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Everyday Action in Schizophrenia: Performance Patterns and Underlying Cognitive Mechanisms

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Everyday action is impaired among individuals with schizophrenia, yet few studies have characterized the nature of this deficit using performance-based measures. This study examined the performance of 20 individuals with schizophrenia or schizoaffective disorder on the Naturalistic Action Test (M. F. Schwartz, L. J. Buxbaum, M. Ferraro, T. Veramonti, & M. Segal, 2003). Performance was coded to examine overall impairment, task accomplishment, and error patterns and was compared with that of healthy controls ($n = 28$) and individuals with mild dementia ($n = 23$). Additionally, 2 competing accounts of everyday action deficits, the resource theory and an executive account, were evaluated. When compared with controls, the participants with schizophrenia demonstrated impaired performance. Relative to dementia patients, participants with schizophrenia obtained higher accomplishment scores but committed comparable rates of errors. Moreover, distributions of error types for the 2 groups differed, with the participants with schizophrenia demonstrating greater proportions of errors associated with executive dysfunction. This is the 1st study to show different Naturalistic Action Test performance patterns between 2 neurologically impaired populations. The distinct performance pattern demonstrated by individuals with schizophrenia reflects specific deficits in executive function.

Keywords: naturalistic action, activities of daily living, executive function, resource theory, psychosis

Everyday action, or naturalistic action, is behavior in the service of everyday tasks (e.g., cooking, grooming) that involves using multiple objects in an appropriate sequence. Everyday action difficulties are common among individuals with schizophrenia (Semkovska, Bedard, Godbout, Limoge, & Stip, 2004; Semkovska, Stip, Godbout, Paquet, & Bedard, 2002) and contribute to this population's high cost of care (Sharma & Antonova, 2003). Traditionally, everyday difficulties among those with schizophrenia have been examined with either self- or caregiver report (Green, Kern, Braff, & Mintz, 2000). These methods have drawbacks, including patients' lack of insight and caregiver biases (Arguelles, Loewenstein, Eisdorfer, & Arguelles, 2001; Atkinson, Zibin, & Chuang, 1997; Bellack, 1989; Patterson, Semple, Shaw, Grant, & Jeste, 1996; Sager et al., 1992; Zanetti, Geroldi, Frisoni, Bianchetti, & Trabucchi, 1999). Additionally, questionnaires provide little information regarding the type and frequency of errors and the causes of action impairment.

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Several studies have used performance-based measures to assess everyday action among individuals with schizophrenia (Evans et al., 2003; Klapow et al., 1997; Patterson et al., 1998; Patterson, Goldman, McKibbin, Hughs, & Jeste, 2001; Semkovska et al., 2002, 2004; Twamley et al., 2002; Velligan et al., 1997). However, to our knowledge, no study has examined a complete array of action errors with a validated and well-researched measure. Additionally, the performance of individuals with schizophrenia has not been compared with that of other groups with neurological impairments. As a result, it is impossible to know whether the performance patterns exhibited are unique to those with schizophrenia or are common among individuals with cognitive impairments. This study addressed the limitations of previous research by comparing action performance in participants with schizophrenia with that of healthy controls using the Naturalistic Action Test (NAT; Schwartz, Buxbaum, Ferraro, Veramonti, & Segal, 2003; Schwartz, Segal, Veramonti, Ferrara, & Buxbaum, 2002), a validated, performance-based measure that examines a wide range of errors. NAT performance was also compared with that of a previously reported sample of individuals with dementia to elucidate the causal mechanisms of action impairment among individuals with schizophrenia (Giovanetti, Libon, Buxbaum, & Schwartz, 2002).

Research using the NAT with other populations, including patients with brain injury, right- and left-hemisphere stroke, and dementia, has supported the *resource theory* of everyday action impairment (Buxbaum, Schwartz, & Montgomery, 1998; Giovannetti et al., 2002; Schwartz, 2006; Schwartz et al., 1998, 1999). This theory proposes that everyday action is resource demanding and that errors arise when cognitive resources are limited as a consequence of brain damage and/or distraction.[1] The resource

[1] Schwartz et al. (1998) defined resources as attention, effort, activation, or "a limited-capacity commodity that enables processing to go forward" (p. 25).

theory is supported by several findings in the literature. First, patients who show low task accomplishment on everyday tasks also show high rates of commission errors, suggesting that impairments on seemingly distinct components of performance may be explained by a unitary construct, namely, resource limitations (Schwartz, 2006; Schwartz et al., 1998). Second, diverse populations with neurological impairments have demonstrated strikingly similar distributions of error types on the NAT (Buxbaum et al., 1998; Giovannetti et al., 2002; Schwartz et al., 1998, 1999). Similar error patterns in the face of different cognitive profiles suggest that action difficulties are best explained by a reduction in global cognitive resources. Third, measures of global cognitive functioning, but not of specific cognitive processes, are strong predictors of action impairment (Buxbaum et al., 1998; Schwartz et al. 1998, 1999).

There is a long history of attributing the cognitive deficits associated with schizophrenia to a generalized deficit or global reduction in processing resources (Blanchard & Neale, 1994; Bilder et al., 2000; Chapman & Chapman, 1978; Nuechterlein & Dawson, 1984). Thus, the resource theory is a plausible account for action impairment in this population. In fact, several studies have found relations between general cognitive functioning and adaptive functioning among individuals with schizophrenia (Evans et al., 2003; Twamley et al., 2002). However, other predictions from the resource theory have not been previously evaluated but were addressed in the present study.

A competing account of everyday action impairment attributes action errors to deficient executive functioning. Executive functions are crucial to the initiation and execution of goal-oriented behaviors, which require the capacity to ignore irrelevant stimuli and to inhibit inappropriate and perseverative actions (Luria, 1966; Shallice, 1988). This account is applicable to schizophrenia (Frith, 1992; Velligan & Bow-Thomas, 1999), as studies have demonstrated an association between executive dysfunction and everyday action performance (Krabbendam, de Vugt, Derix, & Jolles, 1999; Royall et al., 1993; Secrest, Wood, & Tapp, 2000; Semkovska et al., 2002, 2004; Twamley et al., 2002; Velligan, Ritch, Sui, DiCocco, & Huntzinger, 2002; Wykes, Sturt, & Katz, 1990; see also Green, 1996; Green et al., 2000). However, many studies do not account for global cognitive functioning, making it difficult to tease apart the influences of global resources and executive functions (Krabbendam et al., 1999; Semkovska et al., 2002, 2004; Velligan et al., 2002).

Two predictions follow from an executive account of action impairment among individuals with schizophrenia. First, participants should demonstrate a unique pattern of errors relative to those of other populations with neurological impairments that have been reported (e.g., patients with dementia) to support the resource theory. More specifically, given that executive dysfunction diminishes top-down control over performance to prevent repetitive and off-task behavior (Semkovska et al., 2002, 2004; Shallice, 1988; Sirigu et al., 1996), perseverations and action additions (i.e., off-task behavior) should be especially prominent among individuals with schizophrenia. Second, the relation between NAT performance and measures of executive function should be stronger than the relation between NAT performance and measures of global cognition.

In sum, a well-researched, performance-based measure of everyday action was administered to individuals with schizophrenia. Task accomplishment, overall error rate, and error pattern were compared with those of healthy controls and individuals with dementia in an attempt to (a) characterize the degree and nature of everyday action impairment among individuals with schizophrenia and (b) determine whether the resource theory or an executive account is most suitable to explain the source of action impairment in this population.

Method

Participants

The schizophrenia group consisted of 23 individuals recruited from inpatient units at two local hospitals. Eighteen individuals met *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV*; American Psychiatric Association, 1994) criteria for schizophrenia, and 5 met criteria for schizoaffective disorder. Participants also met the following inclusion criteria: (a) no alcohol or illicit substance abuse in the past month; (b) no history of traumatic brain injury or neurological disorder, such as cerebral vascular accident or epilepsy; and (c) no mental retardation. All participants were English speaking. Relevant information was obtained from medical charts and neuropsychological assessment. Three participants were excluded because mental retardation could not be ruled out.

Demographics for the remaining 20 participants are provided in Table 1. Medication information was lost for 2 participants. Of the remaining 18 participants, all of whom were taking at least one antipsychotic medication, 17 (94%) were taking atypical antipsychotics, and 10 (56%) were taking conventional antipsychotics.

Data for 28 healthy controls were obtained from previously published studies and the NAT manual (see Giovannetti, Schwartz,

Table 1
Demographics for Schizophrenia, Control, and Dementia Participants

	Age		Education		Illness duration		IQ		Sex
Group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	% Men
SZ	45.95	10.48	12.65	2.48	24.47	10.29	79.05	10.73	55
NC	55.00	17.70	13.25	2.47					46
DE	76.30	9.42	11.60	2.36					30
M-DE	72.87	12.22	12.13	2.48					35

Note. SZ = schizophrenia group; NC = normal controls; DE = dementia group; M-DE = mildly impaired dementia group.

& Holz, 2005; Schwartz et al., 2003). All controls spoke English and had no history of substance abuse, traumatic brain injury, neurological disorder, or mental retardation. Demographic information is provided in Table 1.

Data for 53 patients with dementia were obtained from previously published studies (see Giovannetti et al., 2002, 2005). Participants with dementia were recruited from an outpatient memory clinic, where they were assessed by a social worker, psychiatrist, neurologist, and neuropsychologist. A diagnosis of dementia was made during an interdisciplinary team conference on the basis of clinical interviews with the patient and family, neuropsychological testing, physical evaluation, lab tests, and neuroimaging results. On average, the participants with dementia were mildly to moderately impaired (participants with dementia, $M = 22.13$, $SD = 3.49$). Other demographics are provided in Table 1.

Procedures

The study was approved by Temple University's Institutional Review Board. Participants signed an approved consent form and were paid for their time. All measures were administered in two to three sessions over the course of 4 weeks to minimize fatigue.

Measures

Everyday Action

Everyday action was assessed with the NAT (Schwartz et al., 2002, 2003), a standardized and published measure of everyday action with good psychometric properties (Schwartz et al., 2003). Normative data are reported in the NAT manual (Schwartz et al., 2003) and in previously published studies (Schwartz et al., 2002; Sestito, Schmidt, Gallo, Giovannetti, & Libon, 2005). 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).

Instructions, object placement, cuing procedures, and scoring are standardized and described in detail in the test manual. During the evaluation, participants sit at a U-shaped table upon which all task items are placed. The NAT involves three independent trials in which an everyday task (or tasks) is performed with little guidance from the examiner. The trials include (a) preparing toast with butter and jelly and preparing coffee with cream and sugar; (b) wrapping a gift with related distractor objects (e.g., gardening clippers, stapler) present in the array; and (c) packing a lunchbox with a sandwich, snack, and drink and packing a schoolbag with school supplies while several necessary objects (e.g., knife, thermos lids) are stored out of view in a drawer that contains additional, potentially distracting objects (e.g., ice tongs, measuring tape).

NAT performance was videotaped for subsequent scoring. The following dependent variables were obtained according to the test manual.

NAT score. NAT score is an overall measure of task performance that incorporates both the percentage of task steps accomplished and the occurrence of a subset of 25 key errors. NAT scores range from 0 to 18, with higher scores indicating better performance. A score of 18 is assigned when all task steps are correctly accomplished (100% accomplishment) and fewer than 4 key errors are committed.

Accomplishment score. Accomplishment score is a measure that reflects the percentage of task steps correctly accomplished. Accomplishment scores range from 0 to 100, with higher scores indicating greater accomplishment.

Comprehensive error score. Comprehensive error score is a measure of the total number of errors committed during the three NAT tasks. Errors are tallied and classified according to a comprehensive taxonomy, which is described in the test manual. NAT errors include omissions, substitutions, sequencing errors (i.e., anticipation omissions and reversals), perseverations, action additions (i.e., off-task behaviors), and other errors (i.e., infrequently occurring errors that include quality, gesture substitution, spatial misorientation or misestimation, and tool omission errors). Table 2 presents definitions and examples of each NAT error. In some analyses, we examined only commission errors, which include all errors except for omissions.

Table 2
Definitions and Examples of NAT Errors

Error type	Definition	Examples from toast and coffee and present tasks
Omission	A step or subtask is not performed.	Does not add sugar to coffee.
Substitution	A semantically related or perceptually similar alternate object is used in place of another.	Spreads butter on toast with spoon instead of knife.
Anticipation-omission	Anticipation of a step that 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 that is 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).

Note. NAT = Naturalistic Action Test.

Intellectual Functioning

To rule out the presence of mental retardation, we assessed participants' intellectual functioning with the Kaufman Brief Intelligence Test—Second Edition (KBIT–2; Kaufman & Kaufman, 2004). Any participant who received verbal and nonverbal IQ scores lower than 70 was excluded from the study.

Global Cognitive Functioning

Global cognitive functioning was assessed with the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). Scores range from 0 to 30, with higher scores indicating better global cognitive functioning. The MMSE was selected because it has been shown to correlate strongly with NAT variables in the dementia group. Furthermore, we used the MMSE to match participants with schizophrenia and participants with dementia on overall cognitive severity.

Executive Function

All participants with schizophrenia were administered a battery of measures designed to assess various aspects of executive function. The executive tests are described in Table 3. Two participants did not complete one of the executive tests (Trail Making Test), but all 20 of the participants with schizophrenia completed the remaining measures.

Statistical Analyses

All analyses were performed with the Statistical Package for the Social Sciences software, Version 13.0. Because nearly all NAT variables were not normal, nonparametric statistics were used. Significance levels for all comparisons were set at .05., and all tests were two tailed. Between-groups analyses were performed using Mann–Whitney U tests and, when appropriate, chi-square tests (only differences in age were examined with t tests). For small samples, the power efficiency of the Mann–Whitney test is nearly 95% of that of the t test (Siegel & Castellan, 1988). Therefore, effect sizes were estimated with Cohen's d calculations (0.2 = small, 0.5 = medium, 0.8 = large). Phi coefficients were used to calculate the effect size for chi-square analyses (.10 = small, .30 = medium, .50 = large; Cohen, 1988). Correlations among NAT performance variables and between NAT variables and neuropsychological tests were examined with Spearman rank order correlations. We evaluated a total of 18 correlations when examining the relationship between NAT variables and neuropsychological test scores. To minimize the occurrence of a Type I error, we set significance levels at .01 for these analyses. We used this method of correction, as opposed to more conservative methods, because it was feared that the study's small sample size and the use of nonparametric statistics would make it virtually impossible to detect meaningful relations when more stringent corrections were employed. The differences between several pertinent correlations were tested with t tests for correlations from a single sample. We also performed stepwise multiple regression analyses to examine the combinations of neuropsychological tests that best predicted NAT performance.

Results

Demographics

On average, participants with schizophrenia were approximately 4 years younger than controls, $t(46) = 2.22$, $p = .03$. The

Table 3
Neuropsychological Tests of Executive Functions

Targeted function	Test	Description	Dependent variable	Reference
Inhibition	D-KEFS Color–Word Interference Test	Participants name the dissonant ink color of written color words.	Scaled score for completion time.	Delis et al., 2001
Concept formation	D-KEFS Sorting Test	Stimulus cards are sorted according to new categorization rules on up to 10 trials.	Scaled score for the number of confirmed correct sorts.	Delis et al., 2001
Initiation	D-KEFS Verbal Fluency Test, letter fluency condition	Participants name as many words as possible that begin with a specified letter in 1 min.	Scaled score for the number of correct responses.	Delis et al., 2001
Planning	BADS Zoo Map Test	Participants indicate how they would visit a series of designated locations on a map of a zoo while abiding by a set of specified rules.	Total score reflects planning accuracy and rule violation errors.	Wilson et al., 1996
Working memory	WAIS–III Digit Span	Repetition of orally presented numbers, both forward and backward.	Scaled score for the number of correct trials.	Wechsler, 1997
	D-KEFS Color-Word Interference Test, switching condition	Participants switch back and forth between naming the dissonant ink colors of color words and reading the color words.	Scaled score for the completion time.	Delis et al., 2001
Cognitive flexibility	D-KEFS Trail Making Test, switching condition	Participants switch between connecting numbers and letters in sequential order.	Scaled score for completion time.	Delis et al., 2001
	D-KEFS Verbal Fluency Test, switching condition	Participants switch back and forth between naming fruits and furniture.	Scaled score for the number of correct responses.	Delis et al., 2001

Note. D-KEFS = Delis-Kaplan Executive Function System; BADS = Behavioural Assessment of the Dysexecutive Syndrome; WAIS–III = Wechsler Adult Intelligence Scale—Third Edition.

two groups were not significantly different with respect to their education ($z = 0.66$, $p = .51$) and contained equivalent proportions of men and women, $\chi^2(1, N = 48) = 0.34$, $p = .56$. Consistent with previous studies (Buxbaum et al., 1998; Giovannetti et al., 2002; Schwartz et al., 1998), age was not significantly correlated with NAT performance in the schizophrenia group (see below); thus, we suspect that the 4-year age difference between participants with schizophrenia and controls did not meaningfully influence the NAT results.

Participants with schizophrenia were significantly younger than participants with dementia ($z = 6.33$, $p < .001$). The two groups did not differ significantly with respect to their level of education ($z = 1.8$, $p = .07$). The dementia group contained a higher proportion of women than the schizophrenia group, $\chi^2(1, N = 73) = 3.84$, $p = .05$, and had significantly lower MMSE scores (schizophrenia, $M = 26.40$, $SD = 1.79$; dementia, $M = 22.13$, $SD = 3.49$; $z = 4.83$, $p < .001$).

Although this and prior studies have shown no performance differences between men and women on the NAT (see below; Buxbaum et al., 1998; Giovannetti et al., 2002; Schwartz et al., 1998, 1999, 2002), a significant link between the NAT and MMSE scores has been reported (Giovannetti et al., 2002). Thus, there was concern that disparities in NAT performance between the schizophrenia and dementia groups could be due to differences in global impairment. Therefore, a subset of participants with mild to moderate dementia was selected for comparison with the participants with schizophrenia. This group comprised 23 participants with dementia whose MMSE scores were in the range of the schizophrenia group's MMSE scores (M-DE group, $M = 25.77$, $SD = 1.48$; schizophrenia group, $M = 26.40$, $SD = 1.79$). All subsequent analyses with participants with dementia included only this mildly impaired subgroup. Demographic data for the M-DE subgroup are shown in Table 1.

Neither NAT accomplishment scores nor comprehensive error scores were significantly associated with age, education level, gender, or duration of illness for the participants with schizophrenia ($r < .41$, $p > .08$, for all). IQ was significantly associated with accomplishment scores ($r = .61$, $p = .005$) but not with comprehensive error scores ($r = -.42$, $p = .07$). That is, higher IQs were associated with greater levels of accomplishment but not with a decrease in the total number of errors committed on the NAT.

Between-Groups Analyses of NAT Performance

To determine whether participants with schizophrenia exhibited impaired NAT abilities, we compared their performance with that of controls. As shown in Table 4, the schizophrenia group demonstrated worse performance than controls on all NAT variables (NAT score, $z = 4.40$, $p < .001$, $d = 1.28$; accomplishment score, $z = 3.31$, $p = .001$, $d = 1.08$; comprehensive error score, $z = 5.27$, $p < .001$, $d = 1.25$). The proportion of participants who demonstrated impaired NAT performance was also examined. With cut scores set at two standard deviations below control means, 50% of the schizophrenia group was impaired on the NAT scores. Only 35% of the group exhibited impaired accomplishment scores; however, the majority of participants with schizophrenia (79%) were impaired on the comprehensive error scores.

Table 4 also shows that relative to participants with mild to moderate dementia, participants with schizophrenia obtained significantly higher NAT scores ($z = 2.37$, $p = .02$, $d = 0.74$) and accomplished a higher percentage of task steps ($z = 2.23$, $p = .03$, $d = 0.74$). The schizophrenia and M-DE groups did not differ on comprehensive error scores ($z = 1.14$, $p = .26$, $d = 0.32$).

Table 4
Mean NAT Scores, Accomplishment Scores, and Total Comprehensive Error Scores for All Groups

Group	NAT score		Accomplishment score		Total comprehensive error score	
	M	*SD*	*M*	*SD*	*M*	*SD*
SZ	14.42	2.36	90.50	7.59	12.32	9.96
NC	17.29	1.24	97.14	4.80	2.18	1.83
DE	9.83	4.36	66.45	25.76	19.45	10.62
M-DE	11.70	4.17	76.43	23.25	15.70	11.30

Note. NAT = Naturalistic Action Test; SZ = schizophrenia group; NC = normal controls; DE = dementia group; M-DE = mildly impaired dementia group.

Between-Group Analyses of Error Rates and Patterns

As shown in Table 5, the schizophrenia group made more errors than controls for all error types (omissions, $z = 3.38$, $p = .001$, $d = 1.03$; substitutions, $z = 4.45$, $p < .001$, $d = 0.88$; perseverations, $z = 4.74$, $p < .001$, $d = 1.06$; sequencing errors, $z = 2.96$, $p = .003$, $d = 0.88$; other errors, $z = 3.07$, $p = .002$, $d = 0.91$). Although on average participants with schizophrenia committed over five times as many action additions as controls, the two groups did not differ significantly in the total number of action additions ($z = 1.25$, $p = .21$, $d = 0.53$).

Differences in error types and distributions between participants with schizophrenia and participants with mild to moderate dementia are also shown in Table 5. The schizophrenia group committed significantly fewer omissions ($z = 2.00$, $p = .05$, $d = 0.74$) but more perseverations ($z = 2.65$, $p = .008$, $d = 0.75$) than the M-DE subgroup. The two groups did not differ significantly with respect to overall number of sequencing errors, substitutions, action additions, and other errors ($z < .93$, $p > .34$, $d < 0.15$, for all).

Prior studies with the NAT have reported the distribution of error types (as proportions of all errors) for individuals with brain injury, right- and left-hemisphere stroke, and the entire dementia group (see Giovannetti et al., 2002). The error distribution of the M-DE subgroup, shown in Table 5, is virtually identical to those of previously reported patient populations. In contrast, the distribution of schizophrenia group errors differs sharply from those of the M-DE subgroup and the other patient populations. More specifically, the M-DE subgroup committed a greater proportion of omissions than did the schizoprenia group, $\chi^2(1, N = 43) = 14.82$, $p < .001$, $\Phi = .16$. Participants with schizophrenia demonstrated significantly higher proportions of perseverations and action additions than the M-DE subgroup: perseveration, $\chi^2(1, N = 43) = 30.77$, $p < .001$, $\Phi = .23$; action addition, $\chi^2(1, N = 43) = 4.41$, $p = .04$, $\Phi = .09$. The proportions of sequencing errors, substitutions, and other errors for the two groups were not significantly different: sequencing, $\chi^2(1, N = 43) = 3.30$, $p = .07$,

Table 5
Mean Rates and Distribution for All NAT Error Types

Group	Omission *M*	Omission *SD*	Sequence *M*	Sequence *SD*	Perseveration *M*	Perseveration *SD*	Addition *M*	Addition *SD*	Substitution *M*	Substitution *SD*	Other *M*	Other *SD*
NC	0.43	0.92	1.10	1.20	0.04	0.19	0.39	0.69	0.07	0.26	0.15	0.36
SZ	2.32	2.24	2.47	1.68	2.00	2.49	2.10	4.92	2.00	3.13	1.42	1.95
M-DE	5.55	5.25	2.26	2.36	0.53	0.99	1.74	2.91	2.00	2.35	1.17	1.40
Distribution of NAT errors (percentage of all errors)												
SZ	19		20		16		17		16		12	
M-DE	41		18		4		13		15		9	

Note. NAT = Naturalistic Action Test; NC = normal controls; SZ = schizophrenia group; M-DE = mildly impaired dementia group.

$\Phi = .07$; substitution, $\chi^2(1, N = 43) = 1.43$, $p = .23$, $\Phi = 05$; other errors, $\chi^2(1, N = 43) = 2.83$, $p = .09$, $\Phi = .07$.

Correlations Among NAT Variables

As stated, prior studies have reported a significant negative relation between NAT accomplishment scores and NAT commission errors in populations of neurological patients; this association has been cited in support of the resource theory, as it implies that seemingly distinct aspects of everyday action performance may be explained by a unitary construct (see Schwartz, 2006). Thus, this correlation was examined for the M-DE subgroup and schizophrenia group. Consistent with the resource theory, there was a significant negative correlation between NAT accomplishment scores and commission errors for the M-DE subgroup ($r = -.58$, $p = .004$). In contrast, this correlation was not significant for the schizophrenia group ($r = -.35$, $p = .13$).

Correlations Between NAT Variables and Neuropsychological Measures

As shown in Table 6, NAT accomplishment scores were significantly positively associated with MMSE scores. The correlation between comprehensive error scores and MMSE scores was nonsignificant, and the Comprehensive Error Score × MMSE *r* value was significantly weaker than the Accomplishment Score × MMSE *r* value (see Table 6). Note that IQ, another measure of global functioning, also demonstrated a positive correlation with accomplishment scores; however, the relation between IQ and comprehensive error scores was nonsignificant (see above).

Comprehensive error scores were significantly negatively associated with the switching scaled score from the Trail Making Test, a measure of cognitive flexibility. That is, higher overall error rates were associated with less cognitive flexibility. Accomplishment scores were not significantly correlated with the Trail Making Test,

Table 6
Results From Correlation and Stepwise Regression Analyses Showing Relations Between NAT Variables and Neuropsychological Test Scores

Test score	MMSE	Color–Word interference test	Verbal fluency	Trail making test switching condition	Card sorting test	Zoo map test	Digit span	Color–Word interference test switching condition	Verbal fluency switching condition
Correlation between NAT variables and neuropsychological test scores (*r* values)									
Accomplishment score	.64**	.18	.27	.17	.25	−.02	.2	.23	.31
Comprehensive error score	−.4	−.2	−.25	−.61**	−0.3	−.31	−.09	−.53*	−.55*
t value for difference[a]									
	3.10**	0.91	1.27	2.18*	1.35	0.71	0.69	2.03*	2.35*
Stepwise multiple regression analysis (beta values)									
Accomplishment score[b]	.62**	.16	−.08	−.08	.21	.2	.27	.04	.29
Comprehensive error score[c]	.01	.03	.08	−.16	−.15	.1	−.17	−.17	−.58*

Note. NAT = Naturalistic Action Test; MMSE = Mini-Mental State Examination.
[a] Difference between accomplishment score *r* value and comprehensive error score *r* values. [b] $R^2 = .38^{**}$. [c] $R^2 = .34^{*}$.
* $p \leq .05$. ** $p \leq .01$.

and the Comprehensive Error Score × Trail Making Test *r* value was significantly stronger than the Accomplishment Score × Trail Making Test *r* value. Comprehensive error and accomplishment scores were not significantly related to the other primary executive functioning measures (see Table 6).

The relation between the Trail Making Test and NAT comprehensive error scores implies a link between action errors and the ability to switch mental sets. To further explore this relation, we examined correlations between NAT variables and two other D-KEFS measures (see Table 3) of cognitive flexibility (color–word interference switching and verbal fluency switching) post hoc. NAT comprehensive error scores, but not accomplishment scores, were significantly negatively associated with both measures of cognitive flexibility. Again, less cognitive flexibility was associated with more NAT errors. Although the *p* values for these tests exceeded .01, the *r* values indicated a strong effect size (Cohen, 1988). Additionally, the Comprehensive Error Score × Switching Tests *r* values were significantly stronger than Accomplishment Score × Switching Tests *r* values (see Table 6).

We conducted stepwise multiple regression analyses to further explore the aspects of neuropsychological functioning that best predicted action performance in schizophrenia. Two regressions were performed with NAT accomplishment and comprehensive error scores as the dependent variables, and all of the neuropsychological measures entered as the independent variables. The results are shown in Table 6. The best model for NAT accomplishment accounted for 38% of the total variance and included MMSE as the only significant predictor. The best model for comprehensive error scores accounted for 34% of the variance and included verbal fluency switching scores as the only significant predictor.

Discussion

Our first aim in this study was to characterize everyday action problems among individuals with schizophrenia using a psychometrically sound, performance-based measure that characterizes a wide range of errors. Consistent with prior studies with different tasks (Semkovska et al., 2002, 2004), we found that participants with schizophrenia demonstrated impaired everyday action performance relative to healthy controls. Of note is that individuals with schizophrenia were impaired on the NAT tasks, even though all necessary objects were present, and there were no time limits. This result indicates that action impairment among individuals with schizophrenia is not restricted to complex activities. Even relatively circumscribed tasks are problematic for this population.

It is important to note that the overall error rate was a more sensitive measure for discriminating participants with schizophrenia from controls than level of accomplishment. Comparison with participants with dementia showed further evidence for a specific deficit in error production. For instance, relative to the M-DE group, participants with schizophrenia committed a comparable number of errors but accomplished significantly more of the NAT tasks. This underscores the importance of collecting error data or, at the very least, of querying patients and caregivers about errors and task efficiency when action abilities are assessed in individuals with schizophrenia.

Our second aim in this study was to assess the cause of action impairment in schizophrenia; the resource theory and a specific executive account for action impairment were evaluated. As stated earlier, the resource theory attributes action difficulties to a unitary deficit, or a reduction in general cognitive resources (Schwartz et al., 1998). The theory predicts that action impairment should be most strongly linked to measures of global cognitive functioning and that error patterns across diverse patient populations should be quite similar. Despite support for this theory from past studies, as well as a long history of attributing cognitive impairments among individuals with schizophrenia to a generalized deficit, our results did not buttress this account.

First, in contrast with the dementia group, there was no significant relation between task accomplishment and commission errors for individuals with schizophrenia. This finding suggests that in schizophrenia, accomplishment and error production are dissociable aspects of action performance that cannot be attributed to a single deficit or construct. Second, the fact that participants with schizophrenia demonstrated a distinct pattern of errors on the NAT relative to the participants with dementia also contradicts the resource theory and suggests that impairments in both groups are best explained by different mechanisms. Third, correlation and regression analyses demonstrated that global cognitive functioning showed a nonsignificant relation with the total number of action errors committed. Recall that overall error rate, and not task accomplishment, was the best indicator of action impairment in this population.

Although our results did not support the resource theory, several findings were consistent with a specific executive account for action impairment. First, the schizophrenia group's unique error pattern contained a particularly high proportion of perseveration and action-addition errors, which indicates specific problems with inhibiting previously performed actions and exerting cognitive control over behavior. Schwartz et al. (1998) have explicitly stated that an executive account of action impairment would predict a high proportion of perseverations and action additions, with relatively few omissions (see also Shallice, 1988). In fact, this is the exact error pattern displayed by the schizophrenia group. Second, correlation and multiple regression analyses demonstrated that executive measures of cognitive flexibility and control, but not measures of global cognition, significantly predicted the total number of action errors committed. Finally, with respect to performance patterns on the NAT, the schizophrenia group demonstrated high rates of errors and relatively preserved task accomplishment. This pattern signifies a primary difficulty with achieving everyday action goals in an organized and efficient manner. This ability greatly depends on the individual's executive capacity to exert control over a plan of action. Moreover, the relative preservation of task accomplishment suggests that individuals with schizophrenia possess intact task knowledge and the ability to sustain task goals over time.

In sum, our findings suggest that an executive function account better explains everyday action deficits in people with schizophrenia. However, it is important to note that the results of this study are not entirely at odds with the resource theory, as NAT accomplishment was not perfect and correlated with, and only with, two measures of general cognitive functioning (MMSE and IQ scores). This may indicate that this particular aspect of action performance is best explained by a global limitation in cognitive capacity, even in individuals with schizophrenia.

A limitation of the current study is its small sample size. As a result, the power to detect small effects (i.e., $d = 0.20$) between the groups was markedly lower than the suggested 0.80 (actual power = .10). It is possible that meaningful small group differences may have been missed. However, small between-groups effects may have little clinical significance with respect to everyday action performance. Despite power limitations, several important between-groups differences were revealed. Our sample size provided adequate power (.71–.75) to detect large differences ($d = 0.80$), which are more likely to have clinical relevance. A second limitation is that collateral reports of everyday functioning were not obtained. Such ratings would have supported the notion that NAT performance in fact reflects everyday functioning among individuals with schizophrenia. The NAT has been shown to correlate with actual capabilities in instrumental activities of daily living in other populations, and it is likely that this relationship would extend to individuals with schizophrenia as well. Third, our groups differed significantly in age and the distribution of men versus women. We acknowledge the possibility that these variables may have contributed somewhat to group differences. However, age and sex were not related to NAT performance in this and prior studies (Buxbaum et al., 1998; Giovannetti et al., 2002, 2005, 2006; Schwartz et al., 1998, 1999, 2002, 2003; cf., Sestito et al., 2005). Moreover, the significant group effects on the NAT were medium to large. Therefore, we believe that it is unlikely that the study results were due to demographic differences.

These limitations notwithstanding, this study demonstrates that individuals with schizophrenia exhibit a unique pattern of everyday action performance that has never been reported with the NAT. It also provides support for an executive account of action errors in this population. It is our hope that this study, as well as future studies of action impairment among individuals with schizophrenia, will inform interventions to facilitate everyday, real-life functioning in the home or work setting.

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