Neuropsychology
2008, Vol. 22, No. 2, 235–245

0894-4105/08/$12.00 DOI: 10.1037/0894-4105.22.2.235

Coffee With Jelly or Unbuttered Toast: Commissions and Omissions Are Dissociable Aspects of Everyday Action Impairment in Alzheimer's Disease

Tania Giovannetti, Brianne Magouirk Bettcher, and Laura Brennan
Temple University

David J. Libon
New Jersey Institute for Successful Aging, University of Medicine and Dentistry in New Jersey-School of Osteopathic Medicine

Rachel K. Kessler and Katia Duey
Temple University

Relative to our understanding of the memory and language deficits associated with Alzheimer's disease (AD), little is known about problems with everyday action performance (i.e., meal preparation, grooming). The resource theory proposes that everyday action problems are best explained by a unitary deficit in general cognitive resources. However, recent research suggests that omission and commission errors may reflect dissociable aspects of action impairment, with only omissions associated with resource limitations. This study examined everyday action performance in 70 participants with AD who also underwent a neuropsychological evaluation. First, correlation and principal component analyses were performed to examine the construct(s) that might explain everyday action impairment. Second, relations between everyday task component(s) and neuropsychological tests were examined by using correlation and regression analyses. Third, differences in everyday action error patterns were examined among participants of comparable overall impairment levels. Results showed omission and commission errors were uncorrelated and distinct components of everyday action performance, predicted by different neuropsychological tests, and differentially distributed even among participants with comparable overall impairment.

Keywords: naturalistic action, activities of daily living (ADL), instrumental activities of daily living (IADL), ideational apraxia, dementia

It is rare for a well-trained neuropsychologist to conclude from his or her clinical evaluation that an individual suffers from a "memory impairment" or "communication problem." Typically, neuropsychological results provide detailed information regarding the nature of patients' memory/language impairment. This information is compiled to conceptualize the deficit according to the current models of cognitive neuroscience and cognitive psychology. Thus, a "memory problem" is more precisely specified as a deficit in attention, encoding, retrieval, clustering, and so on. Specifying the component process(es) that contribute to real-life problems narrows the possible neurological causes and indicates a particular rehabilitation and intervention strategy (Sohlberg & Mateer, 2001). In contrast to the advances made in the domains of memory/amnesia and language/aphasia, there is relatively little known about the neuropsychological processes and deficits associated with performance of everyday tasks, such as grooming and meal preparation.

Everyday action deficits are still largely characterized in generic terms, such as, "problems in everyday activities," "functional difficulties," and so on. Our rudimentary understanding of everyday action is surprising, as everyday impairment is a criterion for the clinical diagnosis of dementia (American Psychiatric Association, 2000) and poses devastating consequences for both patients and caregivers (Knopman, Kitto, Deinard, & Heiring, 1988; Noale, Maggi, & Minicuci, 2003). Reliance on caregiver questionnaires to assess everyday action performance may be partly to blame for the limits of our current knowledge. These methods are prone to bias and offer only a very gross assessment of performance. Consequently, everyday action problems are underspecified, and intervention/rehabilitation strategies for these problems remain blunt and unfocused. The purpose of this study was to use a standardized, performance-based measure of everyday action to explore meaningful, underlying constructs that might offer more nuanced characterizations of action impairment among individuals diagnosed with Alzheimer's disease (AD).

Tania Giovannetti, Brianne Magouirk Bettcher, Laura Brennan, Rachel K. Kessler, and Katia Duey, Department of Psychology, Temple University, Philadelphia, Pennsylvania; David J. Libon, New Jersey Institute for Successful Aging, University of Medicine and Dentistry in New Jersey-School of Osteopathic Medicine, Stratford, New Jersey.

This article was funded by a New Investigator Research grant (NIRG 1059) from the Alzheimer's Association awarded to Tania Giovannetti. Tania Giovannetti's efforts on this project were also supported by a Research and Study Leave from Temple University. A portion of this paper was presented at the 2007 annual meeting of the International Neuropsychological Society (Portland, OR). The authors are grateful to the study participants and their family members for their time and cooperation.

Correspondence concerning this article should be addressed to Tania Giovannetti, Temple University, Psychology Department, Weiss Hall, 1701 N. 13th Street, Philadelphia, PA 19122. E-mail: tgio@temple.edu

Researchers using standardized performance-based measures have proposed the *resource theory* of everyday action impairment, which posits that everyday action is resource demanding[1] and that errors arise when cognitive resources are limited as a consequence of brain damage and/or distraction (Schwartz et al., 1998). Studies of numerous patient populations, including dementia, have shown support for the resource theory (Buxbaum, Schwartz, & Montgomery, 1998; Giovannetti, Libon, Buxbaum, & Schwartz, 2002a; Schwartz 2006; Schwartz et al., 1998, 1999). First, these studies have shown that individuals who show high rates of omission errors (i.e., failures in performing task steps; e.g., never adding coffee grinds to coffee maker) also show high rates of commission errors (i.e., failures in performing task steps well or accurately; e.g., adding sugar, instead of coffee grinds, to coffee maker[2]). Significant positive relations among different error types suggest 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, several studies also have shown that everyday action performance variables are strongly predicted by measures of global cognitive functioning but not of specific cognitive processes (Buxbaum et al., 1998; Giovannetti et al., 2002a; Schwartz et al., 1999; 1998). In dementia studies, the Mini Mental-State Exam (MMSE; Folstein, Folstein, & McHugh, 1975), a measure of global cognitive functioning and dementia severity, has been used as an index of global resources (see Giovannetti et al., 2002a). Third, strikingly similar distributions of everyday action errors have been observed across diverse patient groups (e.g., right stroke, left stroke, closed head injury, etc.; Buxbaum et al., 1998; Giovannetti et al., 2002a; Schwartz et al., 1999, 1998), providing further evidence that action problems are more strongly linked to general cognitive impairment than a particular neuropsychological profile.

Recent studies with healthy participants and participants with schizophrenia or dementia have led us to reconsider the resource account. Giovannetti and colleagues (2007b) asked healthy participants to learn a complex coffee-making task; performance was analyzed while the task was still relatively novel (i.e., early practice condition) and later when the task was well-practiced but performed with a secondary task (i.e., divided attention condition). Although the resource theory would have predicted a similar pattern of errors in the early practice and divided attention conditions, a very different pattern of performance was observed under the two conditions. Participants were more likely to omit task steps (i.e., omission errors) in the practice condition. In the divided attention condition, commission rates increased dramatically but omissions were quite rare. Thus, contrary to the resource theory, distinct performance patterns were observed when performance was differentially disrupted (i.e., inexperience vs. divided attention). Furthermore, these results imply that patients with different deficits (i.e., insufficient experience or task knowledge vs. limited processing resources) should show a different pattern of everyday action performance.

In a study of everyday action performance in individuals with schizophrenia, Kessler, Giovannetti, and MacMullen (2007) showed that task accomplishment/omission errors and commission errors were dissociable aspects of everyday action performance that could *not* be attributed to a single deficit or construct. Participants with schizophrenia demonstrated a significantly higher proportion of commission errors relative to dementia patients who did not differ in total action errors and overall cognitive impairment/general resources. In addition, measures of global cognitive functioning (i.e., MMSE and IQ) were related to only task accomplishment (and omission errors) but not commission errors. Commission errors were significantly related to executive measures of cognitive flexibility and control. Kessler et al. (2007) concluded that executive control deficits, rather than general resource limitations, better explained everyday action deficits in people with schizophrenia. However, mild difficulties in task accomplishment in this population were best explained by a global limitation in cognitive capacity (i.e., MMSE and IQ).

There is also evidence to suggest that the distinction between task accomplishment (i.e., omissions) and commissions might be useful for explaining everyday action difficulties in individuals with dementia. For instance, in a heterogeneous group of 51 dementia participants, we observed that omission errors on everyday tasks were significantly predicted by general dementia severity (i.e., MMSE; Giovannetti et al., 2002a). In contrast, commission errors were not predicted by dementia severity but correlated only with a measure of visuoconstructional performance/executive functions (i.e., the Clock Drawing Test[3]). In another study, we found that participants with AD differed from those with vascular dementia (VaD) on the rate of key commission errors made in everyday tasks, but not on overall task accomplishment (Giovannetti, Schmidt, Gallo, Sestito, & Libon, 2006). Thus, there is reason to hypothesize that omissions and commissions would reflect distinct, dissociable everyday action error categories in individuals with dementia; however, this hypothesis has never been tested directly.

The goal of this study was to reexamine everyday action performance on the Naturalistic Action Test (NAT; Schwartz et al., 2003) among a group of 70 individuals with AD in light of this new evidence against the resource theory and in favor of dissociable action error categories. The NAT is a well-researched, performance-based measure of everyday action that yields information on a wide-range of action error types, including omissions and a range of commissions (i.e., anticipations, substitutions, perseverations; see Table 1). The three findings in support of the resource theory reviewed above were evaluated in this study. First, NAT errors were subjected to an exploratory principal component analysis (PCA) to examine the component structure of everyday action impairment in this population. The resource theory predicts that the error variance would be explained by a single component or factor. However, based on the study by Kessler et al. (2007), we predicted that omissions and commissions would load on two separate components, reflecting dissociable aspects of everyday action performance. Second, relations among the component(s) obtained from PCA analyses and neuropsychological variables were examined. The resource theory predicts that the NAT component(s) would relate most strongly with the MMSE, a measure

[1] Schwartz et al. (1998) defined resources as attention, effort, activation, or "that which makes cognition go forward."

[2] Note that despite the common terminology, commission and omission errors in everyday tasks may have different causal mechanisms than commission and omission errors observed on other neuropsychological measures (i.e., Continuous Performance Test; Conners, 1995).

[3] Neuropsychological measures of working memory, perseveration, verbal fluency, semantic knowledge, and motor skills were unrelated to either commission or omission errors (Giovannetti et al., 2002a).

Table 1
NAT Comprehensive Error Score Categories

Error category	Definitions	Examples from toast and coffee and present tasks
Omission	A step or subtask is not performed	Does not add sugar to coffee
Commission[a]		
Substitution	Semantically related or perceptually similar alternate object used in place of target object	Spreads butter on toast with spoon instead of knife
Sequence	Anticipation of a step which entails a subsequent omission (anticipation-omission), steps or subtasks are performed in reverse order (reversal)	Applies butter on bread, without first toasting bread; 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
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	A task step is performed without the appropriate object or tool	Rips wrapping paper (i.e., does not use scissors); stirs coffee with finger instead of spoon
Action-addition	Performance of an action not readily interpreted as a task step	Eats toast; drinks coffee

[a] Commission errors entail instances when a task step is inaccurately preformed or an extra, off-task step is performed.

of overall cognitive impairment. However, based on prior studies (Giovannetti et al., 2002a; Kessler et al., 2007), we predicted that the omission and commission factors derived from the NAT would be associated with distinct neuropsychological processes, with only omission errors showing an association with the MMSE/overall cognitive impairment. We also explored whether the different NAT component(s) were comparably related to caregiver reports of everyday functioning in the home, but we had no predictions regarding these analyses. Finally, differences in everyday action impairment patterns were explored among individual participants with comparable overall impairment and NAT error rate. Again, the resource theory predicts homogeneous error patterns among individual participants, particularly when controlling for overall impairment (MMSE) and NAT error rate. Based on the hypothesis that omission and commission errors reflect dissociable aspects of action performance, however, we predicted that we would observe different error distributions among participants with comparable overall impairment.

Method

Participants

All participants ($n = 70$) were recruited from an outpatient assessment program that included evaluation by a geriatrician, neuropsychologist, an MRI of the brain, and appropriate laboratory studies. Inclusion criteria were (1) a diagnosis of AD (McKhann et al., 1984); (2) MMSE <26; (3) native English speaker; and (4) no evidence of a focal lesion(s) or cerebrovascular accident(s) on MRI and neurologic examination. Participants were not recruited for the study if they were diagnosed with a comorbid mood disorder or if they had record of prior brain damage/disease, alcohol/drug abuse, or major psychiatric disorder.

Thirty-six participants were recruited specifically for this study. The remaining 34 participants were recruited for other ongoing everyday action studies that included administration of the NAT and a neuropsychological protocol ($n = 9$; Giovannetti et al., 2007[4]; Giovannetti et al., 2002a; $n = 26$). All participants signed institutional review board-approved consent forms that provided permission to videotape the NAT and access to their clinical neuropsychological protocol.

Procedures

The NAT was administered following a comprehensive neuropsychological protocol administered in a single 2- to 3-hour session. The procedures were identical for all participants.

NAT Procedures

The NAT requires participants to perform three everyday tasks with little guidance from the examiner. Item 1 is to prepare toast with butter and jelly and prepare coffee with cream and sugar; Item 2 is to wrap a gift while distractor objects that are visually/semantically similar to target objects (e.g., gardening clippers for scissors) are available on the table; and Item 3 is to pack a lunch box with a sandwich, snack, and a drink and pack a school bag with supplies for school, while several of the necessary objects (e.g., knife, thermos lids) are stored out of view in a drawer with potentially distracting objects. NAT instructions, object placement, cueing procedures, and scoring are standardized and described in the test manual (Schwartz et al., 2003).

The NAT was developed for use with inpatient rehabilitation populations (i.e., brain injury and stroke), and it has sound psychometric properties (Buxbaum et al., 1998; Schwartz et al., 2003; 1999, 1998, 2002). Prior studies have shown that NAT scores are not affected by participants' level of education, gender, or motor difficulties (Schwartz et al., 2003, 2002). A previous study of a heterogeneous group of dementia participants ($n = 51$) has demonstrated significant correlations between NAT variables and care-

[4] These participants were recruited for an action intervention study. All participants included in this study had no intervention prior to the NAT.

giver reports of activities of daily living (ADL) in the home (Giovannetti et al., 2002a; see also Giovannetti, 2006a).

NAT Scoring Procedures

Performance was videotaped for subsequent scoring. The following scores were obtained according to the procedures outlined in the test manual (Schwartz et al., 2003) and prior publications (Buxbaum et al., 1998; Giovannetti et al., 2002a; Schwartz et al., 1999, 1998).

Accomplishment Score: the percentage of task steps completed with or without error (range = 0–100).

NAT Score: the participant's overall level of performance/impairment. This score combines the Accomplishment Score with the sum of a subset of key errors that have been shown to occur frequently in neurologically impaired patients and reliably distinguish patient from healthy populations. A score ranging from 0 (Accomplishment Score <50% and 0 or more errors) to 6 (Accomplishment Score = 100% and <2 errors) is assigned to each NAT item and summed to equal the NAT Score (range = 0–18; Schwartz et al., 2003). According to norms from older adults, a NAT Score below 14 indicates impairment (Sestito et al., 2005).

Comprehensive Error Score (CES): the total number of errors made on the NAT, including omissions and commissions, such as sequence (anticipation-omission and reversal), perseveration, substitution, action-addition, and so on (gesture substitution, tool omission, spatial misestimation, and quality). See Table 1 for more information on error categories. Participants can obtain a minimum of 0 errors; however, there is no absolute maximum number of errors that could be committed. In our laboratory database of over 200 heterogeneous dementia participants, the maximum number of errors committed was 45.

Neuropsychological Assessment

The MMSE (Folstein et al., 1975), Geriatric Depression Scale (GDS; Yesavage, 1986) and a core set of neuropsychological tests was administered to all participants as part of their clinical evaluation. Table 2 provides descriptions of the neuropsychological measures. Caregiver reports of patients' everyday functioning in the home (ADL/IADL; Lawton & Brody, 1969) also were obtained. The ADL and IADL scales range from 0 to 6 and 0 to 17, respectively, with higher scores indicating greater independence and functioning.

Design and Statistical Analyses

This study used a single-group, cross sectional design. First, correlations and an exploratory PCA were performed to examine the relations among NAT error types. Spearman Rank Order Correlations (r_s) were performed because most NAT variables were not normally distributed. The PCA was performed with the eigenvalue criterion (>1) to determine the number of factors extracted and varimax rotation to simplify the interpretation of factors. Second, the relations between the NAT factor(s) and neuropsychological test scores were examined using correlations and stepwise multiple regression analyses. One-third of the sample (n = 23) did not complete all of the neuropsychological measures for various reasons (i.e., time constraints, scheduling conflicts,

Table 2
Neuropsychological Protocol

Test	Description	References
Executive functions		
Boston Revision of the Wechsler Memory Scale–Mental Control Subtest (Mental Control).	The accuracy of performance on three nonautomatized tasks (months backward, alphabet rhyming, alphabet visualization) was calculated with the following algorithm: [1−(false positives + misses)/(#possible correct)] × 100; possible range = 0–100	Cloud et al., 1994; Lamar et al., 2002
Phonemic word list generation (F, A, S)	The dependent variable is the number of words produced in 60 seconds beginning with F, A, or S, excluding proper noun.	Spreen & Strauss, 1998
Language		
Boston Naming Test	The dependent variable is the number of pictures correctly named spontaneously or after a semantic cue; possible range = 0–60.	Kaplan et al., 1983
Animal Naming-Association Index (AI)	This scoring technique quantifies the the degree of association between successive reponses produced on the animal category naming test; possible range = 0–6	Giovannetti et al., 1997; Libon et al., 1998
Episodic memory		
Philadelphia (Repeatable) Verbal Learning Test–discriminability Index (PrVLT–Discriminability)	Participants were asked to remember a 9-word list, as on the California Verbal Learning Test. The dependent variable was the accuracy on the delayed recognition memory task (Recognition Discriminability); posible range = 0–100. Free-recall test trials were not used as dependent variables because they require executive abilities, such as organizational skills and retrieval. The Recognition Discriminibility index was selected because it is a relatively more pure measure of episodic memory encoding.	Libon et al., 2005
Visuoconstructional skills		
Clock Drawing Test	Participants were asked to (1) draw a clock with the hands set to ten after eleven and (2) copy a drawing of a clock. Ten possible errors were scored on each trial; possible range = 0–20.	Cosentino et al., 2004; Goodglass & Kaplan, 1983; Libon et al., 1993, 1996

inability to tolerate the entire neuropsychological testing session, etc.); therefore, all multiple regression analyses were performed twice: first with only participants who completed all measures and second with missing data replaced by the mean of the sample. Last, differences in error patterns were examined among individual participants with comparable MMSE-scores and NAT error rates. Differences in error distributions were assessed using χ^2 analyses.

Results

Characteristics of the Sample

On average, participants were 79 years old (*SD* = 6.7; range = 60–94) and had completed 12 years of education (*SD* = 2.3; range = 6–19). The majority of the sample (74%; *n* = 52) was comprised of women. The mean MMSE score was 20.8 (*SD* = 3.8; range = 5–25), suggesting mild/moderate overall impairment. Scores on the Geriatric Depression Scale were within the normal range (*M* = 5.43, *SD* = 5.7; Spreen & Strauss, 1998). According to caregiver reports, participants were mildly impaired on ADL (*M* = 4.9, *SD* = 1.5) and moderately/severely impaired on IADL (*M* = 8.3, *SD* = 4.5) in the home. Neuropsychological test scores are reported in Table 3.

NAT Performance

Mean NAT scores are shown in Table 4. All mean scores fell within the impaired range relative to published norms (i.e., cut scores = +/- 2 *SD*; Giovannetti, Libon, & Hart, 2002b; Sestito et al., 2005). Moreover, the distribution of error types was strikingly similar to those reported for a heterogeneous group of dementia participants (see Giovannetti et al., 2002a). Participants made very few quality, gesture substitution, spatial, and tool omission errors. We combined these errors to form an error category called "other," but did not include this heterogeneous category in subsequent analyses because it was still quite small and comprised of very diverse error types.

Correlations and PCA of NAT Error Types

Correlations among NAT error variables revealed several significant relations among NAT error types (See Table 5). Preliminary analyses showed that the data were appropriate for PCA (Kaiser-Meyer-Olkin measure of sampling adequacy = 0.60; Bartlett's test of Sphericity, χ^2 (10) = 23.74, *p* = .008). The PCA yielded a two-component solution, accounting for 57% of the variance. As shown in Table 6, sequence, perseverations, and substitutions (i.e., all commissions) loaded on the first component and omissions loaded on the second component; action-additions also loaded most strongly on the second factor. However, when examining the unrotated results, we observed that additions loaded more strongly with the first factor: commissions (0.61 vs. 0.46); all other relations were similar on the unrotated solution. Therefore, we examined the factor plots for both the rotated and unrotated solutions. As shown in Figure 1, we noted that action-additions consistently fell between omissions and commissions. When the PCA was performed without action-additions, a two-factor solution resulted, with commissions (sequence, perseverations, & substitutions) loading on the first factor (rotated factor loadings = 0.75, 0.71, and 0.68, respectively) and omissions loading on the second factor (0.98). The rotated and unrotated component solutions did not differ.

After considering all of the results, we reasoned that action-additions should be analyzed separately from omissions and commissions. The PCA results were interpreted as suggesting two components underlying NAT performance: commissions and omissions. Action-additions, or off-task errors, loaded on both factors depending on the rotation, suggesting action-additions may be multidetermined and share variance with both factors. In fact, correlations among these error types showed action-additions were significantly correlated with both commissions (i.e., sequence, perseverations, & substitutions combined; $r_s = 0.37$, $p < .01$) and omissions ($r_s = 0.30$, $p = .01$). However, the correlation between omissions and commissions was weak and nonsignificant ($r_s = 0.08$). Thus, for the following analyses, sequence, perseveration, and substitution errors were summed to form a single commission error category, and omissions and additions were analyzed as separate error categories. Next, we examined the neuropsychological measures associated with these aspects of everyday action performance.

Relations Among NAT Variables and Neuropsychological Test Scores

Correlations among neuropsychological measures and NAT omissions, commissions, and action-additions are shown in Table 7. Omissions and commissions significantly correlated with several neuropsychological tests. Action-additions, however, were not significantly related to any test score. All correlations indicated that more omission/commission errors were associated with more impaired scores on neuropsychological tests.

Table 3
Mean Neuropsychological Test Scores for the Sample and Normative Data

	AD participants *M* (*SD*)	Normative scores *M* (*SD*)
Mental Control	64.1 (27.4)	91.14 (10.62)
Clock Drawing Test- errors	5.6 (3.4)	1.5 (1.5)
Phonemic Letter Fluency (F, A, S)	19.0 (9.6)	35.27 (3.28)
Boston Naming Test	33.7 (14.2)	53.73 (6.97)
Animal Naming-AI	2.89 (0.90)	3.4 (50)[a]
PrVLT Recognition Discriminability	66.1 (16.3)	96.61 (4.00)

Note. AD = Alzheimer's disease; AI = Association Index; PrVLT = Philadelphia (repeatable) Verbal Learning Test.
[a]Normative data from Giovannetti et al., 1997; all other normative data from Libon et al., 2004; Price et al., 2005.

Table 4
Mean Naturalistic Action Test Scores and Distribution of Error Types (n = 70)

	M	*SD*	Minimum	Maximum	% of total errors[a]
Accomplishment Score	61	28	0	100	—
NAT Score	9.2	5.2	0	18	—
Total CES	19	10.4	3	41	—
Omissions	8.8	7.9	0	29	46
Sequence	2.3	2.3	0	11	16
Perseverations	1.5	1.6	0	9	9
Substitutions	2.1	2.1	0	8	11
Action-additions	2.3	2.3	0	12	12
Other	1.2	1.7	0	9	6

Note. NAT = Naturalistic Action Test; CES = Comprehensive Error Score.
[a] Proportions calculated from the total sum of errors.

To examine whether the relations among test scores and NAT omissions and commissions could be more parsimoniously explained by overall dementia severity, two stepwise multiple regression analyses were performed with neuropsychological test scores as the predictor variables. In the first regression, total omissions was the dependent variable; the best model accounted for 34% of the variance, $F(2, 44) = 11.1$, $p < .01$, with MMSE, $\beta = -.48$, $p < .01$, and Philadelphia (repeatable) Verbal Learning Test (PrVLT)-Discriminability, $\beta = -.26$, $p = .04$, as the only significant predictor variables. The stepwise regression for commissions accounted for 22% of the variance, $F(1, 45) = 12.6$, $p < .01$, and had only Mental Control, $\beta = -.47$, $p < .01$, as a significant predictor. The findings did not change when the regressions were performed including all participants and missing data replaced with the sample mean values.

Relations Among NAT Variables and Caregiver Reports

We were interested in learning whether the omissions, commissions, and/or action-additions were differentially related to caregiver reports of functioning in the home; therefore, correlation analyses were performed between caregiver ADL/IADL reports and NAT variables. As shown in Table 8, only omissions significantly correlated with caregiver reports. However, because prior analyses revealed a strong association between omissions and MMSE, we attempted to rule out the possibility that the link between omissions and caregiver reports was mediated by dementia severity. Partial correlations, controlling for MMSE, showed somewhat weaker relations; however, modest and significant partial r values supported the association between omissions and caregiver reports of ADL ($pr = -.28$, $p = .05$) and IADL ($pr = -.39$, $p = .007$).

Omission-Commission Patterns Among AD Participants

As stated, the resource theory predicts that individuals with comparable resource limitations should demonstrate similar error patterns. Thus, we explored differences in the distribution of omissions, commissions, and action-additions among participants with comparable rates of NAT errors and MMSE scores. We found significantly different patterns of NAT errors across participants. For example, as shown in Table 9, both Participants AA37 and AA23 committed 16 errors on the NAT and comparable overall cognitive impairment (MMSE), yet they showed significantly different error patterns on the NAT. Almost all of AA37's errors were omissions, but AA23 made no omissions. Similar differences were observed among participants with less and greater overall impairment. Data from all 70 participants are presented in a supplementary appendix available online.

Discussion

As a group, participants with AD demonstrated difficulty accomplishing task steps (e.g., Accomplishment Score; omissions), performing steps accurately (e.g., commissions), and inhibiting irrelevant, off-task actions (action-additions) on the NAT. However, our findings suggest that omissions and commissions are distinct, separable aspects of everyday action impairment. First, the PCA of NAT error types revealed omissions and commissions comprised two separate components; action-additions were related to both components. Second, omissions, commissions, and action-additions were associated with different neuropsychological tests, with only omissions predicted by overall cognitive impairment (i.e., MMSE). Third, significant differences were observed in the distributions of omissions, commissions, and action-additions among individual participants with comparable overall action and cognitive impairment.

Overall, our findings are incompatible with the resource theory, which states that everyday action impairment is best explained as a unitary deficit in general cognitive capacity (Schwartz et al., 1998). Our results imply that action performance in patients with AD may be better explained by at least two underlying component constructs: omissions and commissions. Commission errors, or the inability to accurately perform a task step without error comprised

Table 5
Spearman Rank Order Correlation Coefficients Among NAT Error Types

	Omissions	Sequence	Perseverations	Substitutions	Action-additions
Sequence	.04				
Perseverations	.07	.25*			
Substitutions	.12	.24*	.21		
Action-additions	.30**	.32**	.17	.28*	
Other	.05	.19	.10	.38**	.28*

Note. NAT = Naturalistic Action Test.
* $p \leq .05$. ** $p \leq .01$.

Table 6
Rotated Component Matrix

	Factor 1	Factor 2
Omissions	−0.15	**0.87**
Sequence	**0.76**	−0.07
Perseverations	**0.66**	0.08
Substitutions	**0.63**	−0.0004
Action-additions	**0.36**	**0.68**

Note. Boldface indicates values >.60.

one component of everyday action impairment. Omissions, or the inability to perform a task step, comprised a second, distinct component of performance. Action-additions, or the inability to perform actions within the task parameters, were related to both components. We reasoned that although action-additions shared variance with commissions and omissions, they differ from these errors conceptually. Action-additions denote the ability to inhibit the execution of a step that is outside of the general task parameters and/or knowledge deficits regarding the appropriate steps of a task. Therefore, we chose to analyze action-additions as a separate error category. However, we acknowledge that the empirical evidence for action-additions as clearly distinct from omissions and commissions is weak.

There is a precedent for conceptualizing omissions and commissions as dissociable components of various cognitive processes, such as attention, episodic memory, and so on (Armstrong, 1997; Brooks et al., 2006; Foldi et al., 2005; Hart, Wade, Calabreses, & Colenda, 1998; Irle, Kaiser, & Naumann-Stoll, 1990). However, omissions and commissions may be attributed to very different mechanisms across diverse tasks. Thus, we limited our discussion of the omission-commission distinction to studies of everyday action errors. After studying errors of action in healthy people, Reason (1990) proposed that omissions, or lapses, were caused by different mechanisms than various commissions, which he called slips or mistakes (see also Norman, 1981). In support of Reason's account, Sarter and Alexander (2000) showed omission and commission errors among airline pilots were associated with different situations or task contexts as well as different rates of detection/correction. As stated earlier, Kessler et al. (2007) also have proposed that omission and commission errors may reflect dissociable aspects of everyday action performance among individuals with neuropsychological impairment. Moreover, earlier studies have even provided partial evidence for a distinction between omission and commission errors on everyday tasks in dementia (Giovannetti et al., 2002a). However, to our knowledge this is the first study to directly test and support the hypothesis that omissions and commissions denote dissociable aspects of everyday action impairment in patients with AD.

Also contrary to the resource theory, omissions and commissions were predicted by different neuropsychological test scores. Omissions were best predicted by general dementia severity (MMSE) and episodic memory performance (PrVLT Discriminability). The link between general clinical/dementia severity and omissions has been reported in previous studies of dementia participants (Giovannetti et al., 2002a) as well as other neuropsychological populations, including stroke (Buxbaum et al., 1998; Schwartz et al., 1999), schizophrenia (Kessler et al., 2007), and closed head injury (Schwartz et al., 1998). To explain the link between omissions and resource capacity, Schwartz et al. (1998) proposed that resource limitations "may translate into poverty of effort or, more mechanistically, failure to resolve the competition for schema selection such that none of the candidate action schemas reaches threshold" (p. 26). Our results are consistent with this notion and suggest that resource limitations may best explain omission errors.

Omissions also were predicted by episodic memory performance, suggesting that AD participants may have omitted task steps because they failed to recall the task goals or the portions of

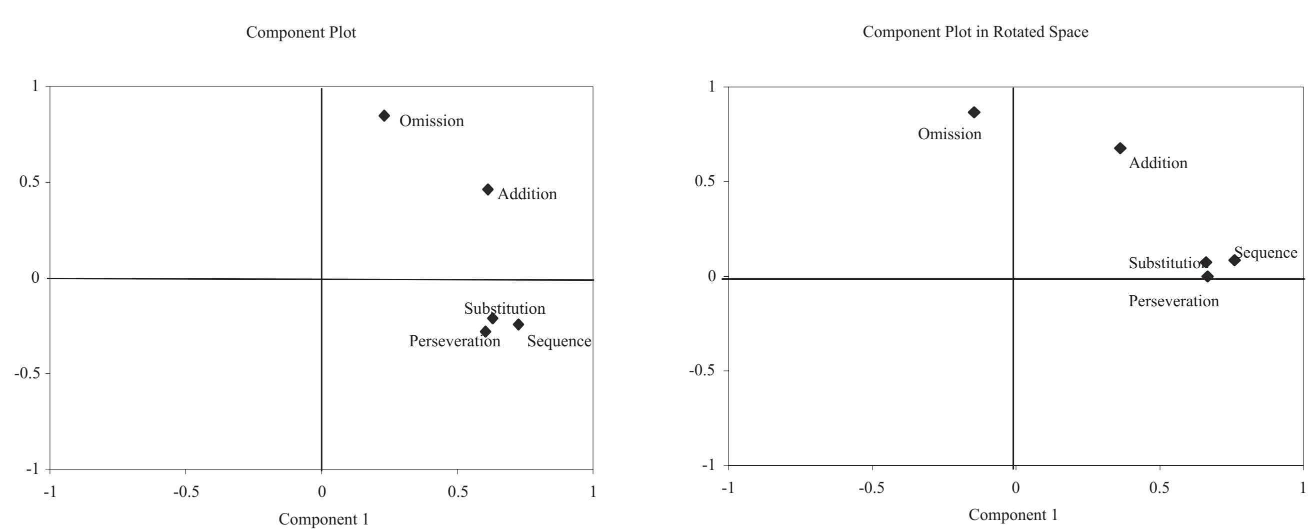

Figure 1. Component loading plots obtained from the unrotated (left) and rotated (right) Principal Component Analyses of NAT Error Types. Both plots show Perseverations, Sequence, and Substitutions (i.e., Commissions) were closely clustered and distinct from Omissions, with Action-Additions (i.e., Addition) falling between Commissions and Omissions.

Table 7
Spearman Rank Order Correlation Coefficients Among Naturalistic Action Test Error Types

	Omissions	Commissions	Action-additions
MMSE (n = 70)	−.49**	−.27*	−.18
Mental Control (n = 56)	−.27*	−.32*	−.10
Phonemic Letter Fluency (F, A, S) (n = 60)	−.33**	−.14	−.20
BNT (n = 64)	−.43**	−.14	−.15
Animal Naming AI (n = 54)	−.18	−.09	−.07
PrVLT (n = 63)	−.14	.05	−.03
Clock Drawing Errors (n = 68)	.47**	.18	.23

Note. MMSE = Mini Mental-State Exam; BNT = Boston Naming Test; AI = Association Index; PrVLT = Philadelphia (repeatable) Verbal Learning Test.
* $p \leq .05$. ** $p \leq .01$.

the task that had (or had not) been accomplished. However, we interpret the association between episodic memory impairment and omissions with caution, as the bivariate correlation between these variables was weak and nonsignificant, and the link between omissions and MMSE was considerably more robust. Nevertheless, there is support in the literature for a link between episodic memory deficits and omissions in everyday tasks. For example, Reason (1990) proposed that some everyday omission errors made by healthy people might be caused by lapses, or failures to recall intentions or task goals. Consistent with this notion, Giovannetti et al. (2007b) observed that healthy controls made omission errors most frequently when tasks were unpracticed and less familiar, suggesting that omissions may be caused by episodic memory failures for task instructions for a new task, even in healthy controls. While the NAT is comprised of relatively familiar tasks, we suspect that participants differed in their extent of task familiarity and knowledge; this variability may have accounted for a portion of the variance of omission errors as well. Unfortunately, we did not assess this potentially relevant factor in the present study. Future studies should address this possibility.

Commissions were predicted by a measure of executive control and working memory. Kessler et al. (2007) have shown commission errors were significantly related to only executive measures of cognitive control and flexibility in individuals with schizophrenia. Moreover, a study of heterogeneous dementia participants reported commission errors were related to only performance on the Clock Drawing Test (Giovannetti et al., 2002a), a visuoconstructional task that requires planning and executive control (see Freedman et al., 2000). Thus, difficulties in performing everyday task steps in the appropriate sequence and with the appropriate target objects are strongly associated with executive control abilities. We acknowledge, however, that greater distinctions could be made among these commission categories. For example, Humphreys and Forde (1998) reported that two neurologically impaired patients (HG and FK) demonstrated very different types of perseverative errors in everyday tasks. HG repeated task steps in immediate succession, whereas FK repeated steps that had been performed earlier in the task after a longer delay. Thus, additional distinctions and more refined categories among these commission error types may be possible in future studies.

Table 8
Spearman Rank Order Correlation Coefficients For NAT Error Types × Caregiver Report of Everyday Functioning (n = 47)

	Omissions	Commissions	Action-additions
ADL Scale	−.45**	.13	.01
IADL Scale	−.52**	−.02	−.15

Note. ADL = activities of daily living; IADL = instrumental /activities of daily living.
* $p \leq .05$. ** $p \leq .01$.

A closer look at error distributions among individual participants in this study also did not support the resource theory. Unlike past reports showing a homogeneous pattern of NAT errors across diverse patient populations, individual AD participants demonstrated significantly different distributions of NAT error types. Participants could be characterized as having an “ommisive,” “commissive,” or “mixed” pattern of everyday action impairment. Of note is that these diverse error patterns were observed among participants of comparable dementia severity and with comparable total NAT errors.

Based on our findings, we propose a new working model for everyday action impairment in patients with AD that differs from the resource theory. On this model, global cognitive decline is associated with degradation of task knowledge and/or an inability to generate or select a plan for action execution. Episodic memory is essential to recall task goals and to remember which steps have or have not already been performed. Thus, in general, as individuals suffer greater global cognitive impairment and episodic memory deficits, they will be more prone to errors of omission in everyday tasks. On the other hand, executive control abilities are essential for the smooth sequential execution of task steps and the selection of appropriate target objects to achieve task goals and subgoals. Individuals with greater executive control deficits will show more commission errors in everyday tasks. In sum, we propose that individuals who differ with respect to general dementia severity/episodic memory deficits and executive control abilities will demonstrate significantly different patterns of everyday action impairment.

Despite the numerous strengths of this study, including the large sample size and performance-based assessment of everyday action performance, we acknowledge several limitations. First, our neuropsychological protocol was not exhaustive and was not selected specifically to assess the cognitive processes most relevant for everyday action. For instance, measures of task familiarity or knowledge (i.e., knowledge of task steps and the objects used for each step) were not administered. We

Table 9
Participants' Distributions of Naturalistic Action Test Omissions, Commissions, and Action-Additions

S number	MMSE	Total errors	% Omissions	% Commissions	% Action-additions	χ^2	Cramer's V (effect size)
1004	23	6	67	0	33		
AA31	25	6	0	100	0	12.1^{**}	1
1007	20	12	33	5	17		
AA07	21	12	0	92	8	5.8^{*}	0.05
AA37	24	16	94	6	0		
AA23	24	16	0	38	62	28.57^{**}	0.94
AA22	17	35	83	6	11		
AA43	17	41	46	44	10	14.5^{**}	0.44

Note. MMSE = Mini Mental-State Exam.
$^{*}p \leq .05$. $^{**}p \leq .01$.

believe that knowledge deficits or inexperience may contribute to omission errors (see Giovannetti et al., 2007b), and we intend to explore the integrity of task knowledge in future studies. Measures of impulsivity and the ability to resist interference from distractors, which may be related to addition errors, also were not included in the neuropsychological protocol. Another limitation is that only participants with AD were tested. In a previous study, we speculated that individuals diagnosed with AD, but not those diagnosed with VaD, may have omitted large task segments on the NAT because of episodic memory deficits (Giovannetti et al., 2006). In other words, we suggested that omissions might have occurred for different reasons across the groups. Others also have proposed that similar everyday deficits might occur for very different reasons across patients or populations (Buxbaum et al., 1998; Hartman et al., 2005). Thus, more research is needed to examine whether our findings hold for individuals with other dementia syndromes or clinical disorders.

These limitations notwithstanding, our results have implications for the clinical assessment of everyday action performance in patients with AD. Our results indicate that individuals with high rates of omissions were perceived by their caregivers to be more impaired than those with low rates of omissions, and this relation held even after controlling for dementia severity (MMSE). By contrast, this pattern was not observed for commission errors. This finding may suggest several different implications. First, it is possible that commission errors, as measured on performance-based tests, have no relation to real life abilities. Performance-based measures entail standardized procedures in a laboratory setting, which may differ considerably from a patient's real-life routine. On the other hand, it is possible that the relation between commissions and caregiver ratings may be moderated by error monitoring abilities. That is, patients who commit high rates of commissions but detect and correct their errors may have better functional abilities than those with lower rates of commissions and impaired error monitoring. Error monitoring was not assessed in the present study, but this possibility should be explored in future research. Another possible interpretation is that omissions are more debilitating than commissions in everyday life. Alternatively, it is possible that omissions are more distressing to caregivers and/or impose a greater caregiving burden than commission errors. If so, caregiver ratings might provide an incomplete picture of everyday difficulties among individuals with dementia. It is important for future studies to adjudicate among these alternative explanations. It is clear, however, that our data demonstrate that caregiver ratings and performance-based tests provide both overlapping and unique information regarding everyday action performance. Thus, we recommend that clinicians and researchers consider using both methods to obtain a complete picture of everyday action abilities. In addition, specific queries regarding commission errors might be incorporated into informant-ratings or clinical interviews to assess a broader array of functional difficulties.

Our results also have implications for treatment. We recommend future studies evaluate whether participants with distinct action deficits will respond best to targeted intervention strategies. For instance, it is possible that individuals with "omissive" patterns might respond best to task retraining, goal reminders, and checklists; whereas "commissive" deficits may be best treated by interventions aimed at increasing cognitive control over performance (i.e., Goal Management Training; Levine et al., 2000, 2007; Manly et al., 2002; Robertson, 1996).

In conclusion, our results do not strongly support the resource theory but suggest a new preliminary model for everyday action impairment in patients with AD, on which omissions, commissions and action additions reflect distinct everyday action deficits. While more research is needed to support and explicate this new model, we hope that our results will urge neuropsychologists to consider collecting more detailed information regarding the nature of their patients' everyday, functional deficits based on performance-based assessment. Thus, rather than concluding that a patient has a "functional deficit," neuropsychologists might begin to offer more nuanced characterizations of everyday action deficits that are empirically supported and informed by cognitive neuroscience. Specification of functional deficits may offer patients and caregivers greater insight and spur targeted intervention strategies to reduced caregiver burden and improve everyday functioning in patients with AD.

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text revision). Washington, DC: Author.

Armstrong, C. (1997). Selective versus sustained attention: A continuous performance test revisited. *The Clinical Neuropsychologist, 11,* 18–33.

Brooks, J. O., Wang, P. W., Strong, C., Sachs, N., Hoblyn, J. C., Fenn, R., et al. (2006). Preliminary evidence of differential relations between prefrontal cortex metabolism and sustained attention in depressed adults with bipolar disorder and healthy controls. *Bipolar Disorders, 8,* 248–254.

Buxbaum, L. J., Schwartz, M. F., & Montgomery, M. (1998). Ideational apraxia and naturalistic action. *Cognitive Neuropsychology, 15,* 617–643.

Cloud, B. S., Swenson, R., Malamut, B. L., Kaplan, E., Sands, L. P., Gitlin, H., et al. (1994). The Boston revision of the Wechsler Memory Scale-Mental Control Subtest. *Journal of the International Neuropsychological Society, 1,* 354.

Conners, C. K., & Multi-Health Systems Staff (1995). *Conner's Continuous Performance Test.* Toronto: MHS.

Cosentino, S., Jefferson, A. J., Chute, D. L., Kaplan, E., & Libon, D. L. (2004). Clock drawing errors in dementia: Neuropsychological and neuroanatomic considerations. *Cognitive and Behavioral Neurology, 17,* 74–83.

Foldi, N. S., Schaefer, L. A., White, R. E., Johnson, R., Berger, J. T., Carney, M. T., et al. (2005). Effects of graded levels of physical similarity and density on visual selective attention in patients with Alzheimer's disease. *Neuropsychology, 19,* 5–17.

Folstein, M., Folstein, S., & McHugh, P. (1975). Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189–198.

Freedman, R. Q., Giovannetti, T., Lamar, M., Cloud, B. S., Stern, R., Kaplan, E., et al. (2000). Different underlying mechanisms for visuoconstructional deficits in dementia. *Neuropsychology, 14,* 415–426.

Giovannetti, T. (2006). Assessing everyday action in dementia: A response to de Jonghe. *Journal of the International Neuropsychological Society, 12,* 756–757.

Giovannetti, T., Bettcher, B. M., Libon, D. J., Brennan, L., Sestito, N., & Kessler, R. (2007a). Environmental adaptations improve everyday action performance in Alzheimer's disease: Empirical support from performance-based assessment, *Neuropsychology, 21,* 448–457.

Giovannetti, T., Lamar, M., Cloud, B. S., Grossman, M., & Libon, D. J. (1997). Impairment in category fluency in ischemic vascular dementia. *Neuropsychology, 11,* 400–412.

Giovannetti, T., Libon, D. J., Buxbaum, L., & Schwartz, M. F. (2002a). Naturalistic action impairments in dementia. *Neuropsychologia, 40,* 1220–1232.

Giovannetti, T., Libon, D. J., & Hart, T. (2002b). Awareness of naturalistic action errors in dementia. *Journal of the International Neuropsychological Society, 8,* 633–644.

Giovannetti, T., Schmidt, K., Gallo, J., Sestito, N., & Libon, D. J. (2006). Everyday action in dementia: Evidence for differential deficit in Alzheimer's disease versus subcortical vascular dementia. *Journal of the International Neuropsychological Society, 12,* 45–53.

Giovannetti T., Schwartz M. F., & Buxbaum L. J. (2007b). The Coffee Challenge: A new method for the study of everyday action errors. *Journal of Clinical and Experimental Neuropsychology, 29,* 690–705.

Goodglass, H., & Kaplan, E. (1983). *The assessment of aphasia and related disorders* (2nd ed.). Philadelphia: Lea & Febiger.

Hart, R. P., Wade, J. B., Calabreses, V. P., & Colenda, C. C. (1998). Vigilance performance in Parkinsons's disease and depression. *Journal of Clinical and Experimental Neuropsychology, 20,* 111–117.

Hartman, K., Goldenberg, G., Daumüller, M., Hermsdörfer, J. (2005). It takes the whole brain to make a cup of coffee: The neuropsychology of naturalistic actions involving technical devices. *Neuropsychologia, 43,* 625–637.

Humphreys, G. W., & Forde, E. M. E. (1998). Disordered action schema and action disorganization syndrome. *Cognitive Neuropsychology, 15,* 771–811.

Irle, E., Kaiser, P., & Naumann-Stoll, G. (1990). Differential patterns of memory loss in patients with Alzheimer's disease and Korsakoff's disease. *International Journal of Neuroscience, 52,* 67–77.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test.* Philadelphia: Lea and Febiger.

Kessler, R., Giovannetti, T., & MacMullen, L. (2007). Everyday action in schizophrenia: Performance patterns and underlying mechanisms. *Neuropsychology, 21,* 439–447.

Knopman, D. S., Kitto, J., Deinard, S., & Heiring, J. (1988). Longitudinal study of death and institutionalization in patients with primary degenerative dementia. *Journal of the American Geriatric Society, 36,* 108–112.

Lamar, M., Price, C., Davis, K. L., Kaplan, E., & Libon, D. J. (2002). Capacity to maintain mental set in dementia. *Neuropsychologia, 40,* 435–445.

Lawton, M., & Brody, E. (1969). Assessment of older people self-maintaining and instrumental activities of daily living. *Gerontologist, 9,* 179–186.

Levine, B., Robertson, I., Clare, L., Carter, G., Hong, L., Wilson, B. A., et al. (2000). Rehabilitation of executive functioning: An experimental-clinical validation. *Journal of Clinical and Experimental Neuropsychology, 20,* 30–41.

Levine, B., Stuss, D. T., Winocur, G., Binns, M. A., Fahy, L., Mandic, M., et al. (2007). Cognitive rehabilitation in the elderly: Effect on strategic behavior in relation to goal management. *Journal of the International Neuropsychology Society, 13,* 143–152.

Libon, D. J., Bogdanoff, B., Cloud, B. S., Skalina, S., Giovannetti, T., Gitlin, H. L., et al. (1998). Declarative and procedural learning, quantitative measures of hippocampus, and subcortical white alterations in Alzheimer's disease and ischaemic vascular dementia. *Journal of Clinical and Experimental Neuropsychology, 20,* 19–32.

Libon, D. J., Malimut, B. L., Swenson, R., & Cloud, B. S. (1996). Further analysis of clock drawings among demented and non-demented subjects. *Archives of Clinical Neuropsychology, 11,* 193–211.

Libon, D. J., Price, C., Garrett, K. D., & Giovannetti, T. (2004). From Binswanger's disease to Leukoaraiosis: What we have learned about subcortical vascular dementia. *The Clinical Neuropsychologist–Vascular Dementia Special Edition, 18,* 83–100.

Libon, D. J., Schmidt, K. S., Gallo, J. L., Penney, D. L., Swenson, R., Giovannetti, T., et al. (2005). The prototypicality of extra-list intrusion errors produced on a serial list-learning task by patients with mild dementia [Abstract]. *Journal of the International Neuropsychological Society, 11*(Suppl. 1), 92–93.

Libon, D. J., Swenson, R., Barnoski, E., & Sands, L. P. (1993). Clock drawing as an assessment tool for dementia. *Archives of Clinical Neuropsychology, 8,* 405–416.

Manly, T., Lewis, G., Robertson, I., Watson, P., & Datta, A. (2002). Coffee in the cornflakes: Time-of-day as a modulator of executive response control. *Neuropsychologia, 40,* 1–6.

McKhann, G., Drachmann, D., Folstein, M., Katzman, R., Price, D., & Stadan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of the Department of Health and Human Task Force on Alzheimer's Disease. *Neurology, 34,* 939–943.

Noale, M., Maggi, S., & Minicuci, N. (2003). Dementia and disability: Impact on mortality. *Dementia and Geriatric Cognitive Disorders, 16,* 7–14.

Norman, D. A. (1981). Categorization of action slips. *Psychological Review, 88,* 1–15.

Price, C. Jefferson, A. L., Merino, J., Heilman, K., & Libon, D. J. (2005). Towards an operational definition of the Research Criteria for Subcortical Vascular Dementia: Integrating neuroradiological and neuropsychological data. *Neurology, 65,* 376–382.

Reason, J. T. (1990). *Human error*. London: Cambridge University Press.

Robertson, I. H. (1996). Goal management training: A clinical manual. Cambridge, United Kingdom: PsyConsult.

Sarter, N. B., & Alexander, H. M. (2000). Error types and related error detection mechanisms in the aviation domain: An analysis of aviation safety reporting system incident reports. *The International Journal of Aviation Psychology, 10,* 189–206.

Schwartz, M. F. (2006). The cognitive neuropsychology of everyday action and planning. *Cognitive Neuropsychology, 23,* 202–221.

Schwartz, M. F., Buxbaum, L. J., Ferraro, M., Veramonti, T., & Segal, M. (2003). The Naturalistic Action Test. Bury St. Edmunds, United Kingdom: Thames Valley Test Company.

Schwartz, M. F., Buxbaum, L. J., Montgomery, M. W., Fitzpatrick-DeSalme, E., Hart, T., Ferraro, M., et al. (1999). Naturalistic action production following right hemisphere stroke. *Neuropsychologia, 37,* 51–66.

Schwartz, M. F., Montgomery, M. W., Buxbaum, L. J., Lee, S., Carew, T. G., Coslett, H. B., et al. (1998). Naturalistic action impairment in closed head injury. *Neuropsychology, 12,* 13–28.

Schwartz, M. F., Segal, M. E., Veramonti, T., Ferraro, M., & Buxbaum, L. J. (2002). The Naturalistic Action Test: A standardised assessment for everyday-action impairment. *Neuropsychological Rehabilitation, 12,* 311–339.

Sestito, N., Schmidt, K., Gallo, J., Giovannetti, T., & Libon, D. (2005). Using the Naturalistic Action Test (NAT) to Assess Everyday Action in Healthy Older Adults and Patients with Dementia [Abstract]. *Journal of the International Neuropsychological Society, 11*(Suppl. 1), 90–91.

Sohlberg, M. M., & Mateer, C. A. (2001). *Cognitive rehabilitation: An integrative neuropsychological approach*. New York: Guilford Press.

Spreen, O., & Strauss, E. (1998). *A compendium of neuropsychological tests* (2nd ed.). New York: Oxford.

Yesavage, J. (1986). The use of self-rating depression scales in the elderly. *Handbook of Clinical Memory Assessment Older Adults,* 213–21.

Received March 13, 2007
Revision received August 21, 2007
Accepted August 23, 2007 ■