventions reduce the demands placed on executive processes such as planning and problem-solving. Additionally, environmental adaptations take into account other deficits in attention, memory, and motor coordination. To ensure that interventions are maintained or altered when necessary, a CAT therapist visits participants on a weekly basis (Velligan et al., 2000).

Several controlled studies have demonstrated that CAT leads to improvements in multiple areas of functioning (Velligan et al., 2000; Velligan, Prihoda et al., 2002; Velligan, Diamond, Mintz et al., 2008). CAT was shown to be more effective than a condition that controlled for therapist contact, in reducing both positive and negative symptoms over time. When compared to those in the control condition, individuals who received CAT had significantly lower rates of relapse and hospitalization. CAT also led to improvements in quality of life, whereas the control condition did not. Additionally

CAT improved global, community, and adaptive functioning as compared to control conditions. Moreover, many of these gains were maintained over a follow-up period of nine months. CAT has also been shown to lead to improvements in medication adherence, which is important for reducing the risk of relapse and hospitalization (Velligan, Diamond, Mintz et al., 2008). In this study, only 34% of participants who received CAT relapsed within 15 months of the intervention, compared to 81% of those who received treatment as usual. Thus, CAT appears to provide important, clinically significant improvements in a variety of functional domains.

Despite these promising results, a major drawback of CAT is its expense. The nature of the treatment necessitates that much time is spent on devising and maintaining specific adaptations for every individual. Weekly therapist visits also contribute to time-consuming and expensive nature of this intervention. Because of these concerns, Velligan and colleagues have devised a less individualized and expensive treatment, Generic Environmental Supports (GES; Velligan, Diamond, Maples et al., 2008; Velligan et al., 2009). GES is a clinic-based intervention that provides participants with a generic set of environmental supports such as calendars, pill boxes, and alarm clocks. The supports are not customized and are given to participants during their regular clinic visits. Participants are expected to set up the supports on their own; however, participants discuss with their case workers how and where to use the supports. This conversation is audio-taped, and a copy of it is given to the participant to aid in setting up the environmental interventions. Supports are replaced monthly as needed.

A study that compared CAT and GES demonstrated slightly better functional outcomes following CAT. In specific, there was a non-significant trend for CAT participants to demonstrate higher scores on the Social and Occupational Functional Scale following the interventions (Velligan et al., 2009). Additionally, rates of utilization for the environmental supports were found to be higher for CAT as opposed to GES participants (83.3% versus 49.8%; Velligan, Diamond Maples et al., 2008), and CAT participants were more likely to improve on specific target behaviors such as medication adherence, orientation, and grooming and hygiene. However, the groups did not differ with respect to outcomes on an additional functional outcomes measure, the Multnomah Community Ability Scale (Velligan, Diamond, Maples et al., 2008). Additionally, both CAT and GES were found to be superior to treatment as usual, indicating that even generic environmental supports are beneficial for this population. This study was the first to demonstrate that non-customized, inexpensive environmental supports can improve functional outcomes in schizophrenia.

Velligan and colleagues have also noted that an alternative way to cut the cost of CAT is to decrease the frequency of therapist visits over time. In traditional CAT, a therapist visits the participant's home on a weekly basis. Velligan et al (2009) examined whether treatment gains could be maintained when therapist visits were decreased in frequency from weekly to monthly. In this study, CAT participants received weekly visits for nine months; from 9 to 12 months visits were made every two weeks, and from 12 to 24 months, visits were made monthly. Results indicated that treatment gains decreased

when the frequency of therapist visits were reduced, indicating that for CAT to be most beneficial, treatment intensity must be high.

In sum, research demonstrates that CAT is an effective, although time- and resource-consuming treatment for bypassing cognitive deficits and improving functional outcomes in schizophrenia. However, more recent research has shown that even inexpensive, non-customized, environmental interventions can improve functioning in this population. Although simple environmental adaptations are promising means for improving outcomes in schizophrenia, they have not been well studied. Additionally, Velligan and colleagues have studied the impact of GES on functioning using broad outcome measures. Importantly, they have not examined the impact of these interventions on everyday action using performance-based measures. As assessment methods, both self and other report can be unreliable and subject to biases (Arguelles, Loewenstein, Eisdorfer, & Arguelles, 2001; Atkinson, Zibin, & Chuang, 1997; Bellack, 1989; Loewenstein et al., 2001); some have argued that performance-based measures are the best way to assess many functional deficits in schizophrenia (Harvey, Velligan, & Bellack, 2007). Moreover, the assessment measures used in the CAT studies are relatively broad and provide little information with respect to the details of everyday action impairment. Thus, many gaps in the literature remain.

The current study aims to add to the body of work on environmental interventions in schizophrenia by examining the impact of environmental adaptations on everyday action using a performance-based measure. The interventions used in the current study are standardized, do not require training, and are based on human factors

and classic cognitive psychology principles. Moreover, this study examines the cognitive characteristics that are associated with improvement following the adaptations. This investigation will elucidate whether environmental interventions benefit some participants to a greater degree than others.

Environmental Adaptations for Everyday Action

Human factors is the scientific study of workspace and object design for the purpose of facilitating action performance and minimizing error (Norman, 1990; Reason, 1990). This literature suggests several principles that may be used to facilitate everyday action in schizophrenia. First, action performance is facilitated when the relationship between the environment and an action is natural and highly compatible, a principle referred to as "stimulus-response (S-R) compatibility" in cognitive psychology (Fitts & Seeger, 1953). In situations of high S-R compatibility, action is performed more automatically and places fewer processing demands on the action performance system. Specifically, when the action-environment relationship is made more apparent and understandable, the number of potential actions or responses becomes constrained; this in turn diminishes the likelihood that an error of action will occur. In contrast, situations with low S-R compatibility elicit action performances that are error-prone, inefficient, and require greater cognitive control and resources. The principle of S-R compatibility has been incorporated into the design of complex, high-risk workplaces, such as cockpits (Norman, 1990; Reason, 1990). Additionally, recent work has demonstrated that interventions that facilitate the action-environment relationship can improve everyday action performance in individuals with dementia (Giovannetti et al., 2007).

Increasing the compatibility of action and the environment can be used to circumvent executive functioning deficits. Individuals with executive dysfunction have problems with performing everyday tasks that require planning and cognitive control (Velligan & Bow-Thomas, 1999). Situations with low S-R compatibility likely necessitate the recruitment of high level cognitive processes such as problem solving and planning. In contrast, situations with high S-R compatibility could potentially bypass the need for such executive mechanisms, by making action performance more automatic and less dependent on deliberate cognitive control. In essence, situations with high S-R compatibility are inherently more organized and structured than situations with low S-R compatibility. Because high S-R compatibility situations impose structure onto the environment, they could theoretically compensate for deficient top-down executive mechanisms. In fact, CAT utilizes strategies that increase environmental structure in order to address executive dysfunction. Thus, increasing action-environment compatibility could be an efficient way to bypass executive deficits and improve action performance in schizophrenia.

The human factors literature also suggests that the achievement of action goals is facilitated when the environment encourages monitoring. Because it is difficult to entirely eliminate the occurrence of errors, monitoring can be used to increase the likelihood of error detection. Detection, in turn, increases the probability of error correction, and ultimately achieving the task goals (Norman 1990; Reason, 1990). Individuals with schizophrenia are known to exhibit deficient error monitoring (Alain, McNeely, He, Christensen, & West, 2002; Bates, Liddle, Kiehl, & Ngan, 2004; Mathalon et al., 2002;

Mathalon, Jorgensen, Roach, & Ford, 2009; Silver & Goodman, 2007); however no studies have examined strategies to improve the monitoring of everyday action errors in this population.

Strategies that facilitate monitoring have been shown to assist executively impaired persons in completing complex tasks (Levine et al., 2000; Manly, Hawkins, Evans, Woldt, & Robertson, 2002). In a study of individuals with executive dysfunction following traumatic brain injury, a five step training technique that incorporated monitoring was found to improve performance on paper and pencil tests that were designed to mimic everyday tasks (Levine et al., 2000). Additionally, this technique also improved the real-life meal preparation abilities of a woman with executive deficits. However, this training technique required participants to remember to monitor their behavior; as such it is most suitable for individuals with high levels of motivation and insight (Levine et al., 2000). Because individuals with schizophrenia often lack insight into their symptoms and deficits, the training of internally-generated monitoring may be problematic for this population (Amador & Gorman, 1998; Medalia & Lim, 2004).

Alternatively, the use of environmentally-supported, external cues that prompt monitoring may be a more efficient way of facilitating action awareness in schizophrenia. Manly and colleagues (2002) have described one such strategy to promote self-monitoring in individuals with executive dysfunction. In this study, the presentation of an auditory alert tone signaled participants to stop and think about their current behavior and overall performance goals. Results showed that participants committed significantly fewer errors on a complex task with the auditory cues than without them. Human factors

researches have implemented similar techniques, including indicator lights and dialog boxes (e.g., "Are you sure you want to shut down your computer?"), in attempt to prevent high-risk errors in complex tasks (Norman, 1990). External cues may similarly promote monitoring and facilitate action performance in individuals with schizophrenia, although this has not been well studied.

The Current Study

Aim One

The current study has four aims. The primary purpose of this study was to examine whether standardized and easily implemented environmental adaptations can positively impact everyday action performance in individuals with schizophrenia. This was done by administering individuals with schizophrenia two versions of the Naturalistic Action Test (NAT; Schwartz, Buxbaum, Ferraro, Veramonti, & Segal, 2003): the Standard NAT (ST-NAT) and the User-Centered NAT (UC-NAT). Action performance was compared across both conditions. The ST-NAT requires participants to perform three everyday tasks using objects that are placed before them on a U-shaped table. Although object placement is standardized, objects are neither grouped together in any meaningful way, nor are they laid out on the table in the order that they are supposed to be used in the tasks. In contrast, the UC-NAT makes use of environmental adaptations that are based on human factors principles, and have been demonstrated to improve everyday action performance in individuals with dementia (Giovannetti et al., 2007).

In the present study, compatibility between the action and the environment was enacted via two specific environmental manipulations. First, NAT objects that are used

for the same task or sub-goal were placed in closer spatial proximity than objects that are used for separate tasks. For example, one NAT task involves making a slice of toast with butter and jelly, and a cup of instant coffee with cream and sugar. In the UC-NAT version of this task, the bread and toaster are closer to one another than the bread and the coffee mug. This manipulation aims to facilitate object selection and guide action performance. A second adaptation capitalized on our left-to-right cultural standard of displaying sequential order. This adaptation involves placing objects on the table from left to right, in the order that they are to be used in the task. Objects that are used in the beginning of the task are placed on the left end of the table, and are followed by objects that are used later on. Objects that are needed for the final steps of the task are situated on the far right end of the table. This sequential ordering of task objects should enable participants to move across the tabletop and use objects one after another as they appear in the environment.

The present study also incorporated an intervention designed to encourage monitoring. A bell with a label that read "check your work" was placed at the far right of the tabletop. Participants were told to press the bell at the end of the task, only after they had checked their work. This bell acts an external cue to prompt participants to detect and correct their errors.

I hypothesized that these environmental interventions would improve NAT performance. Specifically, I hypothesized that the UC-NAT adaptations would positively impact various aspects of NAT performance including overall performance, accomplishment, and total error rates. I also predicted that participants would take less

time to complete the UC-NAT than the ST-NAT, as the environmental interventions should make performance more efficient and streamlined. I also examined each of the three NAT tasks (i.e. toast and coffee, wrapping a present, and packing a lunchbox and a schoolbag) separately, to determine if environmental adaptations are more or less beneficial in particular contexts (i.e. when distracter objects are present, when tasks are more complex). However, I had no a priori hypotheses regarding which NAT level would demonstrate the most improvement following environmental adaptations.

Aim Two

A second aim of this study was to elucidate the mechanisms through which such interventions improve performance. These environmental adaptations could improve performance for a variety of reasons. First, as mentioned previously, these adaptations act to impose structure onto the environment. This is important, given that individuals with impaired executive functioning have problems with generating plans and exerting cognitive control over actions. Theoretically, these environmental interventions could compensate for defective top-down control mechanisms by instituting bottom-up, or environmental structure and order. Thus, the adaptations could improve everyday action performance in schizophrenia specifically because they compensate for defective executive functioning.

Additionally, adaptations that increase the compatibility between the action and the environment reduce the cognitive load that is needed to perform an everyday task. In fact, the resource theory predicts that environmental factors should influence everyday action performance (Schwartz, 2006; Schwartz et al., 1998). When the relationship

between the action and the environment is made obvious, action performance becomes more automatic, effortless, and requires fewer general cognitive resources. Thus, the proposed environmental adaptations could also improve everyday action performance by making tasks more automatic and less resource-demanding.

Previous research (Kessler et al., 2007) has demonstrated that distinct components of action performance in schizophrenia (i.e. accomplishment/omissions and commissions) are likely driven by separate aspects of cognition—global cognitive resources and executive functioning. It is therefore possible that environmental adaptations could influence action performance by compensating for executive dysfunction, for deficient global resources, or for both. The current study aims to clarify which aspect of cognitive functioning, if any, is compensated for by environmental interventions. This was done by examining the rates of different error types across the two NAT conditions.

Kessler et al (2007) demonstrated that NAT accomplishment/omissions are related to limitations in global cognitive resources whereas commissions (i.e. all non-omission errors) are best explained by executive dysfunction. If the environmental adaptations in this study confer benefits through compensating for deficient global resources, the rate of omission errors should be impacted to a greater degree than commissions. However, if the interventions improve performance via circumventing executive dysfunction, commissions, particularly action-additions and perseverations, should show the greatest degree of reduction. If rates of both omissions and commissions are comparably reduced, the interventions likely improve everyday action through

compensating for both global resource limitations and executive functioning difficulties. I hypothesized that the interventions would exert their effect by compensating for executive dysfunction, and that executive errors would be decreased to a greater degree than other error types.

In order to better understand the cognitive mechanism(s) underlying improvement, this study explored whether particular participant characteristics predict who is most likely to benefit from the environmental interventions. If the executive account of compensation is substantiated, participants with poor executive functioning should demonstrate the greatest degree of improvement following the interventions. However, if a resource account of improvement is more appropriate, participants with poor global cognitive functioning should benefit most from the UC-NAT adaptations. I hypothesized that individuals with poor executive function would show a greater degree of improvement on the UC-NAT. Additionally, exploratory analyses were conducted to determine if other participant characteristics, such as symptom profile and demographic variables, predict who is most likely to show improvement on the UC-NAT. However, I had no a priori hypotheses regarding these potential relationships.

Aim Three

The third aim of the current study was to establish the NAT's validity and reliability with respect to assessing everyday action impairments in schizophrenia. In order to determine if individuals with schizophrenia demonstrate a reliable pattern of NAT performance, the performance of a portion of the current study's participants was compared to that of the participants described in a previous study (Kessler et al., 2007).

Various aspects of performance including overall performance, accomplishment, total error rates, and error patterns were examined to replicate the findings of previous research. The NAT's convergent and discriminant validity were examined by looking at the relationships between NAT variables and a measure of ADL functioning (convergent), and the relationships between NAT variables and a measure of positive symptoms (discriminant). I hypothesized that the NAT would demonstrate reliability, convergent validity, and discriminant validity.

Aim Four

A final aim of the present study was to compare the NAT performance of individuals with schizophrenia to that of a previously studied dementia group (Giovannetti et al, 2007). Past work has demonstrated that the UC-NAT interventions significantly improve everyday action performance for individuals with dementia. This study examines whether the UC-NAT interventions improve performance to the same degree for both groups. That is, are the UC-NAT interventions differentially effective across populations? I hypothesized that the interventions would be equally effective for both groups.

CHAPTER 2

METHOD

Participants

Fifty participants were recruited for the proposed study to provide sufficient power (.955) to detect a medium effect size when alpha (p-value) was set at .05 (Erdfelder, Faul, & Buchner, 1996). Participants were recruited from the inpatient psychiatric units of two local hospitals—Temple University Hospital-Episcopal Campus and Girard Medical Center. The inpatient psychiatric units of both hospitals are comprised of adults with severe, persistent, and chronic mental illness. The typical length of stay is several months. Both hospitals are located in a low-income, urban section of North Philadelphia and the inpatient population mirrors the demographic characteristics of the surrounding community.

Participants were recruited if they were between the ages of 18-65 and if they had a primary diagnosis of schizophrenia or schizoaffective disorder according to DSM-IV criteria (American Psychiatric Association, 1994). Diagnosis was determined through chart review and structured diagnostic interviews. For three participants, diagnoses obtained from chart review conflicted with diagnoses obtained from structured diagnostic interviews. In these instances, the diagnoses were determined from the structured diagnostic interviews.[1] The decision to recruit individuals with both schizophrenia and schizoaffective disorder was based on research that has failed to indicate group

[1] In two cases, chart review indicated a diagnosis of schizoaffective disorder, whereas the SCID indicated schizophrenia. In a third case, the chart indicated schizophrenia, whereas the SCID indicated schizoaffective disorder.

differences with respect to cognitive deficits and symptom profiles (Beatty, Jocic, Monson, & Katzung, 1994; Bornstein et al., 1990; Evans et al., 1999; Fiszdon, Richardson, Greig, & Bell, 2007; Maj, Starace, & Pirozzi, 1991; Whaley, 2002). Importantly, the two diagnostic groups have also been shown to be comparable in terms of their performance on tests of executive function (Beatty et al., 1994; Beatty, Jocic, Monson, & Dennis, 1993). All of these similarities have led some researchers to conclude that schizoaffective disorder may in fact represent a variant of schizophrenia with respect to cognitive difficulties and symptoms (Evans et al., 1999). Additionally, previous research has revealed no significant differences between individuals with schizophrenia and schizoaffective disorder on both the NAT and on tests of executive function (Kessler et al., 2007). Other studies of everyday action performance have also grouped together participants with schizophrenia and schizoaffective disorder (Evans et al., 2003; Patterson et al., 1998, 2001; Twamley et al., 2002; Velligan et al., 1997; Velligan et al., 2007).

Exclusion criteria included: 1) alcohol/illicit drug abuse in the past month, 2) the presence of any neurological disorder, such as stroke or epilepsy, or history of significant traumatic brain injury, 3) mental retardation, 4) non-English speaking. The first three exclusion criteria were necessary to eliminate participants whose cognitive functioning or everyday action abilities may have been impaired for reasons other than schizophrenia/schizoaffective disorder. Non-English speakers were excluded because several of the study measures were verbal in nature and required participants to be fluent in English. These exclusion criteria mirror those used in other studies of everyday action in schizophrenia (Evans et al., 2003; Klapow et al., 1997; Patterson et al., 1998, 2001;

Semkovska et al., 2002, 2004; Twamley et al., 2002; Velligan et al., 1997). Information pertinent to exclusion criteria was obtained from medical chart review and tests of intellectual functioning.

Recruitment

All potential participants were approached by a psychiatrist or a member of the hospital staff, such as a nurse or mental health worker. Inpatients were asked if they were interested in participating in a research project, and if they would allow being approached by a member of the research team. If an individual was interested in participating, s/he was approached by a researcher who briefly explained the study. Potential participants also read and signed a HIPAA consent form which allowed the researcher to review their medical charts to determine study eligibility. Following chart review, a member of the research team approached individuals who met inclusion criteria. The research study was described to eligible individuals, and informed consent was obtained from those who agreed to participate. In addition to signing an IRB-approved consent form, participants signed a separate form that specified that they consented to having their NAT performances videotaped. Participants were compensated $25 for the sessions.

Participants did not have an identified Power of Attorney for Medical Decisions. As such, they were deemed responsible for their own medical and research decisions. Previous research has demonstrated that many individuals with schizophrenia are competent to provide informed consent (Moser et al., 2002; Pinals, Malhotra, Breier, & Pickar, 1998; Wirshing, Wirshing, Marder, Liberman, & Mintz, 1998). Nevertheless, prior to signing the consent form, participants were asked to complete a questionnaire

that assessed their understanding of the study as well as its risks and benefits. The questionnaire also assessed whether participants understood that they had the ability to withdraw their consent at any point in time. The questionnaire that was used is an adapted version of one that has been used to evaluate the comprehension capabilities of dementia patients (Buckles, et al., 2003). If participants answered any of the questionnaire items incorrectly, the study procedures were reviewed again, for a maximum of three times. However, only one participant required the study procedures to be repeated more than once. Thus, all participants were deemed competent to provide informed consent.

Measures

The diagnoses of participants were confirmed using structured diagnostic interviews. Additionally, intellectual functioning, negative and positive symptoms, everyday action abilities, global cognitive functioning, and executive functioning of participants were evaluated. Several distinct aspects of executive functioning were examined with separate measures. A collateral measure of ADL functioning was also collected. The following measures were used for this study:

Structured Clinical Interview for DSM-IV Axis I Disorders- Clinician Version

In order to verify diagnostic information, all potential participants were administered modules B and C (psychotic symptoms & psychotic disorders sections) of the Structured Clinical Interview for DSM-IV Axis I Disorders-Clinician Version (SCID-CV; First, Spitzer, Gibbon, & Williams, 1997). The SCID-CV is a structured diagnostic interview that contains questions based on DSM-IV criteria. According to the SCID-CV manual, some people, such as hospitalized individuals with psychotic symptoms, are likely to be

poor reporters of their symptoms. As a result, much of the necessary information may be obtained from reviewing medical charts and consulting with other informants, such as hospital staff members. Accordingly, the diagnostic information for this study was gathered through interviewing participants, consulting with hospital staff, and gathering information from medical charts. According to the SCID-CV manual, the measure has adequate inter-rater reliability (kappas range from .70-1.00 for different diagnostic groups).

Kaufman Brief Intelligence Test-Second Edition

The Kaufman Brief Intelligence Test-Second Edition (KBIT 2; Kaufman & Kaufman, 2004) was administered to assess for intellectual functioning in order to rule out the presence of mental retardation. The KBIT-2 is a brief measure of intellectual functioning that assesses both verbal and nonverbal intelligence. An overall intelligence composite score (IQ), verbal intelligence quotient (VIQ), and non-verbal intelligence quotient (NVIQ) can be derived. Verbal intellectual functioning is assessed by the Verbal Knowledge and Riddles subtests. The Verbal Knowledge subtest is a 60 item measure of receptive vocabulary and fund of general knowledge that requires participants to select either the correct pictorial depiction of an orally presented word or the pictorial depiction of the correct answer to an orally presented question. The Word Reasoning subtest is a 48 item measure of verbal comprehension, reasoning, and vocabulary that requires participants to provide the correct answer to a riddle that is presented by the examiner. Non-verbal intelligence is assessed with the 46 item Matrices subtest in which participants have to select the missing portion of an incomplete matrix. A KBIT-2 score

less than 70 is considered to be one that falls in the lower extreme. For this study, any participant who received VIQ and NVIQ scores less than 70 was excluded from participation due to the concern of mental retardation.

The KBIT-2 can be used to assess the intellectual functioning of individuals aged 4-90. For adults aged 19 and older, the K-BIT 2 has good internal consistency (Cronbach's α for VIQ = .92, NVIQ = .91, IQ composite = .93) and test-retest reliability (average test interval was approximately four weeks; *r* = .85-.92). The KBIT-2 has been shown to correlate with other tests of intellectual functioning such as the Wechsler Abbreviated Scale of Intelligence (WASI, Psychological Corporation, 1999; *r* = .80-.90 for adults aged 35-52) and the Wechsler Adult Intelligence Scale- Third Edition (WAIS-III, Wechsler, 1997; *r* = .79-.89 for adults aged 20-48). Additionally, in a study of psychiatric inpatients, an earlier version of the KBIT-2 was shown to correlate strongly with the WASI (*r* = .89; Hays, Reas, & Shaw, 2002).

The Naturalistic Action Test

The Naturalistic Action Test (NAT; Schwartz et al., 2003) is a standardized and published performance-based measure of everyday action. Instructions, object placement, cuing procedures, and scoring are systematized and described in detail in the test manual. The NAT involves three independent trials in which an everyday task(s) is performed with little guidance from the examiner. The trials include: 1) prepare a single slice of toast with butter and jelly and prepare a cup of instant coffee with cream and sugar; 2) wrap a gift with related distracter objects (gardening clippers, stapler, etc.) present in the array; and 3) pack a lunchbox with a sandwich, snack, and a drink and pack a schoolbag

with supplies for school, while several of the necessary objects (knife, thermos lids) are stored out of view in a drawer with additional, and potentially distracting, objects (ice tongs, measuring tape, etc). The third NAT task also requires participants to ring a bell after they complete each subtask (i.e. after packing the lunchbox and after packing the schoolbag).

The NAT was validated in a study involving 75 cerebral vascular accident patients, 25 traumatic brain injury patients, and 28 healthy controls. The NAT reliably discriminates cognitively impaired individuals from age-matched controls. The NAT has good internal consistency (Cronbach's $\alpha = .79$) and has been shown to correlate with the Functional Impairment Measure (FIM), a measure of disability that is based on clinician ratings ($r = .5$). Additionally, with dementia patients, NAT performance has been shown to correlate significantly with performance of ADL/IADL in the home (accomplishment $r = .34$; total error score $r = .45$; Giovannetti et al., 2002). Inter-rater reliability for scoring the NAT is excellent for both accomplishment scores (median kappa= .98) and overall error rates (median kappa = .95). The test-retest reliability of the NAT for individuals suffering from acute injuries in a rehabilitation setting is moderate ($r = .66$). However, this finding is not surprising given that these NATs were given in a rehabilitation setting in which cognitive functioning is not stable and some functional improvements should be expected. Thus, it is reasonable that the two tests would be imperfectly correlated.

The NAT has been used to study diverse groups of cognitively impaired individuals that include CHI (Schwartz et al., 1998), CVA (Buxbaum, Schwartz, & Montgomery, 1998; Schwartz et al., 1999), and dementia patients (Giovannetti et al.,

2002). Normative data are reported in the NAT manual (Schwartz et al., 2003) and in previously published studies (Schwartz, Segal, Veramonti, Ferrara, & Buxbaum, 2002; Sestito, Schmidt, Gallo, Giovannetti, & Libon, 2005). Previous studies have demonstrated that NAT variables are not affected by education, gender, or motor problems (Buxbaum et al., 1998; Giovannetti et al., 2002; Schwartz et al., 1998, 1999, 2002; Sestito et al., 2005).

In this study, participants performed the NAT under two conditions: 1) Standard NAT (ST-NAT); 2) User-Centered NAT (UC-NAT). In the ST-NAT condition, the NAT was administered as described in the manual. During the evaluation, participants sat at a U-shaped table on which all necessary tasks items were placed. The task objects were distributed on the tabletop to the right and left of the participant, but they were not grouped or ordered in any meaningful fashion.

In the UC-NAT condition, three environmental adaptations based on human factor principles were implemented. These environmental adaptations have been shown to improve the everyday action performance in individuals with dementia (Giovannetti et al., 2007). However, their effect on the action performance of schizophrenia participants has never been evaluated. In order to increase the compatibility between the action and the environment, objects were grouped together meaningfully, such that those that were used for the same task step were in closer spatial proximity than those that were used for different steps. For instance, the objects used for making toast were arranged in a cluster separate from the objects used for making coffee. Additionally, objects were arranged on the table from left to right in the order that they should be used in the task. For example,

in the toast and coffee task the bread was placed to the left of the toaster and the butter and jelly were placed to the right of the toaster. Participants were instructed to work from left to right, using the objects one after another; they were also told that the order of the objects would help them get through the task. Additionally, on the second NAT task, the distracter objects were placed at the far right of the table. To encourage monitoring, a bell with a label that read "check your work" was placed to the right of the last object. Participants were told to press the bell after they had checked their work and were finished with the task. See figures 1, 2, and 3 for the layout of the objects in the UC tasks.

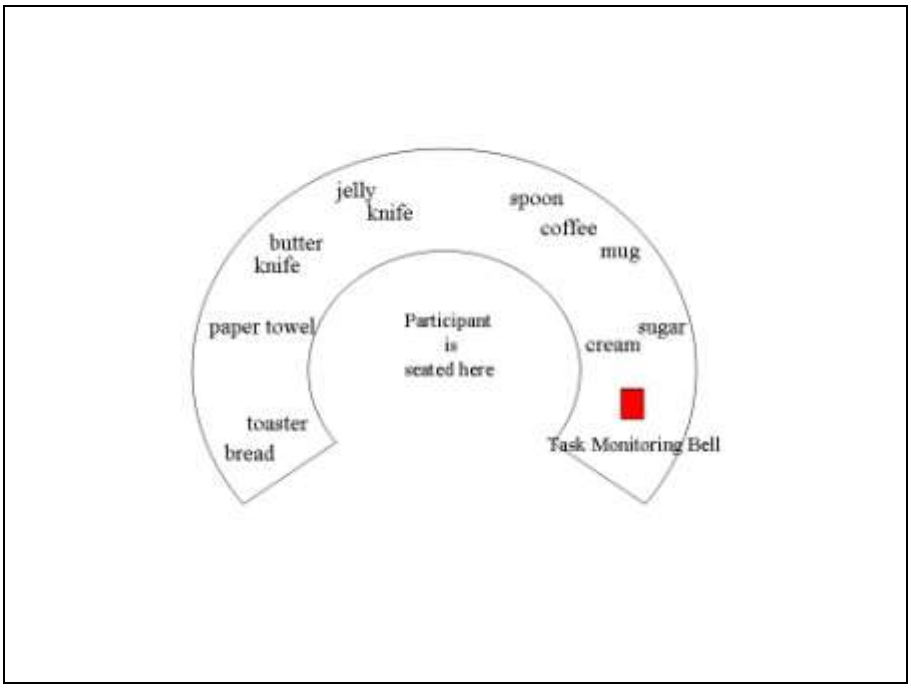

Figure 1. Layout of Objects in Level 1 of User-Centered NAT

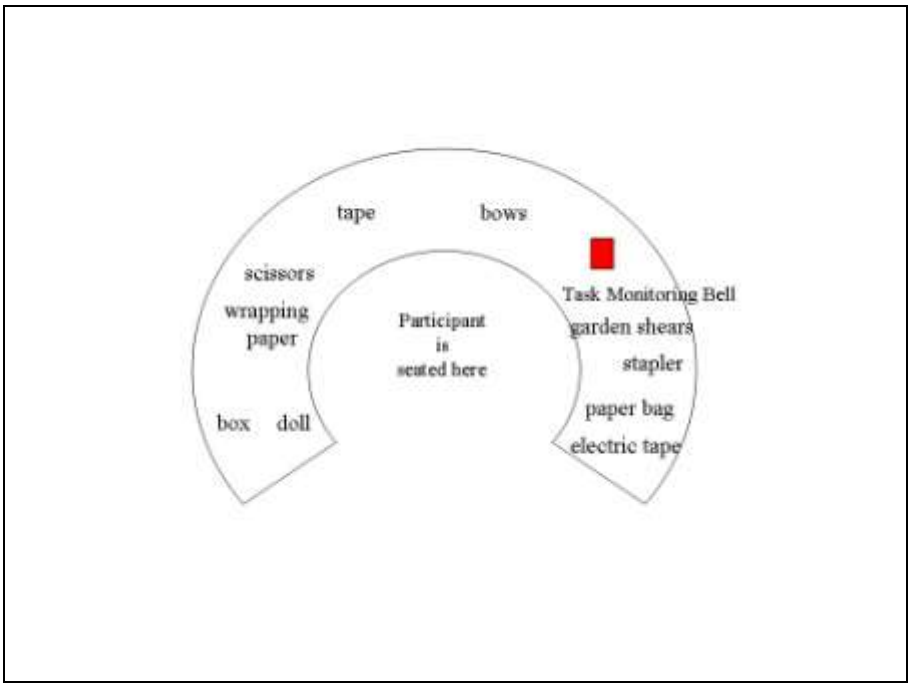

Figure 2. Layout of Objects in Level 2 of User-Centered NAT

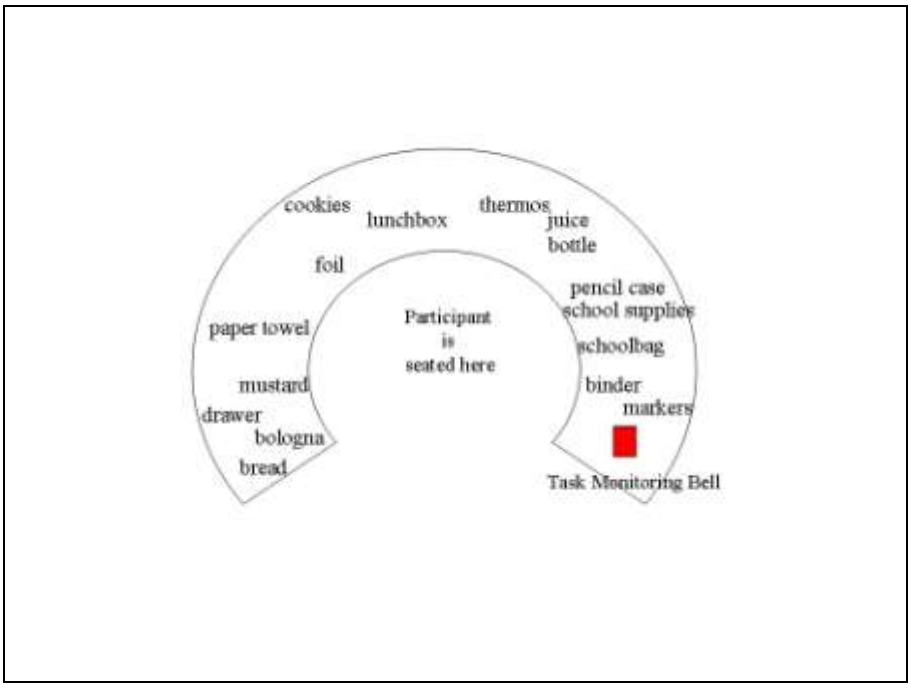

Figure 3. Layout of Objects in Level 3 of User-Centered NAT

ST-NAT and UC-NAT performances were videotaped for scoring purposes. Both ST- NAT and UC-NAT performances were scored according to the detailed research scoring system referenced in the NAT manual and described in detail in previous publications (Schwartz et al., 2002, 2003; Giovannetti et al., 2002). Several scores can be derived from the NAT and were used in this study. The NAT ACE score is an overall measure of task performance that incorporates both the percent of task steps accomplished and the occurrence of a subset of 25 key errors. ACE scores range from 0-18, with higher scores indicating better performance. For example, a score of 18 is assigned when all task steps are correctly accomplished (100% accomplishment) and fewer than four key errors are committed. For this study, in addition to ACE scores, separate Accomplishment Scores (AS) were also calculated, which reflect only task step accomplishment. AS range from 0-20, with higher scores indicating greater accomplishment. Additionally, AS% (range = 0 - 100) were calculated, which reflect the percentage of task steps accomplished.

Comprehensive Error Scores (CES) were also calculated. The CES is a measure of the total number of errors committed during the three NAT tasks. Errors are tallied and classified according to an established error taxonomy. Table 1 presents definitions and examples of each type of NAT error. Additionally, some analyses in this study examine only commission errors. Commissions consist of all NAT errors, excluding omissions.

Errors that are most frequently committed on the NAT, and that are of greatest interest for this study are omissions, anticipation-omissions, reversals, perseverations, action-additions, substitutions, and quality errors. Because other types of errors are

committed infrequently, they were grouped together into an "other errors" category. Additionally, anticipation-omissions and reversals both involve errors in the sequencing of task steps. As such, they were grouped together to form a "sequencing errors" category.

Completion time, or the number of seconds participants spent working on the entire NAT, were also collected. Time data were collected from videotape counters. Timing began when the participants initiated the first task step of each item; timing ended when participants indicated that they had finished an item.

Mini-Mental State Examination

The Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) is a 30 item measure of overall cognitive functioning that requires participants to answer questions that tap into a variety of cognitive abilities. The total score reflects the number of questions answered correctly, with higher scores indicating better global cognitive functioning. Inter-rater reliability is adequate (above .65; Folstein, et al., 1975). Test-retest reliability has been found to range from .80-.95 over intervals that are less than two months (Spreen & Strauss, 1998). Estimates of internal consistency range from .31 to .96, depending on the population being assessed (Spreen & Strauss, 1998).

Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference Test

This executive function test (Delis, Kaplan, & Kramer, 2001) is a classic measure of inhibition that requires participants to name the dissonant ink color of written color words. For example, if the word "red" is written in blue ink, participants are asked to name the ink color (blue) and not read the word (red). For this study, the scaled score for

completion time in seconds during this condition was used as a primary measure of inhibition. In a second condition of this task, participants are asked to switch back and forth between naming the dissonant ink colors and reading the color words. The scaled score for the completion time in the switching condition was used as a measure of cognitive flexibility.

Data on 101 individuals from the D-KEFS standardization sample have indicated that the inhibition and switching conditions of the Color-Word Interference Test have moderate test-retest reliability (average length of test-retest period = 25 days; inhibition r = .50-.75, switching r = .52-.57 for different adult age groups). The test-retest reliability of these measures was likely impacted by practice effects, as performance improved from the first to the second testing. The Color-Word Interference Test shows good internal consistency (Spearman Brown corrected r = .72-.86 for different adult age groups). In a subset of 23 adults age 19-78, the times to completion on the inhibition and switching conditions were shown to modestly negatively correlate with the number of categories achieved on the WCST (inhibition r = -.53, switching r = -.31), indicating that the tests show some overlap in that they assess executive functions, but that they likely tap into distinct aspects of this cognitive process (Delis et al., 2001).

D-KEFS Trail Making Test

This executive function measure (Delis et al., 2001) assesses cognitive flexibility as indicated by the ability to switch mental sets. The main condition of this task requires participants to switch between connecting numbers and letters of the alphabet in sequential order. For example, the number “1” is connected to the letter “A” which is

then connected to the number "2." For this study, a scaled score derived from the completion time in seconds was used as a measure of cognitive flexibility. The switching condition of the D-KEFS Trail Making Test has been shown to have low to moderate test retest reliability (average length of test-retest period = 25 days; *r* = .36-.55 for different adult age groups). Again, the test retest reliability of this test was likely affected by practice effects. The Trail Making Test shows good internal consistency (Spearman Brown corrected *r* = .74-.81 for different adult age groups). The time to completion on the switching condition has been shown to negatively correlate with the number of categories achieved on the WCST (*r* = -.49; Delis et al., 2001).

D-KEFS Verbal Fluency Test

This executive measure of initiation and perseveration (Delis et al., 2001) involves three conditions. In the letter fluency condition, participants have one minute to name as many words as possible that begin with a specified letter, whereas in the category fluency condition, participants name as many animals and boys' names as possible. In the category switching condition, participants must switch back and forth between naming fruits and pieces of furniture. The scaled score for the number of correct responses given in the letter fluency condition was used as a measure of initiation. Additionally, the scaled score for the switching condition of this test was used as a measure of cognitive flexibility.

The letter fluency condition of the D-KEFS Verbal Fluency Test has good test-retest reliability (average length of test-retest period = 25 days; *r* = .76-.88 for different adult age groups). The switching condition demonstrates moderate test-retest reliability (*r*

= .49-.51 for different adult age groups). The letter fluency condition shows good internal consistency (r = .77-.90 for different adult age groups) and the switching condition shows moderate internal consistency (Spearman Brown corrected r = .43-.68 for different adult age groups). The number of total correct responses on the switching condition has been shown to correlate with the number of categories achieved on the WCST (r = .33; Delis et al., 2001).

Behavioural Assessment of the Dysexecutive Syndrome (BADS) Zoo Map Test

This executive measure of planning abilities (Wilson, Alderman, Burgess, Emslie, & Evans, 1996) requires participants to demonstrate how they would visit a series of designated locations on a map of a zoo. Participants must plan their routes while abiding by a set of specified rules (e.g. participants must begin and finish the visit at designated locations on the map, they may use certain routes only once). Participants indicate their routes by drawing them on the zoo map. There are two conditions to this measure. In the first condition, participants are not given the sequence in which to visit the different locations, whereas in the second condition, the order in which to visit the locations is specified. For each condition, both the order in which the participant visits the locations (i.e. the sequence score) and the total number of errors made are examined. Sequence scores range from 0-8, with higher scores reflecting better planning. A total score for each condition can be derived by subtracting the total number of errors made from the sequence score. For this study, the total scores for both conditions were summed to produce an overall measure of planning abilities.

In a subset of 25 healthy individuals from the BADS standardization sample, the inter-rater reliability for the Zoo Map Test was shown to be good (median kappa = 96-1.00 for sequence and error scores). The test-retest reliability of the Zoo Map Test for 29 healthy adults was relatively low (test-retest period = 6 months to one year; r = .39). However, in order for the Zoo Map Test to be useful in assessing executive functioning, it must be novel. Thus, the measure's test-retest reliability would not be expected to be especially high, as the test is not novel when administered for the second time (Wilson et al., 1996). In a group of 78 neurologically impaired individuals who were part of the BADS standardization sample, the Zoo Map Test has been shown to negatively correlate with other-report ratings of everyday executive functioning problems (r = -.46).

Digit Span Subtest from the Wechsler Adult Intelligence Scale-Third Edition

This executive measure of working memory (Wechsler, 1997) requires participants to repeat orally presented strings of numbers both forward and backward. In this study, a scaled score that reflects the number of correct trials was used as a measure of working memory. This measure demonstrates internal consistency (reliability coefficients = .89-.93 for different adult age groups; Wechsler, 1997). In a subset of 394 individuals from the WAIS-III standardization sample, the Digit Span subtest showed good test-retest reliability over an interval that ranged from 2 to 12 weeks (r = .75-.79 for individuals aged 16-54). Inter-rater reliability is also good (on average, in the high .90s) for all WAIS-III subtests, including the Digit Span subtest (Wechsler, 1997).

Scale for the Assessment of Negative Symptoms

The Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1984a) is a 25 item measure provides a comprehensive assessment of the negative symptoms that are part of schizophrenia. It consists of five scales (alogia, affective blunting, avolition-apathy, anhedonia-asociality, attentional impairment) that assess different aspects of negative symptoms. Each scale is given a global rating that can range from 0-5, with higher ratings indicating greater negative symptoms. Thus, SANS summary scores range from 0-25. SANS items are rated on the basis of a clinical interview, direct observation, and any additional sources of information including staff report.

In a sample of 110 individuals with schizophrenia, the SANS demonstrated good internal consistency (Cronbach's $\alpha = .85$ for entire measure; Andreasen, 1990). In a study of 26 inpatients, Andreasen found that the SANS demonstrated good inter-rater reliability (intra-class correlation coefficient for global ratings of scales = .86-.92; Andreasen, 1982). A study of 339 outpatients also demonstrated good inter-rater reliability (intra-class correlation coefficient for summary score = .83; Schuldberg, Quinlan, Morgenstern, & Glazer, 1990); however, others have demonstrated less inter-rater reliability (intra-class correlation coefficients for global ratings = .26- .70; Mueser, Sayers, Schooler, Mance, & Haas, 1994; intra-class correlation coefficient for summary score = .60; Norman, Malla, Cortese, & Diaz, 1996). The SANS summary score has been shown to correlate with the negative symptoms scale of The Positive and Negative Syndrome Scale, another measure of symptomatology (PANSS; Kay, Opler, & Lindenmayer, 1987; $r = .88$; Norman, Malla, Cortese, & Diaz, 1996). The SANS demonstrates moderate to

low test-retest reliability (interval of 3-6 months r = .24-.46 for global ratings; Mueser et al., 1994; interval of 24 months r = .48 for summary score; Schuldberg et al., 1990).

Scale for the Assessment of Positive Symptoms

The Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984b) is a 34 item measure of positive symptoms consists of four scales (hallucinations, delusions, bizarre behavior, and positive formal thought disorder) that assess different aspects of positive symptoms. Each scale is given a global rating that can range from 0-5, with higher ratings indicating greater symptom levels. Thus, SAPS summary scores range from 0-20, and provide an overall index of positive symptoms. SAPS items are rated on the basis of a clinical interview, standardized questions, direct observation, and any additional sources of information including staff report.

In a study of 117 individuals with schizophrenia, the individual scales of the SAPS were found to demonstrate internal consistency (Cronbach's α = .66-.79 for different scales; Andreasen, 1990). However, the measure as a whole was found to have lower internal consistency (Cronbach's α = .48), indicating that different types of positive symptoms may not be strongly correlated with one another. In a study of 85 individuals with schizophrenia, Norman et al. (1996) found that the SAPS demonstrated adequate inter-rater reliability (average intra-class correlation coefficient for global ratings = .75). Others have also demonstrated good inter-rater reliability for the SAPS (intra-class correlation coefficient for summary score = .89; Schuldberg et al., 1990). The SAPS summary score has been shown to correlate with the positive symptoms scale of the

PANSS (r = .91; Norman et al., 1996). The SAPS demonstrated relatively low test retest reliability over a 24 month interval (r = .40 for summary score; Schuldberg et al., 1990).

Modified Version of the Physical Self-Maintenance Scale

To assess the real-life ADL functioning of participants, the members of the hospital staff who oversaw the participants' daily activities completed a modified version of the Physical Self-Maintenance Scale (PSMS; Lawton & Brody, 1969). This measure assesses five different ADLs: toileting, feeding, dressing, grooming, and bathing. Each ADL is rated on a scale from 1 to 5, with higher scores indicating worse ADL functioning. To increase reliability, all scores are anchored to a description. For example, in the grooming domain, a score of 1 is given when an individual is always neatly dressed and well groomed and does not require assistance. A score of 5 is given when an individual actively resists all efforts of others to maintain grooming. Ratings across all domains were summed to produce an overall ADL rating score that ranged from 5-25.

The PSMS is internally consistent (Cronbach's α = .83) and demonstrates moderate test-retest reliability (r = .56; Lawton, 1988). The PSMS demonstrates good inter-rater reliability (r = .87-.91 for patient and non-patient populations) and has been shown to correlate with ratings of functional health (r = .62) as well as with a measure of IADL functioning (r = .61; Lawton & Brody, 1969).

Procedure

All participants were tested at either Temple University Hospital-Episcopal Campus or Girard Medical Center. After participants signed the consent forms, they were administered modules B and C of the SCID-CV to verify diagnostic information. Both

versions of the NAT and the neuropsychological tests were administered over two to three testing sessions; however, the ST-NAT and UC-NAT were always administered in the first two sessions. Each session lasted approximately one and a half to two hours and began with the administration of the NAT. The order of the NAT conditions was counterbalanced across subjects to minimize order effects. Sessions one and two were separated by at least one week in order to minimize practice effects on the NAT. If a third session was necessary, it was scheduled within four weeks of the second session. NAT performance was videotaped for subsequent analysis by the investigators. In order to obtain concurrent ADL ratings, the modified PSMS was filled out by a member of the hospital staff within two weeks of the last testing session. The schedules for all of the sessions were as follows:

Session 1: NAT 1, KBIT 2, MMSE, BADS Zoo Map Test, WAIS-III Digit Span

Session 2: NAT 2; D-KEFS Color-Word Interference Test, D-KEFS Trail Making Test, D-KEFS Verbal Fluency, SAPS, SANS

Sessions 3: Necessary only if testing time for the first two sessions was excessively long.

Statistical Analyses

All statistical analyses were performed using Statistical Package for the Social Sciences, version 16.0 Gradpack. Inter-rater reliability for the NAT was established by comparing NAT AS, CES, and time to completion of two independent coders. Inter-rater reliability was examined using Cohen's κ and correlation analyses. Additional preliminary analyses were used to calculate the mean and standard deviation for each variable. The normality of all variables and the assumptions of statistical tests were

checked. Normality was examined using Shapiro-Wilk tests, and nearly all variables were not normal. Normally distributed variables included MMSE, SANS scores, IQ, ST-NAT ACE scores, and verbal fluency scores (i.e. FAS). For all analyses, attempts were made to normalize non-normal variables using several transformations (X^2, X^3, $\sqrt{X}$, log X, 1/X). However, transformations were never successful for all variables involved in a given analysis. As such non-parametric statistics were utilized. The practice of utilizing ranked-data ANOVAs for non-normal data is somewhat controversial (Erceg-Hurn & Mirosevich, 2008). Therefore, analyses were also run using parametric statistics (ANOVAs with non-ranked data), and results were compared. For all repeated measures ANOVAs, the data were examined for potential violations of sphericity. However, no violations of sphericity were present, so corrections to the data were unnecessary. When appropriate, homogeneity of variance was examined. Statistical analyses addressed the four aims of the study with several questions:

Aim One: Examine Effectiveness of UC-NAT Interventions

I. Do the UC environmental manipulations improve everyday action performance? In specific, do participants show better overall performance, accomplish more of the task steps, and commit fewer errors on the UC-NAT as opposed to the ST-NAT? Do they take less time to complete the UC-NAT?

Before the primary questions could be addressed, it was necessary to look for potential order effects. Order effects for the NAT conditions were examined using three mixed ANOVAs. NAT order (ST-NAT first vs. ST-NAT second) was a between-subjects factor and condition (ST vs. UC) acted as a within-participants factor. NAT ACE scores,

AS, and CES were dependent variables. The interaction effects of the ANOVAs, as well as the main effect for NAT order assignment and condition, were examined.

To address the primary questions of interest, separate within-sample comparisons were performed for NAT ACE scores, AS, CES, and time to completion. Performance was compared between the ST-NAT and UC-NAT conditions using Wilcoxon Signed-Rank tests. Because these analyses are of primary importance for this study, corrections for multiple comparisons were made using a very conservative approach, the Bonferroni method; as such, the p-value for each comparison was set at .0125. For small samples, the power efficiency of the Wilcoxon is nearly 95 percent of the paired-sample t-test (Seigal & Castellan, 1988). Therefore, effect sizes for all ST-NAT vs. UC-NAT analyses were estimated using Cohen's d calculations (Cohen, 1988).

The percentage of participants who fell in the impaired range on the NAT on both the ST and UC conditions was also examined. NAT ACE scores below 14.81 and CES above 5.84 are indicative of impaired NAT performance, as these scores are more than two standard deviations below/above those of healthy controls. Chi square analyses were utilized to determine whether the percentage of impaired participants differed significantly across the two conditions.

II. Does the degree of improvement vary across the different NAT levels (toast and coffee vs. present wrapping vs. lunchbox and schoolbag)?

Two repeated measures ANOVAs were conducted to address this question. NAT level (1 vs. 2 vs. 3) and condition (ST vs. UC) acted as within-participant factors. NAT CES and NAT AS (ranked data; Akritas & Arnold, 1994) were dependent variables.

Main effects and two-way interaction effects were examined and post-hoc tests were performed using Bonferroni pairwise comparisons. Effect sizes for the interactions were computed using Eta squared.

Aim Two: Elucidate the Mechanisms That Underlie NAT Improvement

I. Do UC interventions compensate for global cognitive deficiencies, for executive dysfunction, or for both?

a. Are rates of omissions and commissions (especially perseverations and action-additions) comparably reduced by the UC interventions?

This question was addressed using a repeated measures ANOVA with error type (perseverations vs. action-additions vs. omissions) and condition (ST vs. UC) as the within-participant factors; total number of NAT errors (ranked data) acted as the dependent variable. The interaction effect was examined, and post-hoc tests were performed using Bonferroni pairwise comparisons. Effect size was computed using Eta squared.

b. Are individuals with poor global cognitive functioning or executive functioning more likely to benefit from UC adaptations?

To address this question, CES difference scores were calculated between the ST-NAT and UC-NAT [CES difference score = (ST NAT CES – UC NAT CES)/ ST NAT CES]. A positive difference score reflects lower total error rates in the UC-NAT condition (i.e. improvement). Difference scores could not be calculated for NAT AS, due to the restricted range of that variable.

To assess the cognitive characteristics associated with benefit from environmental adaptations, Spearman-Rank Order correlations were performed between CES difference scores and neuropsychological test scores. For this analysis, all three executive measures of switching were averaged to yield a cognitive flexibility composite score. In total, six correlations were examined: the relationship between CES difference scores and 1) MMSE, 2) switching composite score, 3) color-word interference test/inhibition, 4) verbal fluency/initiation, 5) digit span/working memory, and 6) zoo map test/planning. Because these analyses are not primary for this study and are exploratory in nature, a less conservative method was used to correct for multiple comparisons: overall alpha was set at .1 and divided by the number of tests conducted (p-values = .1 / 6 = .017).

NAT difference scores were also calculated separately for omission and commission errors [e.g. omission difference score = (ST NAT omission – UC NAT omission)/ ST NAT omission]. Positive difference score reflects fewer errors in the UC condition (i.e. improvement). Separate correlation analyses between the six cognitive measures and both omission and commission differences scores were also conducted. Corrections for multiple comparisons were made in the manner described above.

Additionally, the relations between neuropsychological test scores and NAT variables for both conditions were examined in a post-hoc manner with Spearman-Rank Order correlations. Multiple regression analyses were conducted to help further clarify the relationship between neuropsychological functioning and NAT performance.

II. Do other participant characteristics, such as symptoms or demographic variables predict who is more likely to benefit from the UC interventions?

Spearman-Rank Order analyses were used to examine the relationships between NAT improvement and demographic and symptom variables. The following correlations were examined: the relationship between CES difference scores and 1) SANS, 2) SAPS, 3) IQ, 4) age, 5) education, and 6) gender. Corrections for multiple comparisons were made in the manner described above (p-values = .1 / 6 = .017). The relationships between demographic/symptom variables and omission and commission difference scores were also examined.

The relations between demographics and NAT variables for both conditions were examined in a post-hoc manner with Spearman-Rank Order correlations. Multiple regression analyses were conducted to further clarify the relationship between neuropsychological functioning, demographics, and NAT performance.

Aim Three: Establish Reliability and Validity of the NAT for a Schizophrenia Population

I. Do individuals with schizophrenia demonstrate a reliable pattern of ST NAT performance?

To address this question, the current sample was divided into two waves. The first wave was included in a previous study of everyday action performance (Kessler et al., 2007) and was assessed at an earlier point in time. The second wave was assessed at a later point in time and had never been previously studied. ST-NAT ACE scores, AS, and CES were compared for the two groups using Mann-Whitney U tests. Performance differences between these two groups were not expected and would be cause for concern. Thus, to increase the power of these analyses, the p-values for these tests were set at .05. Effect sizes were estimated with Cohen's d calculations (Cohen, 1988).

Chi Square tests were used to compare the error patterns (i.e. the distributions of different error types) of the two groups. Additionally, the relationship between ST-NAT accomplishment and commission errors was examined for the new schizophrenia participants. This was done to determine whether the previous finding of no significant relationship between these variables holds true for the current sample.

II. Does the ST NAT demonstrate convergent and discriminant validity for schizophrenia populations?

To demonstrate convergent validity, the relationships between Modified Physical Self-Maintenance Scale scores (i.e. ratings of ADL functioning) and ST-NAT ACE scores, AS, and CES were examined using Spearman-Rank Order correlations. Multiple comparisons were corrected for by setting the overall alpha at .1 and dividing it by the number of tests conducted (p-values = .1 / 3 = .033). In order to establish discriminant validity for the NAT, correlations between the SAPS and NAT ACE scores, AS, and CES were examined. Given that previous research has determined that functional impairments in schizophrenia are not associated with positive symptoms, the NAT was not expected to correlate with the SAPS (Green, 1996; Green et al., 2000).

Aim Four: Compare NAT Performance to that of Dementia Patients

I. How does NAT performance of the schizophrenia group compare to that of individuals with dementia? Do the populations demonstrate equivalent degrees of improvement from the ST-NAT to the UC-NAT?

NAT ACE scores, AS, and CES for the two groups were compared using Mann-Whitney U tests. Three mixed ANOVAS with group (schizophrenia versus dementia) as

the between-group factor, and condition (ST-NAT vs. UC-NAT) as the within-subject factor, were run to determine whether both groups showed equal improvement from the ST-NAT to the UC-NAT. Dependent variables were ranked ACE scores, AS, and CES.

CHAPTER 3

RESULTS

Missing and Excluded Data

Data were collected for 50 participants. Eight participants were excluded from analyses due to IQ scores that fell below 70. For the remaining 42 participants, ST-NAT time data were missing for two individuals, and CES information was missing for one person, due to videotape malfunctions. All other NAT variables were available for the entire sample. With respect to demographics, it was not possible to determine age of onset/duration of illness for four participants. SAPS and ADL measurements were available for 28 and 22 participants, respectively, as these measures were included halfway through the study. With respect to neuropsychological test variables, two participants were unable to complete the Trail Making Test, and three were unable to complete the Zoo Map Test. These participants did not comprehend the neuropsychological task requirements, despite multiple repetitions of directions and cues. Other demographic and neuropsychological test variables were available for all 42 participants.

Demographics

The sample consisted of 42 individuals, 22 (52.4%) of whom were men. 76.2% (*n* = 32) of the sample was African American, 21.4% was Caucasian (*n* = 9), and 2.4% (*n* = 1) was Latino/Hispanic. Information regarding medication was lost for one participant. Of the remaining 41 participants, 25 (60.98%) took atypical antipsychotics, 6 (14.63%) took typical antipsychotics, and 10 (24.39%) took both typical and atypical

antipsychotics. The remaining demographics of all participants are provided in Table 2, and show that, in general, the sample exhibited Borderline intellectual functioning and moderate-level negative and positive symptoms.

Table 2. Demographics

	N	Mean	SD
Age	42	43.79	11.00
Education	42	12.14	2.05
Illness Duration (years)	38	23.08	10.96
IQ	42	76.52	6.31
SANS	42	12.60	4.28
SAPS	28	11.21	4.70

SANS = Scale for the Assessment of Negative Symptoms; SAPS = Scale for the Assessment of Positive Symptoms

Inter-rater Reliability for NAT variables

With respect to CES, the raters demonstrated 98.77% agreement in coding NAT errors (CES Cohen's $\kappa = .88$, almost perfect agreement; Landis & Koch, 1977). The raters agreed on 99.00% of AS points (Cohen's $\kappa = .94$; almost perfect agreement). Mean Total Times between the two raters differed by less than 1 second (Rater 1 $M = 1109.00$, $SD = 616.72$; Rater 2 $M = 1109.90$, $SD = 618.97$) and were very strongly and significantly correlated ($r = .99$, $p < .01$).

Hypothesis Testing

Aim 1: Examine Effectiveness of UC-NAT Interventions

Order Effect Data

Three condition (ST-NAT versus UC-NAT) by order (ST-NAT first versus second ST-NAT second) mixed ANOVAs were examined to determine whether there were order effects for the NAT ACE, AS, and CES. The main effects for order were non-significant for ACE scores, AS, and CES (ACE order F (1, 40) = .16, p = .69; AS order F (1, 40) =.29, p = .60; CES order F (1, 39) = .08, p = .78), indicating that improvement on the NAT cannot be attributed to order assignment alone. The effect of condition also was significant for all three dependent variables (these comparisons will be discussed below).

The condition by order interaction for ACE was not significant (ACE interaction F (1, 40) = 2.00, p = .17). The interaction effects for both AS and CES were significant (AS interaction F (1, 40) = 4.84, p = .03, η^2 = .09, medium effect; CES interaction F (1, 39) = 5.22, p = .03, η^2 = .09, medium effect), indicating that individuals showed a greater degree of improvement from the ST-NAT to the UC-NAT when the ST-NAT was administered first (see Figures 4 - 6).[2] For CES, the effect size for condition (η^2 = .27, large effect) was greater than the effect size for the order x condition interaction (η^2 = .09, medium effect). There was a similar difference between the AS effect size for condition (η^2 = .18, large effect), and the effect size for the condition x order interaction (η^2 = .09, medium effect). Despite the significant interaction effects for AS and CES,

[2] Results were unchanged when ANOVAs were run using non-ranked data, with the exception that the Order x Condition interaction effect for CES was non-significant (F (1, 39) = 1.93, p = .17).

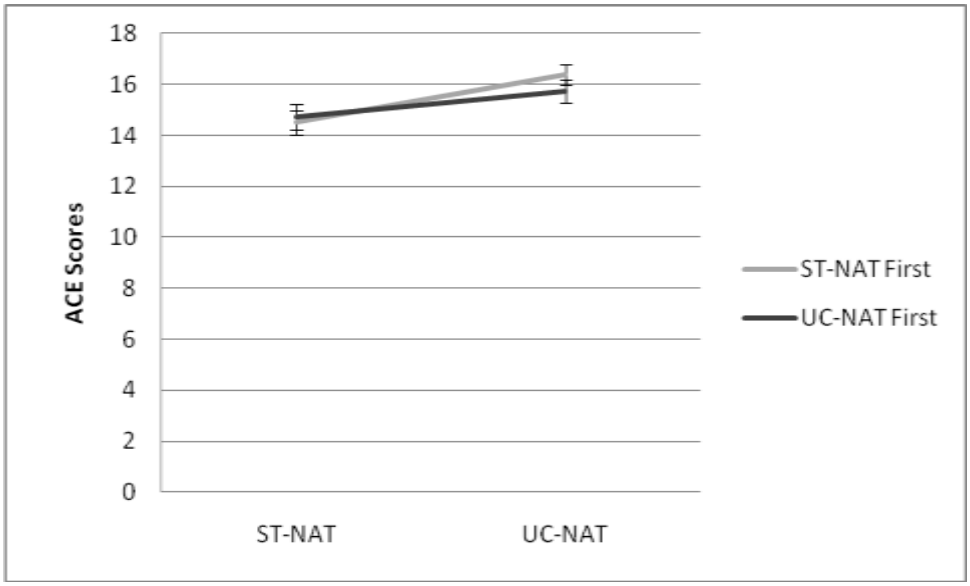

Figure 4. Mean NAT ACE Score by Condition and Session Order (Error Bars Represent 1 Standard Error of the Mean)

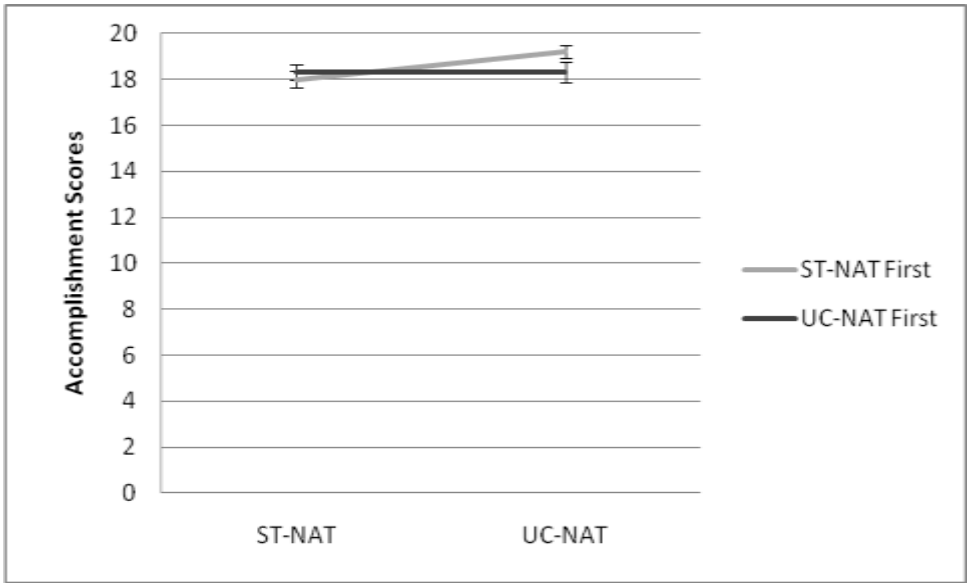

Figure 5. Mean NAT Accomplishment Score by Condition and Session Order (Error Bars Represent 1 Standard Error of the Mean)

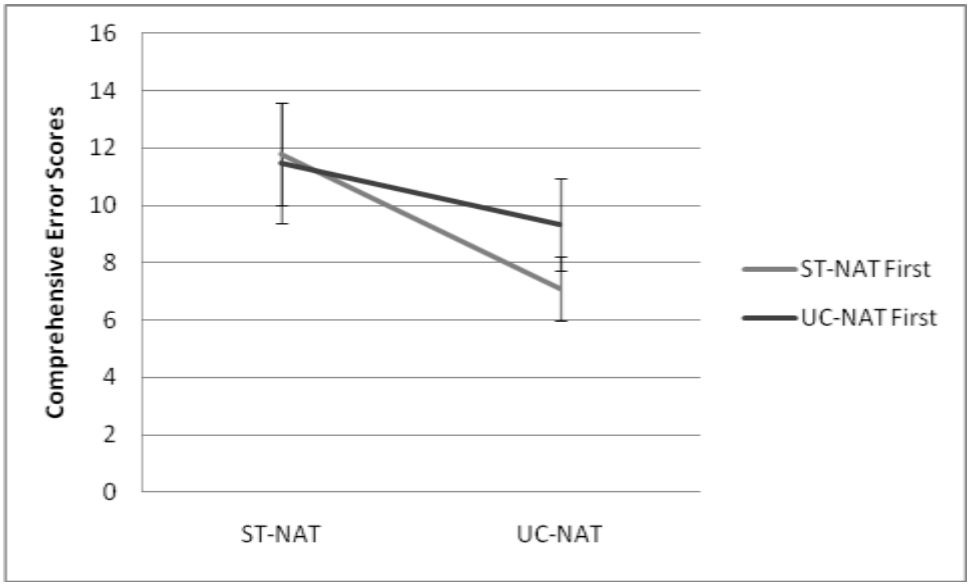

Figure 6. Mean NAT Comprehensive Error Score by Condition and Session Order (Error Bars Represent 1 Standard Error of the Mean)

the non-significant main effect of order assignment along with the large effect sizes for the main effect of condition, indicate that NAT order assignment is not entirely responsible for improvement from ST-NAT to UC-NAT conditions.

ST-NAT Versus UC-NAT Comparisons

Participants demonstrated better overall performance on the UC-NAT than the ST-NAT, as indicated by ACE scores (M Ranks: 50.56 vs. 34.44; $Z = 3.58$, $p < .001$). They also had higher levels of accomplishment, although the comparison just missed statistical significance according to the Bonferroni-corrected p-value of .0125 (M Ranks: 48.24 vs. 36.76; $Z = 2.33$, $p = .02$). Participants made fewer errors on the UC-NAT than on the ST-NAT (M Ranks: 36.20 vs. 47.94; $Z = 3.37$, $p = .001$). Time to completion did not differ between the two conditions (M Ranks: ST-NAT = 42.04 vs. UC-NAT = 40.99, $Z = .73$, $p = .47$). Effect sizes were large for ACE comparisons ($d = .68$) and medium for

AS and CES comparisons (AS d = .35; CES d = .44). For means of NAT variables across conditions, see Table 3. [3]

Table 3. Means and SDs for NAT Variables

	ACE M(SD)	AS M(SD)	CES M(SD)	Time M(SD)
SZ ST-NAT	14.62 (2.24)	18.17 (1.53)	11.63 (8.85)	1145.43 (628.16)
SZ UC-NAT	16.05 (1.96)	18.74 (1.71)	8.26 (6.46)	1048.57 (436.16)

SZ ST-NAT = schizophrenia group standard NAT; SZ UC-NAT = schizophrenia group user-centered NAT; ACE = ACE scores; AS = accomplishment; CES = comprehensive error score; Time = time to completion in seconds

The percentage of participants who fell in the impaired range on the NAT was examined for both ST-NAT and UC-NAT conditions. 47.62% of participants had impaired ACE scores on the ST-NAT whereas 16.67% of participants had impaired UC-NAT ACE scores (ACE cutoff score = 14.81). The percentage of participants with impaired ACE scores was significantly different across ST-NAT versus UC-NAT conditions (X^2 = 9.22, p = .002, ϕ = .33, medium effect). With respect to CES, 78.05% of participants demonstrated impaired performance on the ST-NAT, whereas 57.14% demonstrated impaired performance on the UC-NAT (CES cutoff score = 5.84). This difference is significant (X^2 = 4.13, p = .04, ϕ = .22, small to medium effect).

[3] Results were unchanged when analyses were performed using paired samples t-tests.

Variation in Improvement Across NAT Level

Two NAT level (1 vs. 2 vs. 3) by condition (ST-NAT vs. UC-NAT) repeated-measures ANOVAs were conducted to examine variation in CES and AS%. For CES, the main effect for level was significant (F (2, 80) = 24.87, p <.001, η^2 = .26, large effect). Bonferroni pairwise comparisons revealed that participants made fewer errors on tasks 1 and 2 than on task 3 (p <.001 for both comparisons; M Ranks: Task 1 = 112.03, Task 2 = 100.08, Task 3 = 165.58). CES scores on tasks 1 and 2 were not significantly different (p = .63). As reported above, the effect of condition (ST-NAT vs. UC-NAT) also was significant. However, the condition by level interaction effect was not significant (F (2, 80) = 2.64, p = .08), indicating no significant variation in CES improvement across NAT levels (see Figure 7)[4].

For AS%, the main effect for level was significant (F (2, 82) = 15.52, p < .001, η^2 = .18, large effect). Bonferroni pairwise comparisons indicated that participants accomplished a smaller percentage of steps on task 3 than on tasks 1 and 2 (p < .001 for both comparisons; M Ranks: Task 1 = 140.63, Task 2 = 143.21, Task 3 = 95.67). The percentage of task steps accomplished on tasks 1 and 2 was not significantly different (p = 1.0). With respect to improvement across conditions, the condition by level interaction effect was not significant (F (2, 82) = 1.30, p = .28), indicating no significant variation in AS% improvement across NAT levels (see Figure 8).[5]

[4] Results were unchanged when analyses were performed using non-ranked data.

[5] Results were unchanged when analyses were performed using non-ranked data.

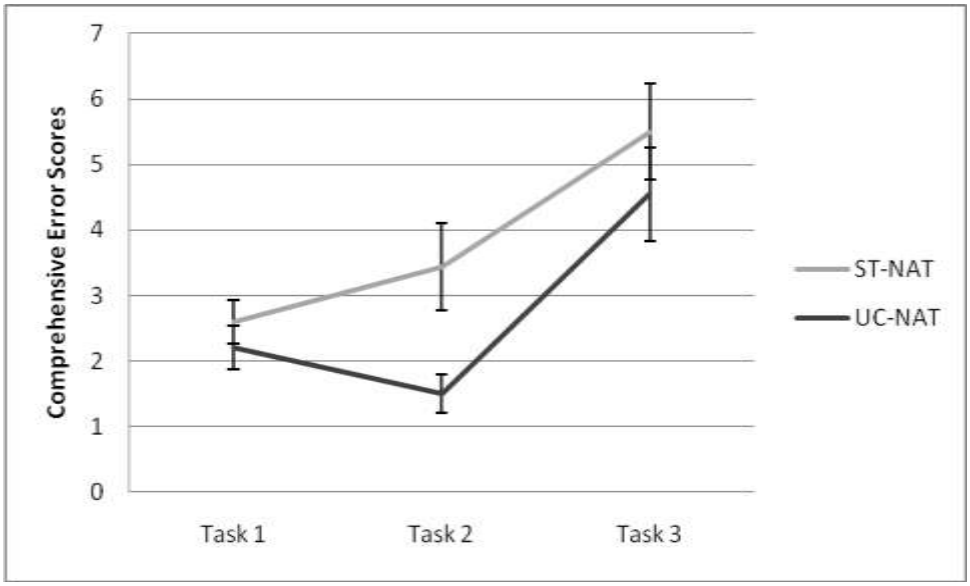

Figure 7. CES Improvement Across NAT Level (Error Bars Represent 1 Standard Error of the Mean)

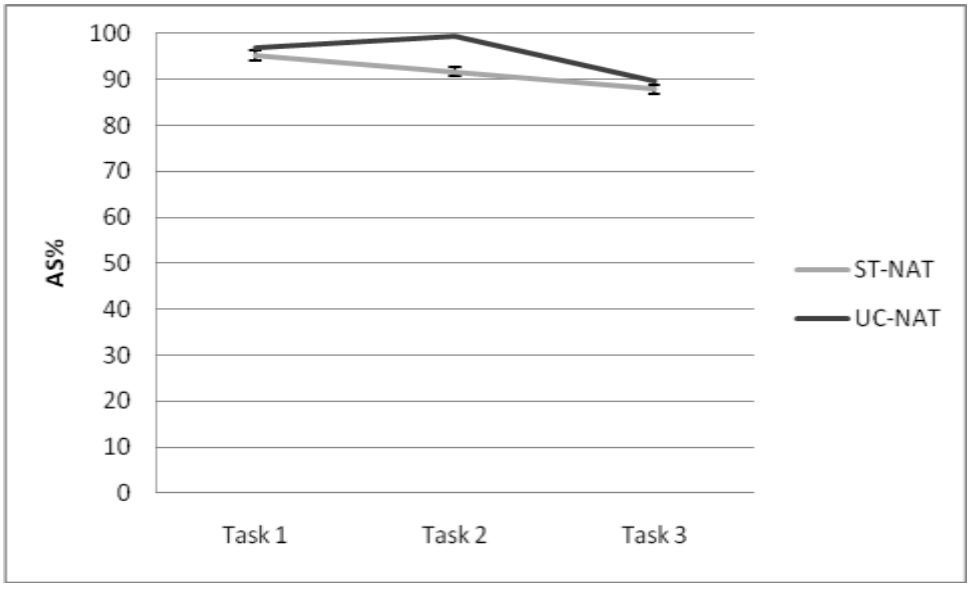

Figure 8. AS% Improvement Across NAT Level (Error Bars Represent 1Standard Error of the Mean)

Aim 2: Elucidate the Mechanisms that Underlie NAT Improvement

Are Commissions and Omissions Comparably Reduced by UC Interventions?

A repeated-measures ANOVA was conducted to examine whether different error types (omissions, perseverations, action-additions) were differentially affected by the UC-NAT interventions. The main effects of error type (F (2, 80) = 3.16, p = .05, η^2 = .05, small effect) and condition (F (1, 40) = 5.53, p = .02, η^2 = .01) were significant. More importantly, the condition (ST-NAT vs. UC-NAT) by error type (perseveration vs. action addition vs. omission) interaction effect was significant (F (2, 80) = 4.44, p = .02, η^2 = .02, small effect), indicating that the error types were differentially affected by the UC-NAT manipulations. Post hoc tests revealed that omissions were significantly reduced by the UC interventions (M Ranks: ST-NAT omissions = 48.52, UC-NAT omissions = 35.63; Z = 2.65, p = .008; see Figure 9). Perseverations and action-additions were not significantly different across the conditions (p > .05 for both comparisons).

The Relation between UC-NAT Improvement and Global and Executive Functioning

CES difference scores were calculated for all participants (M = 0.14, SD = 0.62) to determine whether participants demonstrated improvement on the UC-NAT condition. As stated earlier, a positive difference score reflects improvement in the UC condition. CES improvement was not significantly correlated with any of the neuropsychological test scores (p > .09 for all correlations; see Table 4). Omission (M = 0.21, SD = 1.12) and commission (M = -0.08, SD = 1.04) difference scores were not correlated with any of the neuropsychological test variables (p > .1 for all correlations; for correlations see Table 4).

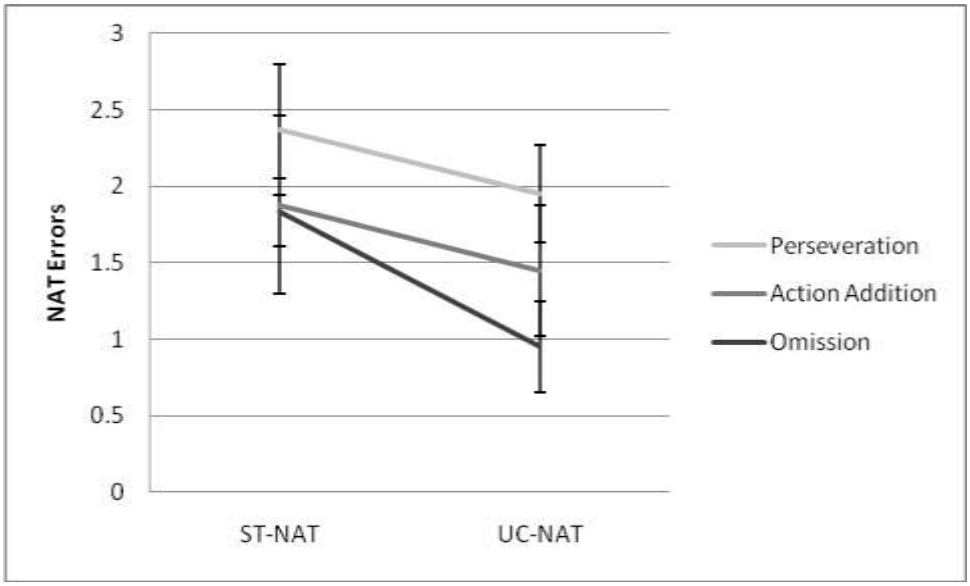

Figure 9. CES Improvement Across Error Type (Error Bars Represent 1 Standard Error of the Mean)

Table 4. Spearman-Rank Order Correlation Coefficients (r_s) between Difference Scores and Neuropsychological Test Scores

	MMSE	FAS	Digits	Stroop	Switch	Zoo Map
CES-Difference	-.09	-.27	.02	.08	.20	-.15
Om-Difference	.04	-.25	-.07	-.16	-.04	-.18
Com-Difference	-.04	-.24	-.04	.01	.14	-.01

MMSE = Mini Mental State Exam; FAS = Verbal Fluency scaled score; Digits = Digit Span scaled score; Stroop = Stroop Inhibition scaled score; Switch = composite switching score; Zoo Map = BADS Zoo Map profile score; CES-Difference = CES difference score; Om-Difference = omission difference score; Com-Difference = commission difference score

Participant Characteristics Associated with UC-NAT Improvement

CES improvement was not significantly correlated with any demographic variables ($p > .2$ for all correlations; see Table 5). The relations between demographics

and omission and commission difference scores were also examined (see Table 5). Omission difference scores were negatively correlated with education (r_s = -.34), although the p-value for this correlation (p = .03) was greater than the corrected p-value for this analysis ($p \leq .017$)[6]. Commission difference scores were not correlated with any of the demographic variables (p >.1 for all correlations).

Table 5. Spearman-Rank Order Correlation Coefficients (r_s) between Difference Scores and Demographics/Symptoms

	Gender	Age	Education	IQ	SAPS	SANS
CES-Difference	.08	-.21	-.11	-.20	-.01	.05
Om-Difference	-.02	-.07	-.34*	-.27	.29	-.09
Com-Difference	.05	-.26	-.15	-.14	.01	-.06

*p ≤ .05; SANS = Scale for the Assessment of Negative Symptoms; SAPS = Scale for the Assessment of Positive Symptoms; CES-Difference = CES difference score; Om-Difference = omission difference score; Com-Difference = commission difference score

Relations between Demographics, Symptoms, and NAT Performance

Because nearly no significant relations were found between NAT improvement and participant characteristics, associations between demographics/symptoms and NAT variables for both conditions were examined to determine whether the two conditions were differentially related to these variables. These analyses were intended to help elucidate which participants might benefit most from the UC interventions. Means and

[6] The direction of this relation indicates that participants with the greatest reduction in omission errors on the UC-NAT had attained lower levels of education.

standard deviations of demographics, symptoms, and NAT variables are provided in Tables 2 and 3. As shown in Table 6, IQ was significantly positively correlated with ST-NAT AS and negatively correlated with CES. All other ST-NAT correlations were non-significant (see Table 6). The relations between demographics/symptoms and UC-NAT performance were also examined. Age was significantly positively correlated with UC-CES and negatively correlated with UC-AS. All other correlations were non-significant (see Table 6).

Table 6. Spearman-Rank Order Correlation Coefficients (r_s) between NAT Variables and Demographics/Symptoms

	Gender	Age	Education	IQ	SAPS	SANS
ST-AS	-.05	-.01	.13	.50***	-.13	-.09
ST-CES	.17	.29	.01	-.41**	.15	.10
UC-AS	-.13	-.31*	-.18	.11	.06	-.02
UC-CES	.08	.46**	.11	-.22	.24	.08

*p ≤ .05; ** p≤ .01; ***p ≤ .001; ST-AS = ST-NAT accomplishment; ST-CES = ST-NAT comprehensive error score; UC-AS = UC-NAT accomplishment; UC-CES = UC-NAT comprehensive error score

Neuropsychological Test Scores and NAT Performance

The means and standard deviations of neuropsychological test scores are provided in Table 7. The relations between ST-NAT performance and neuropsychological test scores were examined using Spearman–Rank Order correlations (see Table 8). The composite switching score and general cognitive functioning (i.e. MMSE score) were positively associated with ST-NAT AS and negatively associated with CES. Zoo Map

scores were negatively correlated with CES. No other correlations between ST-NAT performance and neuropsychological test scores were significant (see Table 8).

The relations between UC-NAT performance and neuropsychological test scores were also examined using Spearman-Rank Order correlations. The composite switching score and MMSE were negatively correlated with UC-CES. All other correlations were non-significant (see Table 8).

Table 7. Neuropsychological Test Scores

	N	Mean	SD
MMSE	42	25.88	2.17
FAS	42	6.07	3.05
Digits	42	6.74	1.67
Stroop	42	4.36	3.88
Switch	40	3.78	2.40
Zoo Map	39	.36	1.27

MMSE = Mini Mental State Exam; FAS = Verbal Fluency scaled score; Digits = Digit Span scaled score; Stroop = Stroop Inhibition scaled score; Switch = composite switching score; Zoo Map = BADS Zoo Map Profile score

Multiple Regression Analyses

Three multiple regression analyses were conducted to further explore the combined effects of demographic and neuropsychological variables as predictors of NAT performance. These exploratory analyses were done to examine the variables that best

Table 8. Spearman-Rank Order Correlation Coefficients (r_s) between NAT Variables and Neuropsychological Test Scores

	MMSE	FAS	Digits	Stroop	Switch	Zoo Map
ST-AS	.32*	.30	.18	.09	.35*	.23
ST-CES	-.39**	-.19	.05	-.13	-.47**	-.40**
UC-AS	.13	.19	-.04	.10	.25	.04
UC-CES	-.31*	.00	.03	-.26	-.64***	-.28

*p ≤ .05; ** p≤ .01; ***p ≤ .001; MMSE = Mini Mental State Exam; FAS = Verbal Fluency scaled score; Digits = Digit Span scaled score; Stroop = Stroop Inhibition scaled score; Switch = composite switching score; Zoo Map = BADS Zoo Map profile score; ST-AS = ST-NAT accomplishment; ST-CES = ST-NAT comprehensive error score; UC-AS = UC-NAT accomplishment; UC-CES = UC-NAT comprehensive error score

predict action performance separately for the two NAT (ST and UC) conditions. Such analyses allow for comparisons across conditions with respect to variables potentially influencing action performance. Demographic and neuropsychological variables that were significantly related to NAT variables in the above correlation analyses were chosen as predictors for the regressions. Conceivably, the relations between neuropsychological factors and everyday action could be explained by demographics such as IQ, which are known to correlate with neuropsychological test scores and action performance. Therefore, predictor variables were entered in two blocks—significant demographic variables were entered together in the first block, and significant neuropsychological test scores were entered together in the second block. This was done to determine if neuropsychological variables contributed to the prediction of everyday action even when IQ and age were taken into account. UC-AS was not analyzed, because this variable was related only to age in the correlation analyses reported above.

Results for all three regressions are shown in Table 9. In the first regression, ST-NAT AS acted as the dependent variable and IQ, MMSE, and composite switching scores were entered as independent variables. For, ST-NAT AS, the model accounted for 23% of the variance and included IQ as the only significant predictor. In the second regression, ST-NAT CES was the dependent variable and IQ, MMSE, composite switching scores, and Zoo Map Profile scores acted as predictors. The model accounted for 31% of the variance and included only Zoo Map Profile scores as a significant predictor. In the final regression, UC-NAT CES was the dependent variable and age, MMSE, and composite switching scores were entered as independent variables. The model accounted for 49% of the total variance and included age and composite switching scores as significant predictors.

Table 9. Multiple Regression Analyses (Beta Values)

	IQ	Age	MMSE	Switch	Zoo Map
ST-NAT AS R^2 = .23 F = 11.03**	.47**	-------	****	****	-------
ST-NAT CES R^2 = .31 F = 3.43*	.09	-------	.04	.33	-.37*
UC-NAT CES R^2 = .49 F = 11.54***	-------	.52***	.29	.63***	-------

------ = variables were not included as predictors in analyses; **** = variables were not included in the final model
*p ≤ .05; ** p≤ .01; ***p ≤ .001; MMSE = Mini Mental State Exam; Switch = composite switching score; Zoo Map = BADS Zoo Map profile score; ST-AS = ST-NAT accomplishment; ST-CES = ST-NAT comprehensive error score; UC-CES = UC-NAT comprehensive error score

Aim 3: Establish Reliability and Validity of the NAT for a Schizophrenia Population

Reliability of SZ NAT Performance

The ST-NAT performance of the first wave of current sample (n = 20) was compared to that of the second wave of the current sample (n = 22). The two groups did not differ with respect to ACE Scores, AS, and CES (ACE M Ranks: first wave = 33.50 vs. second wave = 35.30, Z = .41, p = .68; AS M Ranks: first wave = 35.45 vs. second wave = 37.95, Z = .48, p = .63; CES M Ranks: first wave = 48.84 vs. second wave = 47.16, Z = .25, p = .80), indicating a reliable pattern of NAT performance[7] across the two groups. When the distribution of error types of the two samples were compared, the second wave had proportionally more perseverations (24.3% versus 16.2%; X^2 = 4.76, p = .03, ϕ = .10, small effect). There were no other significant differences in error patterns between the two groups (for all other error types X^2 < 3.29, p > .07). See Figures 10 and11 for error distributions of the two groups.

Previous work with a schizophrenia population demonstrated no relation between AS and commission errors. Correlation analyses were used to determine whether this result was applicable to a portion of the current sample (n = 22). Results indicated no relation between NAT AS and commissions (r_s = -.05, p = .84).

Convergent and Discriminant Validity of the NAT

In order to establish convergent validity, correlations between NAT performance and a measure of ADL functioning were examined. None of the ST-NAT variables were related to ADL functioning (p > .37 for all correlations; see Table 10).

[7] Results were unchanged when analyses were conducted using independent samples t-tests.

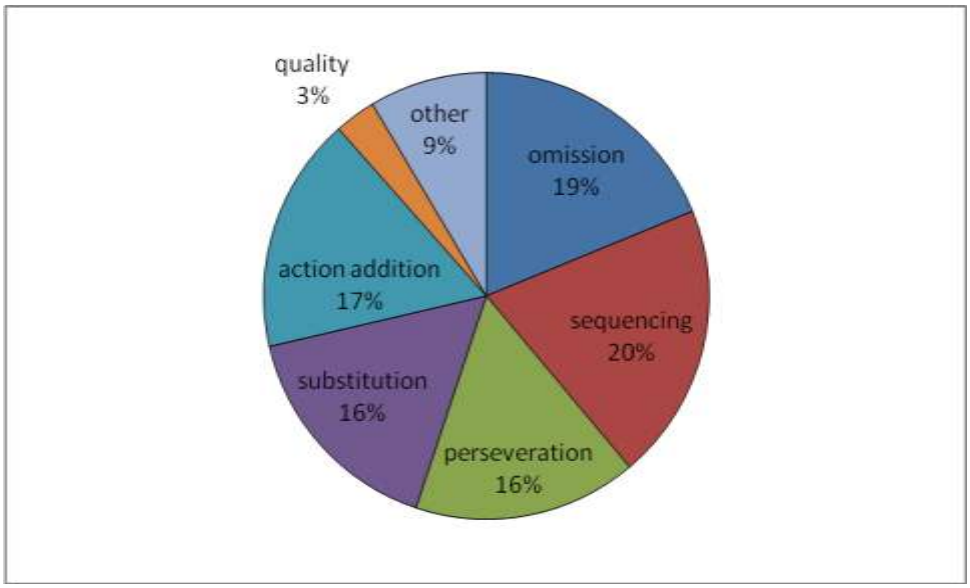

Figure 10. Standard NAT Error Distribution for First Wave of SZ Sample

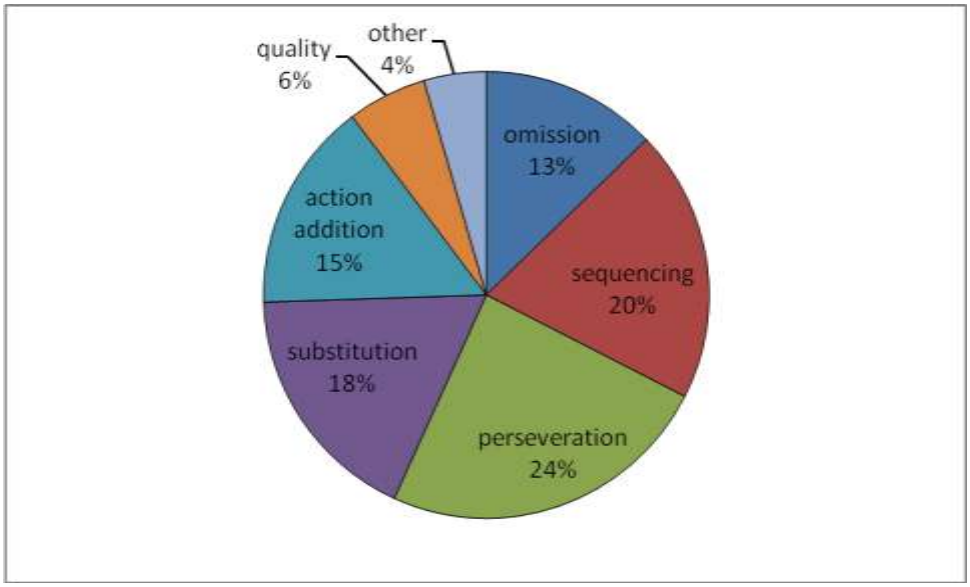

Figure 11. Standard NAT Error Distribution for Second Wave of SZ Sample

In order to establish discriminant validity for the NAT, correlations between ST-NAT performance and the SAPS were examined. Given that previous research has failed to demonstrate a consistent relation between positive symptoms and functional impairments, one would not expect the NAT to correlate with the SAPS. Indeed, none of the correlations were significant ($p > .45$ for all correlations; see Table 10).

Table 10. Spearman-Rank Order Correlation Coefficients (r_s) between NAT Variables and ADL Functioning/SAPS

	N =	ST-ACE	ST-AS	ST-CES
ADL	22	.10	.20	.19
SAPS	28	.01	-.13	.15

ST-ACE = ST-NAT ACE scores; ST-AS = ST-NAT accomplishment; ST-CES = ST-NAT comprehensive error score; ADL = modified Physical Self Maintenance Scale; SAPS = Scale for the Assessment of Positive Symptoms

Aim Four: Compare NAT Performance to that of Dementia Patients

Schizophrenia versus Dementia NAT Performance

ST-NAT and UC-NAT performance of the SZ population was compared to that of a previously studied dementia population (*N* = 51; Giovannetti et al., 2007). The SZ group outperformed the dementia group in every aspect of performance for both ST-NAT and UC-NAT conditions (ST-ACE $Z = 3.63$, $p < .001$; ST-AS $Z = 4.28$, $p < .001$; ST-CES $Z = 2.86$, $p = .004$; UC-ACE $Z = 3.48$, $p = .001$; UC-AS $Z = 3.99$, $p < .001$; UC-CES $Z = 2.32$, $p = .02$). For means and standard deviations of dementia and SZ NAT variables see Table 11. For mean ranks of dementia and SZ NAT variables see Table 12.

Table 11. NAT Variables for Schizophrenia and Dementia Groups

	ACE M(SD)	AS M(SD)	CES M(SD)
SZ ST-NAT	14.62 (2.24)	18.17 (1.53)	11.63 (8.85)
SZ UC-NAT	16.05 (1.96)	18.74 (1.71)	8.26 (6.46)
DE ST-NAT	10.94 (5.16)	13.82 (5.37)	17.76 (10.77)
DE UC-NAT	12.82 (5.10)	15.68 (4.48)	12.46 (9.54)

SZ ST-NAT = schizophrenia group standard NAT; SZ UC-NAT = schizophrenia group user-centered NAT; DE ST-NAT = dementia group standard NAT; DE UC-NAT = dementia group user-centered NAT; ACE = ACE scores; AS = accomplishment; CES = comprehensive error score

Table 12. NAT Variable Mean Ranks for Schizophrenia and Dementia Groups

	ACE Ranked M	AS Ranked M	CES Ranked M
SZ ST-NAT	98.71	107.74	88.52
SZ UC-NAT	128.20	126.62	66.21
DE ST-NAT	64.92	66.29	116.43
DE UC-NAT	85.60	79.42	91.42

SZ ST-NAT = schizophrenia group standard NAT; SZ UC-NAT = schizophrenia group user-centered NAT; ACE = ACE scores; AS = accomplishment; CES = comprehensive error score

Variations in Improvement Between Groups

Three group (SZ vs. dementia) by condition (ST vs. UC) ANOVAs were run to determine whether both groups showed equal improvement from the ST-NAT to UC-NAT conditions. Both groups improved from ST-NAT to UC-NAT with respect to ACE

scores, AS, and CES.[8] As stated above, the group effect also was significant for all dependent variables. The interaction effects of all three ANOVAs were non-significant, indicating that both groups improved to an equal degree from ST-NAT to UC-NAT conditions (See Figures 12-14; ACE interaction F (1, 86) = .94, p = .35; AS interaction F (1, 86) = .45, p = .50; CES interaction F (1, 84) = .113, p = .74)[9].

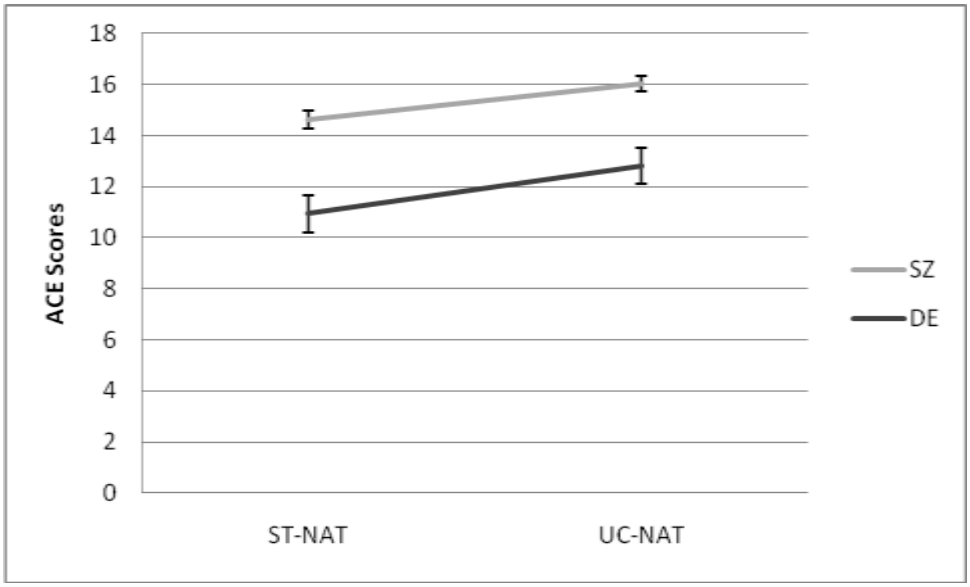

Figure 12. ACE Improvement Across Dementia and Schizophrenia Groups (Error Bars Represent 1 Standard Error of the Mean)

[8] ACE M Ranks: ST-NAT = 79.39 vs. UC-NAT = 106.76, F (1, 86) = 30.38, p <.001, η_p^2 = .26; AS M Ranks: ST-NAT = 83.53 vs. UC-NAT = 102.57, F (1, 86) = 14.00, p <.001, η_p^2 = .14; CES M Ranks; ST-NAT = 105.11 vs. UC-NAT = 79.03, F (1, 84) = 34.94, p <.001, η_p^2 = .29

[9] The results were unchanged when the ANOVAs were run using non-ranked data.

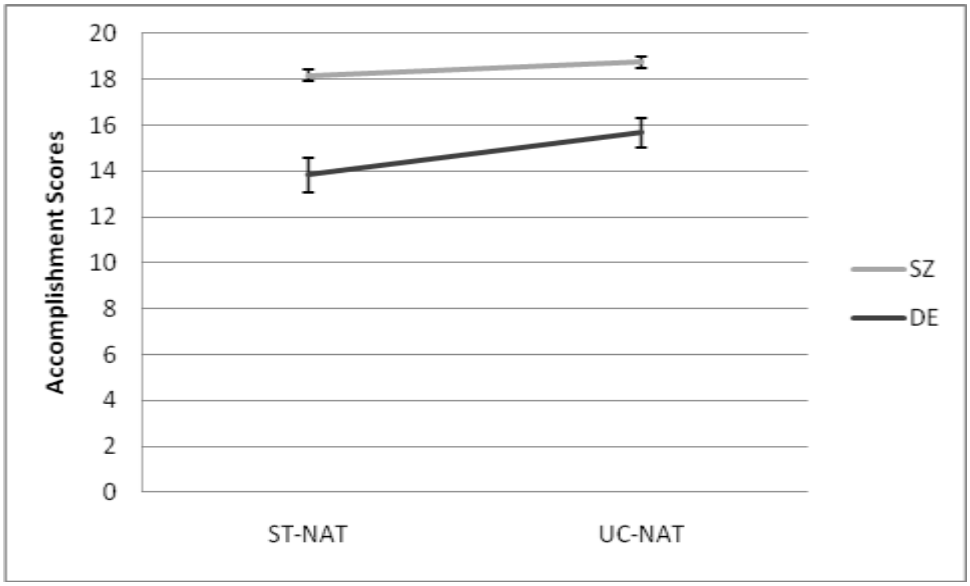

Figure 13. Accomplishment Score Improvement Across Dementia and Schizophrenia Groups (Error Bars Represent 1 Standard Error of the Mean)

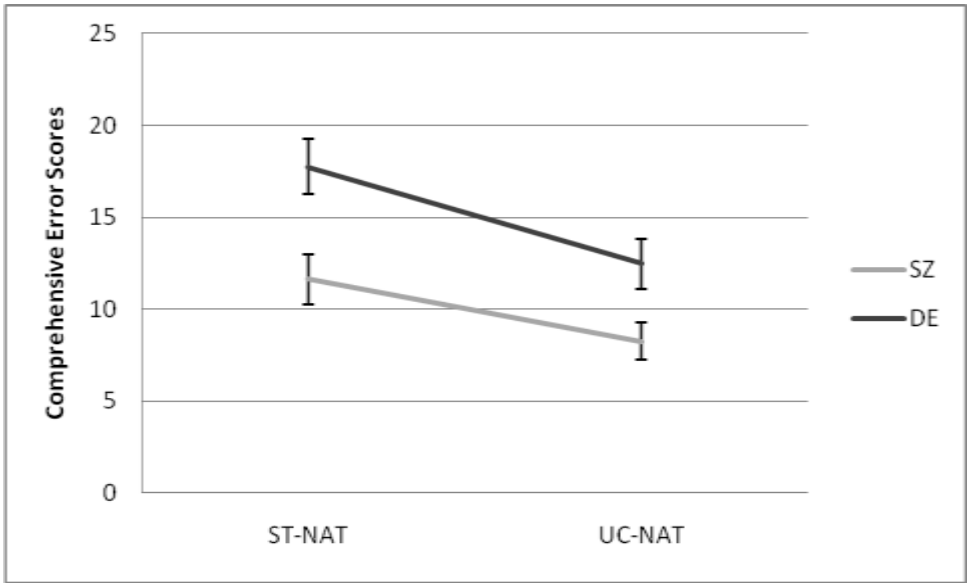

Figure 14. CES Improvement Across Dementia and Schizophrenia Groups (Error bars Represent 1 Standard Error of the Mean)

CHAPTER 4

DISCUSSION

Overview of Primary Findings

This study examined the effect of simple environmental interventions on everyday action performance in schizophrenia. This was done by comparing performance on two different versions of the NAT—the Standard NAT (ST-NAT) and the User Centered NAT (UC-NAT). The UC-NAT utilizes interventions based on the human factors' principle of stimulus-response compatibility to increase the synchrony between action and the environment. The primary aim of the study was to determine if these interventions improved NAT performance. Indeed, participants demonstrated better overall performance, increased accomplishment, and fewer errors on the UC-NAT, as compared to the ST-NAT. Moreover, a smaller percentage of participants demonstrated performance that fell in the clinically impaired range on the UC-NAT versus the ST-NAT. A second aim of this study was to clarify the mechanisms underlying improvement. More specifically, it aimed to examine whether the UC-NAT interventions compensated for deficient global cognitive functioning, executive functioning, or both. Although NAT improvement was unrelated to both measures of global and executive functioning, the UC-NAT interventions reduced omissions to a greater degree than executive errors, suggesting that these manipulations are effective because they compensate for global cognitive impairment.

A third aim of the current study was to establish the NAT's reliability and validity for a schizophrenia population. The first wave of the current sample demonstrated

comparable ST-NAT performance to that of the second wave of participants. Replication of the rate and pattern of ST-NAT accomplishment and error scores suggests reliable NAT performance in this population. Although the NAT demonstrated discriminant validity, it did not correlate with a collateral measure of ADL functioning. Finally, this study aimed to compare NAT performance to that of individuals with dementia. The schizophrenia group demonstrated enhanced NAT performance when compared to the dementia group. However, both groups demonstrated an equal degree of improvement from the ST-NAT to the UC-NAT indicating that the UC-NAT interventions are equally effective across populations.

Effectiveness of UC-NAT Interventions

The UC-NAT interventions were effective in increasing overall NAT performance. Additionally, error rates were lower and accomplishment was higher on the UC version of the NAT, although differences in accomplishment just missed statistical significance according to the conservatively corrected p-value for these analyses. Results indicated a large effect size for overall NAT performance and medium effect sizes for accomplishment and error rate. Contrary to my hypothesis, the amount of time it took to complete the two versions of the NAT did not differ.

That the interventions did not decrease the time it took to complete the tasks is not entirely surprising. Although one may expect that the streamlining nature of interventions would allow for more automatic and quick action performance, other factors may have contributed to the lack of difference in completion times. Results indicated that the interventions reduced errors of omission. That is, participants were less likely to omit

task steps on the UC-NAT compared to the ST-NAT. Because participants completed more steps on the UC-NAT, they presumably took longer to complete the tasks. Theoretically, this could have compensated for the time saved by making task performance more efficient. Moreover, previous work with dementia participants that compared ST-NAT and UC-NAT performance also failed to find a difference in completion times, despite improvements in all other aspects of task performance (Giovannetti et al., 2007). This may indicate that faster action is not necessarily better action, and that completion time is not a clinically meaningful aspect of task performance.

The proportion of participants who fell in the impaired range on the NAT was compared across the two versions of the NAT to examine whether UC-NAT interventions led to clinically meaningful improvement. With respect to overall NAT performance, 48% of participants were impaired on the ST-NAT, compared to 17% on the UC-NAT. This difference indicates that improvements in performance following the UC interventions are not just statistically significant, but are also clinically important, as more than 4/5s of the sample demonstrated overall performance that fell in the clinically normal range on the UC-NAT. Previous work (Kessler, Giovannetti, & MacMullen, 2007) has shown that error rates, as opposed to overall NAT scores, are a more sensitive measure of NAT impairment in schizophrenia populations. Indeed, when overall error rate was utilized as a measure of performance, 78% of participants demonstrated impaired ST-NAT performance. However, only 57% of participants were classified as having impaired overall error rates on the UC-NAT, a statistically significant difference.

That the UC-NAT interventions led to improved action performance is in line with previous work. Giovannetti et al. (2007) demonstrated that the UC-NAT improved overall NAT performance, accomplishment, and error rates for individuals with dementia. With respect to a schizophrenia population in specific, Velligan and colleagues have shown that environmental interventions improve functioning in multiple domains, although they have never directly assessed their impact on everyday action performance. Given that the performance of everyday tasks is crucial for successful independent living, it is likely that their interventions also improved everyday action performance. However, this assumption has never been explicitly tested. Thus, this study is novel in that it is the first to directly assess the effect of environmental interventions on everyday action performance in schizophrenia.

Results indicated that there was no statistically significant variation in improvement across the three NAT levels. That is, both error rates and accomplishment improved from the ST-NAT to the UC-NAT to an equal degree across the three NAT tasks. This finding suggests that the UC interventions may be useful across a broad range of tasks. However, there was a trend for CES to improve to a greater degree on task 2 than on tasks 1 and 3. Task 2 is unique in that it contains the presence of distracter objects that are semantically and visually similar to target objects (e.g., electric tape as distracter for scotch tape). There are no distracter objects in task 1; although distracter objects are present in task 3, they are hidden in a drawer and there is no semantic and visual correspondence between distracters and targets; therefore, distracters on task 3 are less obvious and disruptive to performance (Giovannetti et al., 2010). Distracter objects

could derail performance in several ways. The presence of unnecessary objects in the environment increases the likelihood of object substitutions and off-task behavior. Moreover, distracter objects may have the more generalized effect of decreasing action-environment compatibility. This would likely disrupt the automaticity of action performance and could lead to a host of errors. The UC-NAT interventions for task 2 include placing the distracter objects on the far right side of the U-shaped table, beyond the error-monitoring bell. This essentially removes the distracter objects from the stimulus array, although they are still present on the table. It is possible that the trend towards greatest CES improvement on task 2 can be attributed to the removal of highly salient distracter objects from the action environment. This finding reinforces the validity of one of CAT's greatly utilized strategies—removing clutter and unnecessary objects from the individual's environment. It also emphasizes the importance of environmental factors on everyday action performance.

Although the UC-NAT manipulations were effective in improving action performance, it is important to note the existence of potential order effects for NAT accomplishment and error rate. For both aspects of performance, participants improved from the ST-NAT to the UC-NAT to a greater degree when the ST-NAT was administered first. This indicates that the effect of the UC-NAT interventions is enhanced by practice, and that practice is partially responsible for the medium to large effects of the UC-NAT intervention. Main effects for condition (ST-NAT versus UC-NAT) were significant and large, indicating that the interventions impacted action performance. Importantly the effect sizes for condition were larger than the interaction effect sizes, a

finding that further supports the idea that practice effects are not entirely responsible NAT improvement.

Practice effects appear to play a greater role in improvement for accomplishment than for CES. Individuals who were administered the UC-NAT first did not show improvement on the UC-NAT with respect to accomplishment, whereas individuals who were administered the ST-NAT first did. This was not the case for CES, as even individuals who were administered the UC-NAT first demonstrated reduced error rates on the UC-NAT condition. Moreover, the difference in effect sizes for condition versus interaction effects were greater for CES than for accomplishment. Taken together, this suggests that increasing task familiarity and knowledge in conjunction with environmental accommodations may be the best way to improve accomplishment on everyday action tasks. Increasing task knowledge and familiarity can also boost the effects of environmental interventions on error rates, as order effects appear to play a role in CES improvements from ST-NAT to UC-NAT conditions. Task rehearsal may improve everyday action performance in the same way that drill and practice cognitive remediation techniques have been shown to improve cognitive functioning. Thus, these practice effects suggest an additional route to improving everyday action performance in this population. Because increasing task familiarity likely only improves performance on the rehearsed task (i.e. results may not generalize to other tasks), this strategy may be especially appropriate for important actions that need to be performed routinely.

Mechanisms Underlying Improvement

The second aim of the current study was to examine if the environmental interventions act by compensating for executive deficits, global deficits, or both. Although I hypothesized that the interventions would compensate for executive dysfunction, results tentatively support that the UC-NAT manipulations compensate for global cognitive dysfunction. Omissions were the only error type significantly reduced by the interventions. Importantly, proponents of the resource theory posit that omissions are reflective of general cognitive dysfunction, and not deficits in a particular cognitive domain[10]. Support for this assertion is derived from several studies that found that different neurological populations with distinct cognitive profiles (right CVA, left CVA, closed head injury/CHI, and dementia patients) all demonstrate similar error patterns with high rates of omissions (Buxbaum, Schwartz, & Montgomery, 1998; Giovannetti et al., 2002; Schwartz et al., 1998; Schwartz et al., 1999). What these populations share is a reduction in overall cognitive resources. Because these cognitively distinct populations have nearly identical error patterns with high rates of omissions, omissions are conceptualized as errors that result from a non-specific, general limitation in cognitive resources. Proponents of the resource theory explain that when cognitive capacity is limited, individuals frequently fail to sufficiently activate action schemas above a certain threshold. This lack of activation, in turn, causes a high rate of omissions (Buxbaum, Schwartz, & Montgomery, 1998; Schwartz et al., 1998).

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[10] Resources are defined as a limited capacity commodity that allows for cognitive processing to occur; the concept of cognitive resources is similar, but not identical to constructs of attention, effort, or cerebral activation (Schwartz et al., 1998).

Moreover, Schwartz et al. (1998) have demonstrated that increasing the complexity and difficulty of everyday tasks leads to an increase in omission errors, even in mildly impaired individuals. In their study, the action performance of CHI patients was compared to that of healthy controls. Unsurprisingly, Schwartz and colleagues reported that the action performance of the two groups differed, with CHI patients performing worse than controls. However, the action performance of the two groups appeared to exist on a continuum: controls demonstrated low error rates and made primarily commission errors, mildly impaired patients exhibited similar errors at similar rates, and more severely impaired patients demonstrated high error rates, more omission errors, and more frequent and flagrant commission errors. Notably, on a more challenging action task, the mildly impaired patients not only made more errors than controls but tended to make omission errors as well. This suggests that omission errors are particularly sensitive to the complexity of everyday action tasks, presumably because increasing task difficulty puts a strain on an individual's global cognitive resources. In sum, the Schwartz et al. (1998) study found that increasing task difficulty leads to an increase in omissions. The current study provides support for a parallel finding—that minimizing task difficulty leads to a *decrease* in errors of omission.

It is unclear why the UC-NAT interventions did not lead to significant reductions in executive errors. Theoretically, the interventions should have decreased the need for high levels of executive control by instituting bottom up (i.e. environmentally-driven) structure and organization. It is possible that addressing executive errors such as perseverations and action-additions necessitates different environmental interventions

than the ones used in this study. Notably, Giovannetti et al (2007) similarly found that the UC-NAT interventions did not lead to improvements in perseverations for a dementia population, although the interventions did reduce action-additions. Whenever objects are present in the environment, there is potential for perseverative action and off-task behavior. Even when task objects are placed in the order that they should be used, once an individual picks up an object s/he may find it a challenge to inhibit a perseverative action such as spreading jelly for an excessive amount of time. Similarly, even when distracter objects are removed from the stimulus array, an individual may have difficulty inhibiting inappropriate actions with the objects that are necessary for completing the task. For example, in this study a participant picked up the wrapping paper and waved it around like a flag in task 2. The interventions implemented in this study would not address such off-task behavior. It is possible that using different interventions, such as cuing participants to stay on track or alerting them that they are engaging in perseverative behaviors, may have had a greater impact on reducing executive errors.

The relations between NAT improvement, demographics, and neuropsychological variables were also examined to elucidate the mechanisms underlying action improvement. When NAT change scores were examined, only one significant relation was detected—a negative correlation between omission change scores and education. This indicates that individuals with lower levels of education showed greater improvement from the ST-NAT to the UC-NAT with respect to omissions. This finding suggests that environmental interventions may be especially important for individuals with lower funds of knowledge. This finding is somewhat similar to that of Bell et al.

(2008) who demonstrated that a comprehensive cognitive rehabilitation program was most helpful for individuals with low levels of initial community functioning. Thus, interventions that aim to improve or bypass cognitive deficits may be most helpful for individuals with fewer initial resources.

Additional relations between NAT change scores, demographics and neuropsychological variables were not substantiated. Thus, the relations between demographics/cognitive variables and NAT performance were examined separately for the two NAT conditions. This was done to examine whether the variables potentially influencing action performance were distinct for the two conditions. Regression analyses revealed both similarities and distinct patterns for the two conditions. ST-NAT accomplishment was predicted by IQ, whereas ST-NAT CES was predicted by a measure of executive functioning, Zoo Map test scores. This finding replicates previous work that suggested that accomplishment and error rate are distinct aspects of NAT performance for a schizophrenia population (Kessler, Giovannetti, & MacMullen, 2007). Whereas accomplishment appears to be driven by global cognitive functioning, error rates appear to be influenced by executive functioning.

The relations between demographic/neuropsychological variables and UC-NAT performance were not quite as clear cut. UC-NAT accomplishment was predicted, not by global cognitive functioning, but by age. UC-NAT error rates were predicted by both age and an executive measure of switching. In sum, executive functioning is related to error rates for both the ST-NAT and the UC-NAT. However, the UC-NAT is unique in that age plays an important role for both accomplishment and errors.

Why might UC-NAT performance be related to age? The UC-NAT interventions act to impose structure on the environment. It is possible that older individuals have more severe cognitive difficulties, and are less able to take advantage of structure.[11] Thus, older participants may not benefit from the increased order provided by the UC-NAT. Post hoc analyses examining the relation between age and NAT error type show that age is related to quality errors[12] (i.e. older participants committed more quality errors). The UC-NAT interventions were not designed to address this type of error and in fact did not impact rates of quality errors. Because older participants committed more quality errors, errors that were not targeted with the UC-NAT interventions, it follows that age should be related to UC-NAT performance.

Reliability and Validity of the NAT

This study was the first to examine the NAT's reliability and validity for a schizophrenia population. With respect to inter-rater reliability, two independent coders demonstrated nearly perfect agreement in coding NAT errors, accomplishment, and time to completion. An additional aim for the current study was to determine whether there exists a reliable and unique NAT performance pattern for individuals with schizophrenia. This is especially important given that previous research has found similar error patterns and NAT performance across several distinct neurological populations (CHI, left CVA, right CVA, and dementia; Giovannetti et al., 2002). The performance of the second wave

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[11] Age was significantly negatively correlated with measures of cognitive functioning including MMSE (r_s = -0.33, p = .03) and Trail Making Test Switching scores (r_s = -0.36, p = .02).

[12] r_s = 0.48, p = .002

of participants was very similar to that of the previously studied first wave (Kessler et al., 2007). The two groups did not differ with respect to overall performance, error rates, and accomplishment. Additionally, with the second wave there was no relation found between NAT accomplishment and commission errors, a finding which has been demonstrated previously (Kessler et al., 2007) and is unique to this population. The distribution of error types was similar for the two groups, although the second wave had a greater proportion of perseverations. Despite this small difference in perseverations, the error distributions are quite alike, especially when they are compared to the error patterns of other cognitively impaired populations. The error patterns of those populations are distinct from those of the schizophrenia participants in that they contain high rates of omissions (approximately 43%) and low rates of perseverations (approximately 4%).

In sum, individuals with schizophrenia demonstrate a unique and reliable pattern of NAT performance that is characterized by proportionally low rates of omissions and high rates of perseverations. This error pattern provides some support for an executive account of everyday action impairments in schizophrenia. Perseverations are indicative of specific problems with inhibiting previously performed actions and exerting cognitive control over behavior. The ability to exert top-down control over perseverative behavior relies on adequate executive mechanisms. That individuals with schizophrenia demonstrate a higher proportion of perseverations than other cognitively impaired groups, suggests that impairments in executive functioning may at least partially account for their action difficulties. Furthermore, Schwartz and colleagues (1998) have noted that an executive account of action impairment would predict a high rate of perseverations

with relatively few omissions. In fact, this is the pattern displayed by the schizophrenia group, indicating that executive dysfunction may partially explain difficulties in everyday action.

This study also examined convergent and discriminant validity for the NAT. The NAT demonstrated discriminant validity, as NAT performance showed no relations with a measure of positive symptoms. This finding is in line with several studies which have demonstrated no relations between positive symptoms and functional outcomes in schizophrenia (Green, 1996; Green et al., 2000). However, the NAT's convergent validity for this population was not substantiated in this study. NAT variables showed no relations with a measure of ADL functioning. It is possible that the non-parametric analyses were too conservative to detect potential relationships between ST-NAT performance and ADL functioning, as the sample size for these analyses was small (n = 22).

Notably, the collateral-report measure used in this study assessed ADL, and not IADL (instrumental activities of daily living) functioning. ADLs are the most basic personal care tasks—toileting, feeding, dressing, grooming, and bathing. In contrast to IADL, ADL performance is less demanding and often relatively preserved in schizophrenia. In fact, many of the participants were at ceiling with respect to scores on the collateral measure of ADL functioning. The NAT involves tasks that are more complicated and are better conceptualized as IADLs. IADLs are complex tasks that are necessary for independent living and include meal preparation, transportation, housekeeping, telephone use, and medication management. Had a collateral-report

measure of IADL functioning been used in this study, it is possible that relations with NAT variables would have emerged.

Moreover, participants' ADL functioning was rated within the context of an inpatient unit, where individuals may not perform tasks that they normally do at home. That is, there may be a discrepancy between what participants can do, and what they actually do in an inpatient setting. In fact, this is why a measure of ADL functioning, as opposed to IADL functioning, was chosen for this study. In the inpatient settings in which the participants resided, individuals did not perform IADLs such as cooking and medication management. Therefore, it would have been impossible to obtain IADL ratings from the hospital staff. Assessing functioning in this context makes it difficult to obtain an accurate picture of participants' actual ADL functioning, which may obscure potential relations with NAT performance. As a result, although no relations existed between NAT performance and a measure of ADL functioning, it is premature to call the NAT's convergent validity for this population into question.

Additionally, others have noted the distinction between an individuals' capacity to perform everyday tasks and how s/he actually performs them in the real world (Bellack et al., 2007). Performance-based measures, like the NAT, are imperfect in that they demonstrate an individual's ability to perform a task under contrived settings which may not mirror real life task performance. In real life, successful task performance depends not only on an individual's capacity to perform the task, but also on motivation, insight, and environmental factors. Thus, performance-based measures typically capture an individual's capacity to perform a task under ideal settings, but may not reflect the rate or

quality of real life task performance. Such a discrepancy could also possibly explain the lack of a relation between NAT performance and the measure of ADL functioning.

Comparison to a Dementia Population

This study compared the NAT performance of individuals with schizophrenia to that of a previously studied dementia population (Giovannetti et al., 2007). Additionally, it examined whether the two groups showed an equal degree of improvement from the ST-NAT to the UC-NAT. This was done to determine whether the UC interventions are differentially effective for distinct populations. The schizophrenia participants' NAT performance was superior to that of the dementia participants with respect to overall performance, accomplishment, and error rates. This was true for both the ST-NAT and the UC-NAT. This finding is in line with previous work (Kessler, Giovannetti, & MacMullen, 2007) that demonstrated worse NAT performance for individuals with dementia. The dementia population's worse NAT performance is likely due to their more impaired global functioning, as the group's MMSE scores were significantly lower than those of the schizophrenia group, and previous work has demonstrated significant associations between global cognitive impairment and everyday action performance (Giovannetti et al., 2002; Kessler, Giovannetti, & MacMullen, 2007).

As predicted, the schizophrenia and dementia groups improved to a comparable degree from the ST-NAT to the UC-NAT, indicating that the interventions are equally effective for different populations. This finding suggests the usefulness of environmental interventions for improving everyday action in a variety of neurological populations. Individuals with schizophrenia and dementia show distinct cognitive impairments and

profiles. Nevertheless, the interventions were equally effective for both groups, indicating that increasing S-R compatibility can compensate for a host of cognitive limitations. Alternatively, it is possible that that the interventions have the non-specific effect of making the tasks generally easier, which would also suggest their utility with a variety of cognitively impaired populations. This notion is supported by the fact that for individuals with schizophrenia, the interventions reduced only errors of omission, which are indicative of global cognitive dysfunction.

Like the schizophrenia group, individuals with dementia demonstrated improved overall performance, accomplishment, and error rates on the UC version of the NAT (Giovannetti et al., 2007). However, the dementia participants demonstrated significant reductions in a variety of errors including omissions, action-additions, and object substitutions. As described above, the schizophrenia group showed only reduced omissions. It is uncertain why the interventions reduced several error types for the dementia group, but not the schizophrenia group. It is plausible that both groups saw a reduction in omissions due to the streamlining nature of the interventions. That is, the adaptations compensated for overall resource deficits to an equal degree in both groups. As suggested above, it is possible that the UC-NAT interventions are effective *specifically* because they compensate for global cognitive dysfunction. It has been proffered that global cognitive impairments account for all action difficulties in a dementia population (Giovannetti et al., 2002). In contrast, previous work has suggested that different cognitive mechanisms drive different aspects of action performance in schizophrenia (Kessler, Giovannetti, MacMullen, 2007). More specifically, it has been

suggested that global cognitive functioning drives accomplishment/omissions, whereas executive functioning drives commissions. If the UC-NAT interventions compensate only for global cognitive dysfunction, and not executive difficulties, it follows that only omissions should be reduced for individuals for schizophrenia. However, because global cognitive functioning is related to all aspects of action performance for a dementia population, the UC-NAT manipulations should reduce a host of errors, and not solely omissions.

Alternatively, it is possible that the specific cognitive deficits of each population were differentially affected by the UC-NAT manipulations. Perhaps the executive functioning deficits of the schizophrenia group were too severe to be significantly affected by the UC interventions, which could explain the lack of change in perseverations and action-additions. Conversely, although individuals with dementia are known to exhibit some deficits with executive function, these deficits are less characteristic of the disorder than they are in schizophrenia. Thus, the UC-NAT manipulations may have been sufficient to target the executive deficits of the dementia, but not the schizophrenia group. It is also conceivable that individuals with schizophrenia need different interventions such as cuing and redirecting to fully address executive function impairments, whereas individuals with dementia do not. Nevertheless, that the UC-NAT interventions comparably improved the action performance of two distinct populations indicates that these techniques are promising ways to address everyday action problems across heterogeneous populations.

Limitations

A limitation of the current study is the use of conservative statistics that reduced the power of the analyses. Because nearly all variables were not normal and were unable to be transformed, non-parametric analyses were used throughout the study. Additionally, the p-values for many analyses were set low, which further reduced the study's power. Moreover, the sample sizes for some of the analyses (i.e. analyses that utilized the SAPS and the measure of ADL functioning) were particularly small, as these measures were added to the study midway through the data collection process. To address this issue of reduced power, parametric analyses were always performed alongside non-parametric analyses and the results were compared. In the vast majority of cases, results were unchanged. However, there were a few analyses in which parametric analyses detected results that were not revealed with non-parametric statistics. For example, when Pearson correlations were utilized, a relationship between ADL functioning and NAT CES was detected, such that worse ADL functioning was related to more errors. Additionally, parametric analyses detected a relationship between commission difference scores and education that was not uncovered when non-parametric analyses were utilized. Nevertheless, the results of parametric and non-parametric were almost always in line with one another, suggesting that the analyses used were sufficiently powerful to detect meaningful differences and relationships.

Another limitation of this study is the use of an exclusively inpatient population. This may reduce the study's generalizability in that it only examined individuals who were inpatients in non-acute hospital settings. This cohort may not be regularly

performing ADL/IADL and their NAT performance may differ substantially from outpatients who are more likely to have greater familiarity and more recent experience with performing everyday tasks. It is likely that the population for this study was lower functioning than typical schizophrenia outpatients who are living independently. It is possible that the UC-NAT interventions would be more beneficial for higher functioning individuals who are more likely to be at least partially successful with managing their ADL/IADL. Alternatively, it is conceivable that the manipulations are more effective for severe populations, as they appear to work by compensating for global cognitive dysfunction which tends to be more compromised in lower functioning individuals. Further research is necessary to determine whether the results of this study may apply to other schizophrenia populations.

An additional caveat of this study is that the methodology may have inadvertently introduced a selection bias for willingness to participate. As mentioned earlier, the scoring of the NAT requires that participants be videotaped while performing the everyday activities. Many individuals who were approached for study recruitment declined to participate specifically because they did not want their performance to be captured on tape. As such, the schizophrenia sample included in this study may be less paranoid than the individuals who refused participation. Importantly, many of the individuals who did choose to participate were classified as having chronic paranoid schizophrenia, and many expressed paranoid ideation. Nevertheless, it is possible that people who declined participation were different than those who accepted in other ways. Participants who refused may have been more depressed or may have differed with

respect to symptom level. Thus, the results of this study may not apply to individuals with heightened paranoia who are disinclined to being taped.

Another limitation of this study was the inability to collect collateral measures of IADL functioning outside of the laboratory setting. As described above, because participants resided in inpatient facilities, they were not performing IADL. Thus, it was impossible to have hospital staff rate individuals' IADL functioning. Moreover, most participants lacked family members or close friends who could adequately rate their everyday functioning prior to hospitalization. As a result, only a collateral measure of ADL functioning could be collected for this study, a limitation that made it difficult to accurately assess the NAT's convergent validity for this population. It is likely that NAT performance is more significantly related to IADL functioning than ADL functioning, as the NAT tasks better approximate IADL. Had IADL been assessed, the NAT's convergent validity for schizophrenia may have been established.

A final limitation of the current study is its repeated-measure design which inadvertently introduced order effects. This methodology was implemented because the repeated-measures design allowed for greater control of variability in everyday action performance across participants. Additionally, the sample size necessitated for adequate power with an independent samples design would have been prohibitively large for the scope of this project. An attempt was made to minimize order effects by counterbalancing the order in which the two versions of the NAT were presented. Nevertheless, practice effects emerged, as individuals who received the ST-NAT first showed more improvement on the UC-NAT than those who received it second.

Importantly, this study was modeled after a study of UC-NAT interventions for individuals with dementia (Giovannetti et al., 2007), which similarly utilized a repeated-measures design and did not find practice effects.

Future Directions and Implications

This study demonstrated that environmental interventions can improve some aspects of everyday action performance in schizophrenia. There is evidence to suggest that the interventions exert their effect through compensating for global cognitive dysfunction, but not executive dysfunction. As mentioned earlier, it is possible that different environmental interventions than the ones used in this study may have been more successful at compensating for executive deficits. This in turn may have reduced additional error types such as perseverations and action-additions. CAT utilizes cuing and the removal of clutter to target executive function difficulties. Future studies should examine whether incorporating similar strategies into the UC-NAT would greater enhance action performance. This could be done by hanging signs that list task instructions and contain cuing instructions directing individuals to stay on task. Additionally, all extraneous objects could be completely removed from the stimulus array and not simply placed to the far right of the table or remain in a closed drawer.

Interestingly, repeated practice of the tasks enhanced the effectiveness of UC-NAT intervention, as individuals who received the UC-NAT second demonstrated a greater degree of improvement than those who received it first. Numerous studies have indicated the beneficial effects of drill and practice interventions for improving performance on neuropsychological measures in schizophrenia. Many have suggested

that these improvements should lead to enhanced functional outcomes, although this finding has not been demonstrated unequivocally with respect to everyday action. An alternative to practicing neuropsychological tasks with the aim of improving cognition, and ultimately enhancing functioning, is to practice the everyday tasks themselves. Such a strategy would likely be most effective when used in conjunction with increasing environmental structure and organization. Task rehearsal may aid performance by increasing task knowledge which would reduce the likelihood that task steps would be omitted. Additionally, this strategy may increase procedural knowledge and make the tasks more automatic and effortless, although it would not address how individuals deal with novel tasks, or the everyday complications that arise during the course of action performance (i.e. missing ingredients when one is cooking). Nevertheless, future studies should examine whether practicing everyday tasks in combination with increasing environmental organization leads to improved everyday action performance in this population.

This study also demonstrated that the UC-NAT interventions were equally effective for individuals with schizophrenia and dementia. It is possible that these interventions are useful for a variety of populations specifically because they compensate for global cognitive dysfunction, which is common among cognitive compromised populations. This suggests the possible utility of these interventions for additional populations, such as CVA and TBI survivors, who are also known to demonstrate

difficulty performing everyday tasks. Future studies could expand on the current one by examining whether the UC-NAT interventions enhance action performance in additional neurological populations.

Although the current study provides some evidence for the NAT's reliability and validity for a schizophrenia population, it did not adequately tackle the issue of convergent validity, as a collateral measure of IADL functioning outside of the laboratory was not included in the study. It is important that future studies address this issue by including collateral measures of IADL performance. Studies of dementia populations have demonstrated significant relations between IADL functioning and NAT performance (Giovannetti et al., 2002) and it is expected that the same relationship would emerge for individuals with schizophrenia. However, this assumption should be tested directly in future work.

IADL functioning can only be assessed with *outpatients*, who are at least partially responsible for performing their own ADL/IADL. Future studies should examine NAT performance in outpatients with schizophrenia. Such work could also identify whether the UC-NAT interventions are equally effective for higher functioning individuals. Should the UC-NAT manipulations improve action performance for outpatients, additional studies could examine whether interventions similar to those used in the UC-NAT could be successfully implemented in the home. In this way, the underlying principles of the UC-NAT interventions could be used to guide home-based interventions to address everyday action difficulties in schizophrenia.

Conclusions

This study examined whether standardized, environmental interventions could improve everyday action performance for individuals with schizophrenia. These interventions were based on human factors principles and were relatively easy to implement. Previous studies have demonstrated that generic environmental supports can improve everyday functioning in schizophrenia (Velligan, Diamond, Maples et al., 2008; Velligan et al., 2009). However, this study is novel in that it is the first to assess the impact of environmental manipulations on everyday action performance using a performance-based, validated measure of action. It also builds on previous work that has established the efficacy of the UC-NAT interventions for a dementia population (Giovannetti et al., 2007). Additionally, this study is unique in that it examined participant characteristics and neuropsychological factors associated with action improvement. This examination is essential for revealing the types of individuals that are most likely to benefit from the interventions, as well as to help elucidate the mechanisms through which the interventions exert their effect.

Results indicated that the environmental interventions improved action performance, most likely through compensating for global cognitive dysfunction. This suggests the utility of this intervention for addressing the everyday action difficulties of a variety of populations. The study results also suggest a novel approach to improving the benefit of environmental interventions for everyday action in a schizophrenia population—repeated practice of everyday tasks. The UC-NAT's failure to reduce executive errors such as perseverations and action-additions, suggests that alternative

strategies for compensating for executive dysfunction need to be examined in future work. This study, as well as future studies of everyday action in schizophrenia, will shed light on the underpinnings of everyday, real life difficulties and inform the development of behavioral strategies to facilitate action performance in the home or work setting. Such rehabilitation efforts could enhance independent functioning, productivity, and ultimately decrease the devastating disabilities associated with schizophrenia.

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