

Everyday Activities as a Predictor of Cognitive Risk and Mortality

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ABSTRACT

This study examined the association of a performance-based measure of everyday functioning with clinically meaningful outcomes. Elderly participants in a prospective study of dementia were assessed at two occasions on the Everyday Problems Test for Cognitively Challenged Elderly (EPCCE), a performance-based measure of everyday functioning. Older adults who remained cognitively intact performed approximately 0.66 SD units higher on the EPCCE at both occasions than elders rated as impaired, when covarying on age, education, gender, and cognitive status. Relative to the non-impaired participants, decline in EPCCE performance over a two-year interval was significantly greater for impaired participants and those participants who transitioned from non-impaired to impaired over the course of the study. Increased risk of mortality was associated with lower baseline scores and decline in EPCCE performance even after controlling for demographic variables and performance on the Mini-Mental State Examination. Given the clinical importance of identifying “at risk” elders for impairment, the findings from this study provide initial evidence for the predictive utility of performance-based measures of everyday functioning.

Several recent lines of research have reported an association between everyday activities in old age and clinically meaningful outcomes. Frequency of participation in cognitively stimulating activities has been reported to be associated with reduced risk of dementia as well as magnitude of cognitive decline (Menec, 2003; Wilson, Bennett, Dienias, Mendes de Leon, Morris & Evans, 2003). Moreover, a number of studies have found that limitations in everyday activities required for independent living are predictive of mortality and nursing home placement (Fried, Kronmal, Newman, Bild, et al., 1998; Ganguli, Dodge & Mulsant, 2002; Reuben, Siu, & Kimpau, 1992). The vast majority of these studies have involved self-report measures of everyday activity. In addition, in most studies only a baseline measure of everyday activity has been examined in relation to clinical outcomes (Fried et al., 1998).

Little is known about the association of rate of change in functional activity and these outcomes. In this study we examine the association between a performance-based measure of everyday activity and two clinically meaningful outcomes, dementia and mortality. We consider both the baseline level of performance and change in performance in relation to these outcomes.

The association between cognitively-demanding everyday activities and clinically meaningful outcomes (i.e., risk of dementia and mortality) is believed to stem from the correlation between daily activities and basic cognitive processes (Wilson et al., 2003). People with fewer limitations in activities or who report a higher frequency of cognitive activities would be expected to perform higher on measures of basic cognitive functions. Prior studies have found an association between basic cognitive processes and outcomes such as mortality and risk of dementia (Berg, 1996). In fact, the association of initial level of basic cognitive functioning and mortality has been found, both for nondemented older adult samples (Berg, 1996; Deeg, Hofman & Van Zonneveld, 1990; Maier & Smith, 1999; St John, Montgomery, Kristjansson, & McDowell, 2002) and for demented samples (Bowen, Malter, Sheppard, Kukull, et al., 1996; Uhlmann, Larson, & Buchner, 1987). A few studies have investigated not only baseline level of cognitive functioning but also the relation of rate of decline in basic cognitive abilities and mortality. Bosworth, Schaie, and Willis (1999) reported that rate of decline on basic cognitive abilities was a better predictor of mortality over a 7-year

interval than initial level of performance; prediction of mortality was associated with specific cognitive abilities, such as verbal, spatial orientation, reasoning, and perceptual speed. Similar findings relating rate of cognitive decline and mortality were reported by Deeg and colleagues (Deeg et al., 1990).

The question now arises as to whether performance-based measures of everyday functioning are predictive of clinically meaningful outcomes such as cognitive impairment and mortality. The findings have been mixed in studies that have included both measures of cognition and measures of everyday functioning. In the prospective population-based Cardiovascular Health Study, baseline performance on the Digit Symbol task and difficulty with two or more instrumental activities of daily living (IADL) were both independent predictors of mortality (Fried et al., 1998). In contrast, in a population based prospective dementia study with rural elders, Ganguli and colleagues (2002) found that self reported IADL disability predicted mortality along with older age, being male and number of prescriptions. Cognitive functioning as measured by the MMSE, however, only predicted mortality when IADL disability was excluded from the model.

While limitations in everyday activities have been reported as a predictor of mortality, frequency of engagement in cognitive everyday activities has been associated with another clinical outcome, risk of dementia (Wilson et al., 2003). An association between frequency of cognitive activities and risk of dementia has been reported in cross sectional studies (Friedland et al., 2001; Kondo, Niino & Shido, 1994) and more recently in longitudinal studies (Verghese et al., 2003; Wilson et al., 2002). In the Religious Orders Study (Wilson et al., 2002), cognitive activity was assessed at baseline and members followed for approximately 5-years. A 1-point increase in the cognitive activity score was associated with a 33% reduction in risk of Alzheimer’s disease (AD). However, members were highly educated and were aged 60-70 years on average at baseline. Recently Wilson and colleagues (2003) have reported an association between baseline level of cognitive activity and rate of decline in a limited battery of cognitive measures in a geographically defined biracial community. In the Bronx Aging Study (Verghese et al., 2003) similar findings were reported of a one-point increment in cognitive activity score being associated with reduced risk of dementia and reduced rates of memory decline. Similarly, in the Victoria Longitudinal Study, a measure of participation in intellectually engaging activities (e.g., reading novels, bridge, etc)

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related significantly to cognitive change. Adults with higher activity levels showed less cognitive change despite the fact that education per se was unrelated to change (Hultsch, Hertzog, Small, & Dixon, 1998).

A limitation in these studies examining outcomes of either mortality or risk of dementia is that the measures of cognitive activity or disability in activity have been self report in nature. A number of studies have reported on the positive bias present in self-report measures of competence in everyday activities (Fillenbaum, 1978; Kuriansky, Gurland, Fleiss, & Cowan, 1976). Reporter biases have been noted in both non-impaired and impaired elderly adults. Non-impaired elderly tend to overestimate their level of functional competence, when compared with clinician's ratings of competence (Fillenbaum, 1978). In addition, impaired patients diagnosed as having an organic disorder have been found more likely to overestimate their competence whereas those with a functional disorder were more likely to underestimate performance (Kuriansky, Gurland, Fleiss, & Cowan, 1976). Similarly, measures that require the recall of frequency of engaging in certain events have been shown to be impacted by a variety of factors, including cognition, emotion, and intervening activities (Schooler & Loftus, 1993). There have been very few studies, however, involving objective or performance-based measures of cognitively demanding everyday activities as predictors of clinical outcomes such as mortality and risk of dementia.

In the past two decades within the field of cognitive aging, several performance-based measures of everyday functioning have been developed (Allaire & Marsiske, 1999; Diehl, Willis & Schaie, 1995; Marson, Ingram, Cody, & Harrell, 1995; Willis, 1996). These measures have focused on domains of instrumental activities (e.g., medications, meal preparation, finances, household management) considered essential for independent living (Allaire & Marsiske, 1999; Owsley, Sloane, McGwin & Ball, 2002; Willis, 1993). These performance-based measures have shown significant but modest relationships with self report IADL measures. However, performance-based measures have shown much stronger associations with basic psychometric cognitive abilities than have the self report measures of activity limitations (Allaire & Marsiske, 2002; Cornelius & Caspi, 1987; Diehl, Willis, & Schaie, 1995; Willis, Jay, Diehl, & Marsiske, 1992). The association between objective performance, self report, and proxy reports has been examined both for non-demented elderly and for early stage AD patients (Bertrand & Willis, 1999). In AD patients, performance on the Everyday Problems Test for Cognitively Challenged Elders (EPCCE; Willis, 1993) was significantly related to neuropsychological measures, particularly executive functioning (Willis, Allen-Burge, Dolan, Bertrand, Yesavage, & Taylor, 1998). The limited longitudinal data available on these performance-based everyday activity measures suggest that age-related decline occurs somewhat later than for traditional fluid intelligence abilities. Competence in instrumental everyday activities remains relatively stable until the mid seventies or early eighties; a steep trajectory of decline has been found in the eighties (Willis & Marsiske, 1990; Zarit, Johansson, & Malmberg, 1995).

Though previous research has established a relationship between basic cognitive abilities and everyday functioning as well as basic abilities and clinical outcomes, there is a dearth of research on the association of performance-based measures of everyday functioning and clinical outcomes. The clinical utility of everyday functioning measures depends on evidence of an association between performance (and change) on these measures with outcomes such as diagnosis of cognitive impairment or mortality. Consequently, the purpose of this paper is not to pit the

explanatory power of the EPCCE against a battery of basic cognitive ability tests, but rather to determine if EPCCE performance, like the basic ability tests, is associated with impairment and mortality. Furthermore, we include the MMSE as a covariate because it is most likely the screening instrument that clinicians in high-volume health care settings have at hand. Brief screening measures, like the MMSE, have been shown to be useful in identifying individuals in need of a more exhaustive cognitive evaluation which includes a long battery of neuropsychological measures of cognitive functioning (e.g. MacNeill, & Lichtenberg, 1999).

It is within this context that the current study examines the relation of performance on a performance-based measure known as the Everyday Problems Test for Cognitively Challenged Elders (EPCCE; Willis, 1993) to two clinical outcomes, dementia and mortality. A subgroup of participants from a prospective dementia study (Ganguli, Dodge, Chen, Belle, DeKosky, 2000; Ganguli, Ratcliff, Huff et al., 1991) completed the EPCCE on two occasions separated by two years. At these two occasions and again three years later, participants were rated using the Clinical Dementia Rating scale (CDR; Hughes, Berg, Danziger, Coben, Martin, 1982). Specifically, the study addresses the specific research questions: (1) Does EPCCE performance vary by severity of cognitive impairment? (2) Are changes in EPCCE performance associated with changes in cognitive impairment status? (3) Is EPCCE performance at Time 1 and change in EPCCE performance independent predictors of mortality after controlling for cognitive status (MMSE) and demographic variables?

METHOD

Design

This study was conducted in collaboration with the Monongahela Valley Independent Elders Survey (MoVIES; Ganguli, Ratcliff, Huff et al., 1991, 1993), an ongoing, prospective epidemiological study of cognitive impairment and dementia begun in 1987 to establish a population-based dementia registry. The MoVIES sample includes adults aged 65 years and older selected by age-stratified random sampling from voter registration lists of a group of communities in the Monongahela Valley of Southwestern Pennsylvania. This is a rural population of relatively low socioeconomic status and education. The survey sample reported a median annual income of \$10,000 to \$15,999 and a median education of high school graduate. To be eligible for participation in the study, persons had to be living in the community, be fluent in English, and have at least 6 years of education. MoVIES participants were reassessed at approximate 2-year intervals in the approximate order in which they were originally tested.

The present study was begun at the third wave of the MoVIES project in 1994 - 1996 with a subsample of the MoVIES participants. The EPCCE was administered a second time to this subsample in 1996 - 1998. CDR ratings were made at each MoVIES wave and occurred within a few months of the Time 1 (1994-1996) and 2 (1996-1998) EPCCE testing. A Time 3 CDR rating used in this study occurred in 1999-2001.

Participants

Time 1. The first occasion sample for this study included 773 ($F = 501$, $M = 272$), community-dwelling older adults from rural southwest Pennsylvania. Participants were predominantly Caucasian (98%), with a mean age of 78 years ($SD = 4.56$; $range = 70-94$). The age distribution was: Age 70-74 ($n = 205$; 27%); 75-79 ($n = 318$; 41%); 80-84 ($n = 179$; 23%); 85+ ($n = 71$; 9%) The educational distribution was: < 12 years (8%); high school (8%);

trade or technical school (12%); some college (37%); college (37%); graduate or professional (21%). At Time 1, 72 (9.3%) participants received a CDR of .5 and were assigned to the possible-impairment group; 45 (5.8%) participants were identified as impaired with a CDR rating greater than or equal to 1.

Time 2. At the second occasion a total of 494 participants ($F = 333$; $M = 161$) completed the EPCCE, and the mean age of these participants was 79 years ($SD = 4.25$; $range = 72-94$). The age distribution was: 70-74 ($n = 58$; 12%); 75-79 ($n = 240$; 49%); 80-84 ($n = 136$; 28%) and 85+ ($n = 60$; 12%). Approximately 8% of the sample had less than a high school education (6-9 years, 4%; 10-11 years, 4%); 8% completed high school; 13% went to a post secondary trade or technical school, 38% completed some college; 14% graduated from college and 19% reported graduate or professional training. Of the 494 participants, 43 (8.7%) were assigned to the possible-impairment group ($CDR = .05$) while 27 (5.5%) were identified as impaired ($CDR \geq 1$).

Time 3. At the third occasion only data on impairment (CDR ratings) were available for 453 participants, approximately 60% of the Time 1 sample. Time 1 EPCCE was available on all Time 3 participants and Time 2 EPCCE was available for 341 (75%) of Time 3 sample. The average age of participants at Time 3 was 83 years ($SD = 4.56$; $range = 76 - 97$). The age distribution was: 75-79 ($n = 116$; 26%); 80-84 ($n = 183$; 41%) and 85+ ($n = 144$; 33%). Approximately 8% of the sample had less than a high school education (6-9 years, 4%; 10-11 years, 4%); 6% completed high school; 12% went to a post secondary trade or technical school, 38% completed some college; 13% graduated from college and 23% reported graduate or professional training. Of the 453 participants, 59 (13%) participants were classified with possible-impairment ($CDR = .05$) and 63 (14%) as impaired ($CDR \geq 1$).

Attrition Analysis

Preliminary analysis examined whether differences existed between those participants who completed testing at time 1 and time 2 (returnees; $n = 494$) and participants who did not return at the time 2 (non-returnees; $n = 279$). Non-returnees were significantly ($p < .01$) older ($mean = 79.32$; $SD = 4.77$) at Time 1 than returnees ($mean = 77.47$; $SD = 4.25$). The participants without Time 2 EPCCE also scored more poorly on EPCCE at Time 1 ($mean = 17.56$; $SD = 7.74$) as compared to the returning participants ($mean = 21.37$; $SD = 6.84$) and more poorly on the MMSE ($mean = 25.61$; $SD = 3.04$) than the participants who returned for Time 2 testing ($mean = 26.71$; $SD = 2.42$). However, educational level was not significantly related to attrition.

Time 3 CDR ratings were available on 453 participants; 341 of these participants had Time 2 EPCCE; 112 had only time 1 EPCCE. Mean differences in age, education, time 2 EPCCE and MMSE between those participants who were tested at Time 2 and had CDR ratings at time 3 (returnees; $n = 341$) and participants that did not return at time 3 (non-returnees; $n = 153$) were nonsignificant ($p > .01$).

Mortality

Of the 773 participants initially assessed at time 1, a total of 261 (34%) participants have died. Sixty (34% of the deaths) deaths occurred between time 1 time 2, of which 46 participants were rated as non-impaired at Time 1, 6 participants were rated as possible-impaired and 8 as impaired. Between Time 2 and Time 3 another 58 participants (23% of deaths) died. At Time 2, 24 of these participants were rated as non-impaired, 9 were possibly-impaired, 14 were impaired, and 11 participants did not have a CDR at Time 2. After the final occasion (Time 3), an additional 143 participants (55% of the deaths) have died, of which 47 were

rated as non-impaired, 20 as possible-impaired, 32 as impaired and 44 did not have a CDR at Time 3. For the purposes of the current investigation, mortality status (alive = 0; deceased = 1) was used as well as two variables representing the number of days between the first EPCCE administration and date of death and the number of days between the second administration and date of death. Death certificates were used to confirm the exact date of death.

Procedure

Participants in the current study were assessed in their homes. First, the MoVIES protocol, involving an extensive interview and a battery of clinical and neuropsychological measures, was administered (Ganguli et al., 1991, 2000). The semi-structured interview focused on demographic information, sensory impairments, functioning in daily self-care and instrumental activities, health, nutrition, number and types of medications, and the use of formal and informal health and social services. Following the MoVIES battery, subjects were told that they had the opportunity to take part in a new phase of the study (i.e., EPCCE). Subjects were paid \$10 for their participation in the MoVIES project and an additional \$10 for testing on the EPCCE measure.

Measures

Everyday Problems for Cognitively Challenged Elderly (EPCCE). The test of Everyday Problems for Cognitively Challenged Elderly (EPCCE) measures older adults' cognitive ability to solve tasks associated with everyday activities and has been described in detail in previous reports (see Bertrand & Willis, 1999; Willis et al., 1998; Willis, Dolan, & Bertrand, 1999). This 32-item measure assesses complex cognitive functioning in each of the seven IADL task domains. Participants are shown 16 printed stimuli that represent real-world stimuli encountered in tasks of daily living, such as an itemized phone bill, directions for over-the-counter medication, or a nutrition label. Upon viewing each stimulus, subjects are asked to solve two problems related to the information presented (e.g., "What is the maximum number of teaspoons you could take in a 24-hour period?"). There are two items per stimuli with a total score of 32, where higher scores indicate better performance.

The EPCCE was adapted from its parent measure The Everyday Problems Test (EPT; Marsiske & Willis, 1995; Willis, 1996) to represent an easier and shorter assessment tool appropriate for use with nondemented older adults at risk of cognitive decline, as well as early stage Alzheimer's patients (Bertrand & Willis, 1999; Willis et al., 1998). The EPCCE was designed with a broad range of item difficulty so that neither population would immediately experience floor or ceiling effects, and decline in performance could be detected over the course of a longitudinal study. Sixteen stimuli and 2 corresponding test items (32 items total) from the parent EPT were selected for the EPCCE. These items were chosen because they had been answered correctly by 90% (8 items), 80% (8 items), 70% (8 items), and 60% (8 items) of a larger, more functionally heterogeneous sample. Two month test-retest reliability was $r = .93$ with Spearman-Brown correction. Internal consistency of the EPCCE was $r = .90$.

Mini-Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975). The MMSE is a widely used screening measure for identifying individuals with possible mental impairment.

Clinical Dementia Rating (CDR). Clinical evaluation followed the standardized ADRC and Consortium to Establish a Registry for AD (CERAD; Morris, Heyman, Mohs et al., 1989) protocols. Diagnosis at each wave was made by consensus among all evaluating clinicians and using all available data for that wave,

and was made according to the Diagnostic and Statistical Manual, 3rd ed, revised criteria (American Psychiatric Association, 1987) and according to the Clinical Dementia Rating Scale (Hughes et al., 1982) for which CERAD provides a scoring algorithm based on *functional* rather than *cognitive* impairment. Scores on the CDR of 0, .5, 1, 2, and 3 correspond to no impairment, possible/incipient, mild, moderate, and severe dementia respectively. For the purposes of the current study, participants with a CDR .5 were assigned to the *possible impaired* group while those participants with a CDR of 1 or greater were assigned to the *impaired group*. The decision to collapse across CDR was due the limited number of individuals with ratings greater than 1, and reflects a practice used in previous studies using this data set (Ganguli, Dodge, Chen, et al., 2000; Rodriguez, Dodge, Birzescu, Stoehr, & Ganguli, 2002).

RESULTS

This study examines the association between performance on EPCCE and two clinically meaningful outcomes: cognitive impairment and mortality. Analyses addressed three specific questions: (1) Does EPCCE performance vary by severity of impairment? (2) Are changes in EPCCE performance associated with changes in impairment status? (3) Are EPCCE performance at Time 1 and change in EPCCE performance independent predictors of mortality after controlling for cognitive status (MMSE) and demographic variables?

Mean Differences in EPCCE Performance

Analyses examined whether mean performance on the EPCCE at Time 1 and at Time 2 significantly differed across participants rated as non-impaired, possibly impaired, or impaired at those occasions. The results of which are presented in Table 1. Group differences were examined with and without the covariates of age, gender, education, and MMSE score. Mean EPCCE performance at Time 1 was significantly different across the three impairment groups. Specifically, planned contrasts indicated that the non-impaired participants ($n = 656$) performed significantly ($p \leq .001$) higher on average than the possible-impaired ($n = 72$) and impaired groups ($n = 45$). In addition, the impaired group performed significantly ($p \leq .01$) worse than the possible-impaired group. Mean differences remained even after controlling for age, gender, education, and Time 1 MMSE though the contrast between the two impaired groups was no longer significant.

Table 1

Mean differences in performance on the EPCCE at Time 1 and 2.

Variable	Non-impaired	Possible- Impairment	Impaired	<i>F</i>	<i>p</i>	ζ^2
	Mean (SD)	Mean (SD)	Mean (SD)			
EPCCE Time 1	21.38 (6.63)	13.46 (6.62)	10.29 (6.64)	97.71	.00	.20
EPCCE Time 1 w/ covariates	20.48 (5.37)	17.49 (5.60)	16.96 (5.97)	13.06	.00	.03
EPCCE Time 2	21.02 (7.41)	13.30 (7.41)	8.00 (7.43)	56.30	.00	.19
EPCCE Time 2 w/covariates	20.31 (6.18)	17.09 (6.41)	13.08 (6.50)	17.81	.00	.07

Note: Covariates included age, sex, education, MMSE Time 1.

Turning to time 2, the three impairment groups again significantly differed in mean performance on the EPCCE. Specifically, average performance of non-impaired participants ($n = 424$) was significantly higher ($p \leq .01$) than for the possible-impaired ($n = 43$) and impaired groups ($n = 27$). A significant difference was also found between the two impaired groups, with the impaired group performing significantly ($p \leq .01$) lower on the EPCCE than

the possible-impaired group. EPCCE performance of the non-impaired group was approximately 1.68 and 1.76 SD units above that of the impaired group at Time 1 and Time 2, respectively. Mean differences between the three groups remained significant after the effects of age, gender, education, and time 2 MMSE were controlled for in the analyses.

Longitudinal Change in EPCCE and Impairment Status

Analyses next examined the magnitude of change in performance on the EPCCE across groups of participants whose CDR ratings either became worse or remained the same from Time 1 to Time 2 and from Time 1 to Time 3. For each of the two intervals, three groups of participants were defined, based on changes in their CDR rating: (1) participants who were rated as non-impaired (i.e., CDR = 0) at each occasion in the interval were assigned to the *Non-impaired* group; (2) participants who were non-impaired at the first occasion but who were rated as either possible-impaired (CDR = .05) or impaired (CDR ≥ 1) at the second occasion were assigned to the *Impairment Change* group, and (3) those participants who were rated as either possible-impaired or impaired at both Time points were assigned to the *Impaired* group.

EPCCE Change (Time 1 – 2) by Change in CDR (Time 1 – 2). In the first interval (Time 1 - Time 2), the sample included 492 participants: Non-Impaired Group $n = 424$; Impairment Change $n = 27$; and Impaired group $n = 43$. A repeated measures ANOVA (2 Time x 3 Impairment group) was conducted with age, education, gender, and MMSE Time 1 score included as covariates. Results indicated a significant time by impairment group interaction, $F(2, 487) = 3.50$; $p < .05$, $\eta^2 = .03$. As can be seen in Figure 1, relative to the Non-impaired group change in EPCCE performance from Time 1 to Time 2 was significantly greater in the Impaired and the Impairment Change groups; however, the difference in change between these two groups was nonsignificant.

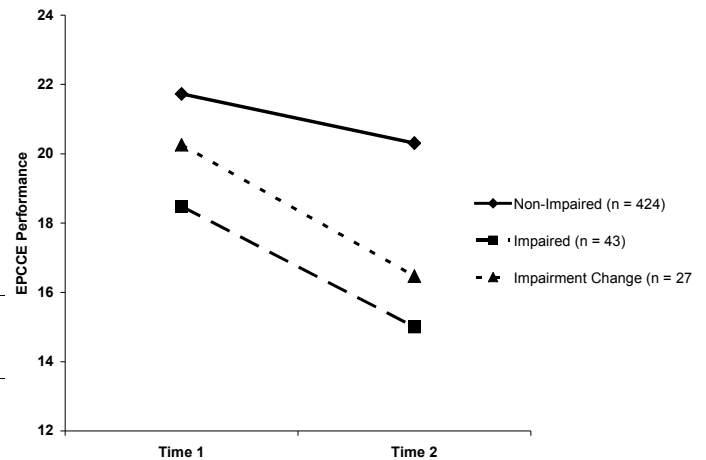


Figure 1. EPCCE Performance (Time 1- Time 2) by Change in Impairment Status (Time 1 – Time 2).

EPCCE Change (Time 1 – 2) by Change in CDR (Time 1 – 3). The relationship between Time 1 to Time 2 EPCCE change and CDR status over an approximate five-year interval (Time 1 to Time 3) was examined for 341 participants (Non-Impaired group $n = 264$; Impairment Change group $n = 50$; Impaired group $n = 27$). A repeated measure ANOVA, again controlling for age, education, gender, and MMSE, indicated that there was a significant between Time x Impairment group

interaction, $F(2, 334) = 4.06; p < .05, \eta^2 = .03$). Follow-up analyses examined group differences with respect to EPCCE change from Time 1 to 2. As can be seen in Figure 2, average EPCCE performance declined from Time 1 to 2 for the participants in both the Impairment Change and Impaired groups and the magnitude of this change was significantly greater in the Impairment Change group relative to the Non-Impaired group ($p = .05$).

Risk of Mortality

To determine if performance on the EPCCE at Time 1 as well as change from Time 1 to 2 were significant predictors of time to death, survival analyses using Cox-regression analysis was conducted. Specifically, two separate hierarchical models were estimated, one for each occasion of EPCCE measurement. In each of these models, the EPCCE was entered at the first step and the covariates of age, gender, education, and MMSE were included in the model at the second step.

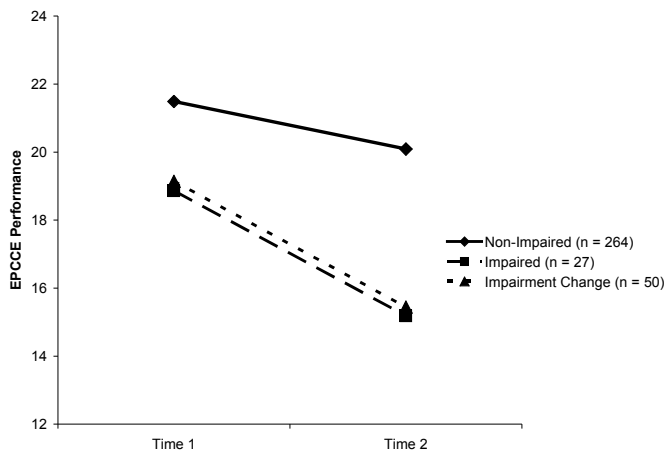


Figure 2. EPCCE Performance (Time 1 - Time 2) by Change in Impairment Status (Time 1 - Time 3).

Table 2 (top) contains the results from the first survival analysis in which performance on the Time 1 EPCCE was used to predict mortality. In this analysis, Time 1 EPCCE data were present for 261 participants who subsequently died and 512 survivors. At the first step, the Time 1 EPCCE was a significant predictor with higher scores associated with a lower risk of death. At the second step, the covariates were included in the model and the EPCCE remained a significant predictor of death ($p = .05$) even though all the covariates were significant with the exception of education. Specifically, there was a 2% increase in mortality risk with every unit decrease in EPCCE. As might be expected, being older was associated with a greater likelihood of dying as was being male. Higher performance on the MMSE (Time 1) was also associated with lower risk of death.

Next, change in performance on the EPCCE from Time 1 to Time 2 was examined as a predictor of mortality (bottom of Table 2) for 104 deceased participants and 390 survivors who had Time 2 EPCCE scores. Change in performance was examined by including Time 1 and Time 2 EPCCE as predictors of mortality in Step 1. As can be seen in the bottom portion of Table 2, Time 2 EPCCE was a significant predictor of mortality controlling for Time 1 performance, indicating that decline in performance was associated with a greater risk of death. The second step of the model included the covariates of age, gender, education, as well as Time 1 and 2 MMSE score. Results indicated that even after controlling for these factors, change in EPCCE performance

remained a significant predictor of mortality, with a 4% increase in mortality risk with every one unit decline in EPCCE performance.

Table 2

EPCCE performance at Time 1 (n = 773) and Time 2 (n = 494) as predictors of mortality risk.

	Variable	β	OR	95% CI	p
Step 1	EPCCE T1	-.07	.93	.92-.95	.00
Step 2	EPCCE T1	-.02	.98	.96-1.00	.04
	Age	.09	1.10	1.07-1.13	.00
	Gender	.52	1.68	1.31-2.16	.00
	Education	-.003	1.00	.92-1.09	.94
	MMSE1	-.09	.91	.87-.96	.00
Step 1	EPCCE T1	-.01	.99	.96-1.02	.53
	EPCCE T2	-.07	.94	.91-.96	.00
Step 2	EPCCE T1	.03	1.03	.99-1.07	.20
	EPCCE T2	-.04	.96	.93-.99	.01
	Age	.09	1.10	1.05-1.15	.00
	Gender	.65	1.92	1.30-2.82	.00
	Education	.01	1.01	.87-1.16	.93
	MMSE T1	.00	1.00	.90-1.10	.94
	MMSE T2	-.10	.91	.84-.98	.01

DISCUSSION

Maintenance of mental competence, and prevention or delay of cognitive deficits are critical to independent functioning in old age. The prevalence of AD varies by age group, but increases with age, and the percentage of older adults diagnosed with AD doubles every 5 years beyond age 60 (Katzman & Fox, 1999). Currently, few potentially modifiable risk factors for dementia have been identified and thus understanding the association between cognitive activity and disease incidence is a matter of substantial public health significance. Furthermore, as effective treatments become available to delay or slow the rate of cognitive loss, reliable identification of adults at high risk for cognitive impairment will increase the utility of these treatments.

In this study we examined the association of performance on cognitively demanding everyday activities to two clinically meaningful outcomes, dementia and mortality. This study complements and extends prior research on the association between everyday activities and clinical outcomes in at least two ways. First, a performance-based assessment of competence in everyday activities, rather than self report, is the focus of the study. Second, change in performance of these everyday activities, rather than only baseline level of activity, are related to clinical outcomes.

The first question addressed whether level of performance on a performance-based measure of everyday activities would differ for groups of older adults rated as non-impaired versus those elders who were rated impaired or possible-impaired, using the stringent CDR criteria for impairment. Significant group differences were found at both occasions. Older

adults who were cognitively intact were functioning approximately a 1.6 standard deviation units higher on the EPCCE impaired elders at both occasions of measurement. Mean differences were attenuated to approximately 0.50 *SD units* at Time 1 and 1.0 *SD units* at Time 2, when controlling for demographic characteristics and general cognitive status. There is the question of whether such group differences are clinically meaningful. These group differences are on the order of the 1.5 *SD* criterion used to differentiate normal and mild cognitive impaired (MCI) individuals (Petersen, 2000).

A second question examined whether decline in the EPCCE over a two-year interval was associated with CDR change status. Individuals rated as non-impaired across the entire study interval exhibited the least EPCCE decline over the two year interval. Rate of EPCCE decline for the normal group was on the order of 0.50 *SD units*. In contrast, for individuals whose CDR rating transitioned from normal to impaired over the study interval, the rate of two-year decline on the EPCCE was also double that of non-impaired participants. Amount of two-year decline in the EPCCE was on the order of 0.91 *SD units*. Thus, rate of EPCCE decline over two years was highly diagnostic of subsequent change in cognitive status as reflected in CDR ratings. The rate of two-year EPCCE decline for participants rated as impaired at Time 1 was approximately 0.50 *SD units*, possibly reflecting a floor effect. The findings on the association of change in EPCCE to change in CDR ratings are particularly useful. Most criteria for identifying impairment have been based on group differences in cognitive status (single occasion measure) rather than cognitive change. It is assumed that group differences in performance level reflect decline, but actual change data are often unavailable.

Finally we examined performance on everyday tasks as a predictor of mortality risk. Results indicated that lower baseline scores on the EPCCE were a significant predictor of time to death even after controlling for demographic variables and MMSE performance. Deceased participants declined on the EPCCE approximately 0.66 *SD units* from Time 1 to Time 2. Of particular note is that the baseline EPCCE score remained a significant predictor after accounting for demographic variables and cognitive status as measured by the MMSE. Prior research has hypothesized that the salience of everyday cognitive activities as predictors of clinically meaning outcomes was due to their association with basic cognitive processes (Wilson et al., 2003). However, the finding of EPCCE as a predictor of mortality when accounting for MMSE suggests that performance on everyday activities is accounting for additional variance than that represented by a global screening measure of cognitive status. It is important to note that the predictive utility of the EPCCE is most likely attenuated when a battery of neuropsychological or psychometric cognitive ability measures is included; though a large scale battery of cognitive measures is typically not readily available to clinicians.

We considered the question of whether mortality was associated with decline in everyday functioning as well as baseline level of performance. The phenomenon of a terminal drop in basic cognitive abilities has been extensively studied (Berg, 1996). Terminal drop has been found to be associated with level of performance on basic cognitive abilities (Deeg et al., 1990) and also with rate of change in cognitive processes (Bosworth et al., 1999). Likewise, self reports of limitations in ADL and IADL tasks have been related to mortality (Fried et al., 1998; Ruben et al., 1992). This study extends prior research on terminal drop by examining change in a performance-based measure of everyday competence as predictor of mortality. Not only was baseline level of EPCCE performance but also change in the EPCCE was predictive of mortality. Furthermore, decline in the EPCCE remained a significant predictor, even after accounting for

demographic variables and rate of decline in global cognition as measured by the MMSE. Thus, change in everyday functioning accounts for additional variance in terminal drop beyond that attributed to decline in global cognition as measured by the MMSE.

Our prior study of the timing of age-related change in basic abilities compared with everyday functioning suggests that decline in everyday task may occur later in the late 70's and early 80's (Willis & Marsiske, 1990). That is, fluid intelligence has been shown to decline on average in the mid sixties, while reliable decline on everyday tasks has been found to occur in the late seventies and early eighties. The sample in the current study was at an advanced age at which decline would be expected not only in basic cognition, but also in everyday competence.

Though the findings from the current study provide initial and exciting insight into the clinical meaningfulness of cognitively demanding everyday activities, some limitations of the study should be noted. Generalizability of the study findings are limited by the attrition in the number of participants with EPCCE scores at two occasions, and thus the opportunity to examine the association of rate of change in everyday functioning to the clinical outcomes. Moreover, the sample is ethnically homogeneous, with few minorities. Future research should focus on study of the association between performance-based measures of everyday functioning and a broader array of clinically meaningful outcomes than the two included in this study. Of particular interest would be study of the association of decline in measures of everyday functioning and loss of ability to live independently in the community. Change in everyday functioning over the relatively brief interval of two years was shown in this study to be predictive of two clinical outcomes – change in CDR rating and mortality status. Examination of the trajectory of everyday functioning over longer time periods is needed to determine how early in the change process clinically meaningful outcomes can be predicted. A broader range of individual difference characteristics associated with accelerated rate of change in everyday functioning need to be considered, other than the demographic variables included in this study.

While prior research has established an association between basic cognition and everyday functioning and also an association between basic cognition and clinical outcomes, there has been limited study of performance-based measures of everyday functioning as a predictor of clinical outcomes. The current study represents one of the first attempts to establish the relationship between a performance-based measure of cognitively demanding everyday activities and clinically meaningful outcomes in older adults. Evidence of this link was supported by the study findings, which indicated that level of performance and change in performance on the EPCCE was a significant and unique predictor of impairment and mortality. Such findings provide support for the clinical utility of these performance-based measures of everyday functioning. Given the clinical importance of identifying “at risk” elders” for impairment, the findings from this study provide initial evidence for the predictive utility of performance-based measures of everyday functioning

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