Published in final edited form as:

J Aging Health. 2013 December ; 25(8 0): . doi:10.1177/0898264313495560.

Cognitive Longitudinal Predictors of Older Adults' Self-Reported IADL Function

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Abstract

Objective—To examine basic and everyday cognitive predictors of older adults' self-reported instrumental activities of daily living (IADL).

Methods—Basic and everyday cognitive predictors of self-reported IADL were examined in a sample of healthy, community-dwelling older adults ($n = 698$) assessed over five years of measurement.

Results—Multilevel longitudinal analyses revealed linear and quadratic change trends for self-reported IADL function, with steeper declines at higher ages. Within-person, when participants exhibited lower cognitive performance, they also reported more IADL impairment. Everyday cognition remained a significant unique predictor of self-reported IADL after controlling for attrition, re-sampling effects, temporal gradients, and baseline levels and changes in demographic, sensory, functional, and basic cognitive measures.

Discussion—By itself, everyday cognition appears to be an important predictor of self-reported IADL, and maintains a unique predictive contribution after many covariates are controlled. Future research should consider the inclusion of everyday cognitive measures in functional assessment batteries.

Keywords

aging; everyday cognition; IADL

A key concept in the gerontological literature is the instrumental activities of daily living (IADL). IADL, as originally delineated by Lawton & Brody (1969) include everyday tasks such as food preparation, medication use, transportation, and financial management (Depp & Jeste, 2009; Willis, 1996) and are most commonly assessed with self- and/or proxy-report measures. Older adults' IADL function is of substantial interest given the prominent role of functional IADL independence in "successful" aging (Depp & Jeste, 2009). Furthermore, impairment in IADL has been associated with adverse outcomes such as dementia (Barberger-Gateau, Fabrigoule, Helmer, Rouch, Dartigues, 1999; Barberger-Gateau, Fabrigoule, Rouch, Letenneur, & Dartigues 1999; Pérès et al., 2008), reduced psychological well-being (Lawton, 1987; Willis, 1991), greater health care utilization, increased rates of institutionalization (Miller & Weissert, 2000; Wolinsky, et al., 1983, 2007; Wolinsky, Callahan, Fitzgerald, & Johnson, 1993) and higher mortality (Ferrucci, et al., 1991; Miller & Weissert, 2000; Naeim, Keeler, & Reuben, 2007; Wolinsky et al., 1993, 2007). IADL functioning in daily life has many components, including physical, emotional, and cognitive (Willis, 1996) that interact to affect the individual over time (Verbrugge & Jette, 1994).

Thus, any explanatory model with IADL as an outcome would ideally take into account these many factors. The present study focused particularly on cognitive predictors of self-reported IADL function in late life.

Among studies examining cognitive predictors of IADL function, most have focused on the role of “basic” cognitive abilities (i.e., psychometrically assessed neuropsychological and experimental measures). Areas of basic cognition assessed have included aspects of memory, executive function, reasoning, and processing speed, all of which are known to decline with increasing age (Grady & Craik, 2000; Lindenberger & Ghisletta, 2009; MacDonald, Hultsch, & Dixon, 2011; Royall, Palmer, Chiodo, & Polk, 2005b; Schaie, 1994). Across studies, measures, and populations of older adults assessed, cross-sectional studies have most frequently reported a significant moderate (.48 to .61) relationship between basic cognitive abilities and IADL function (e.g., Bennett et al., 2006; Farmer & Eakman, 1995; Jefferson, Paul, Ozonoff, & Cohen, 2006; Tan, Hultsch, & Strauss, 2009). Longitudinal studies have reported moderate to large relationships ($r = -.57$ to $-.72$), with changes in IADL function related to changes in memory and executive function (e.g., Tomaszewski Farias et al., 2009; however see Tucker-Drob, 2011). This is consistent with the idea that IADL, such as meal preparation and financial management, might rely on traditionally assessed cognitive skills, such as memory.

Psychometric measures of cognitive and intellectual ability are generally designed to be context-free measures of performance under optimal conditions. Responding to critiques regarding the ecological validity of such measures (e.g., Wagner & Sternberg, 1986; Chaytor & Schmitter-Edgecombe, 2003), investigators have developed measures of “everyday cognition” (Poon, Rubin, & Wilson, 1989). These measures are administered in similar fashion to those of basic cognition (i.e., paper and pencil), are novel in content, and have only one correct response per item (Allaire & Marsiske, 2002). As such, these measures are sensitive to a wide range of individual differences in performance. Everyday cognitive measures utilize stimuli from everyday life, such as nutrition labels, resemble familiar and relevant everyday IADL challenges, and encourage examinees to incorporate past experience and accumulated knowledge (Salthouse, 1990). Furthermore, everyday cognitive measures are distinct from performance-based assessments of IADL, which are commonly administered in the elder’s home by occupational therapists, have a significant physical functioning focus, and are typically assessed on a pass-fail level (e.g., Occupational Therapy Assessment of Performance and Support, see Cahn-Weiner et al., 2000). Everyday cognitive abilities are conceptualized as “hierarchical” in that they rely on basic cognitive abilities, in addition to domain specific knowledge (Marsiske & Margrett, 2006). For example, an everyday cognitive assessment might require examinees to look up a phone number in the phone book, for which they employ memory and processing speed skills, coupled with domain specific knowledge gained from prior experience using a phone book. Given their presumed closer proximity to “real world” cognition, everyday cognitive measures ought to be better predictors of functioning than basic, context-free measures of intelligence and problem solving.

In support of the idea that everyday and basic cognition are related, there is evidence that everyday cognitive tasks share 50–80% of their variance with basic cognitive tasks (e.g., Allaire & Marsiske, 1999; Burton, Strauss, Hultsch, Hunter, 2006; Diehl, Willis, & Schaie, 1995; Marsiske & Margrett, 2006; Thornton, Deria, Gelb, Shapiro, Hill, 2007; Weatherbee & Allaire, 2008; Wood et al., 2005). Longitudinally, Willis, Jay, Diehl, & Marsiske (1992) found that fluid reasoning was a significant predictor of everyday cognitive skills 7 years post-baseline assessment, accounting for 52% of the variance. Two previous papers from the ACTIVE study (Gross, Rebok, Unverzagt, Willis, & Brandt, 2011; Tucker-Drob, 2011) have reported that baseline basic abilities predict level (Covariate adjusted $R^2 = .009$ to $.139$) and

trajectory (Covariate adjusted $R^2 = .013$ to $.051$) of everyday cognition (Gross et al., 2011) as well as significant associations between trajectories of change in basic and everyday cognitive skills ($r_s .31$ to $.94$; Tucker-Drob, 2011).

In addition, consistent with the view that everyday cognition represents the cognitive component of IADL function, several studies have reported associations in the moderate range ($r = 0.36$ – 0.69) between everyday cognition and self-reported IADL (e.g., Allaire & Marsiske, 2002; Diehl et al., 1995; Tan et al., 2009; Willis et al., 1998).

Drawing on these previous findings, the current study examined the extent to which everyday cognition predicts self-reported IADL over time, above and beyond traditionally assessed basic cognitive abilities.

Innovations of the current study include the examination of the way in which basic and everyday cognitive skills and self-reported IADL “travel together” as older adults move, on average, from young-old to old-old age. These relationships were examined in the context of an extensively-specified model with multiple predictors of attrition, re-sampling, self-reported physical health, mood, and multiple basic cognitive abilities, consistent with the conceptualization of IADL skills as contextualized and multidimensional. This model, in effect, represents a strict test of the time-varying relationship between everyday cognition and self-reported IADL. Furthermore, the everyday cognition variable examined is unique in being comprised of three measures, resulting in a multidimensional construct with psychometric variance exceeding single measure designs. Everyday cognitive measures’ capacity to capture the variance of basic abilities in self-reported IADL, as well as any unique variance exceeding these skills would support the utility of everyday cognitive measures as parsimonious clinical tools for the assessment of older adults’ IADL competence, as well as a potential endpoint for intervention efforts.

Method

Design and Procedure

The current study sample was drawn from the Advanced Cognitive Interventions for the Independent and Vital Elderly (ACTIVE) study. The ACTIVE study examined the long-term effects of three cognitive treatment arms on cognition and function in adults aged 65 and older. Participants in ACTIVE were aged 65 and older, and were screened to be free, at intake, of substantial existing cognitive or functional impairment, medical conditions likely to lead to imminent functional decline or mortality (e.g. certain cancers) and severe sensory losses. A total of 2802 cognitively healthy, community-dwelling older adults aged 65 to 94 years comprised the full ACTIVE sample. For more details please see Jobe et al. (2001).

Participants

The analytical sample for this study consisted of the 698 individuals from the ACTIVE no-treatment control group. Participants in this analytic sample had a mean age of 74 years (range of 65–94 years, $SD = 6.05$), an average of 13 years of education ($SD = 2.71$), and an average MMSE score of 27 ($SD = 2.00$). Participants were 73% female, 71% White, 26% African American, and 37% were married. Relative to the rest of the ACTIVE sample at baseline (i.e., those randomized to intervention groups), they were slightly older ($t(2800) = 2.15$, $p = .032$, $d = .09$) but not different in years of education, MMSE scores, gender, race, or marital status.

Aggregate Longitudinal Retention Pattern of the Present Study Sample

The present study assessed data collected at baseline, 1 ($n = 582$), 2 ($n = 551$), 3 ($n = 511$), and 5 ($n = 452$) years of the ACTIVE clinical trial. These numbers are aggregate numbers and at each wave; participants could exit and re-enter the study.

Characterization of Attrition Effects

To characterize the selectivity of attrition, study participants from the original baseline sample ($n = 698$) who were assessed at Year 5, retained (R; $n = 452$) were compared to those who dropped out prior to this occasion (D; $n = 246$). Relative to those who dropped out, returning participants at Year 5 were younger ($t(696) = 2.78, p = .006, d = .22; M_D = 74.91$ years, $SD_D = 6.30; M_R = 73.58$ years, $SD_R = 5.86$), had more years of education ($t(696) = -2.71, p = .007, d = .21; M_D = 13.00$ years, $SD_D = 2.89; M_R = 13.58$ years, $SD_R = 2.58$), higher MMSE scores ($t(696) = -4.41, p < .001, d = .35; M_D = 26.83, SD_D = 2.07; M_R = 27.52, SD_R = 1.92$) and had a higher percentage of females ($\chi^2 = 10.66, p = .001; D = 66\%$ female, $R = 78\%$ female). Those who dropped out reported significantly more depression symptoms ($t(431) = 2.47, p = .014, d = .24; M_D = .13, SD_D = 1.04; M_R = -.06, SD_R = .88$), and worse physical health ($t(467) = -3.34, p = .001, d = .31; M_D = -.035, SD_D = .95; M_R = .21, SD_R = .89$) at baseline. White participants were more likely to be retained at Year 5 than non-white participants ($\chi^2 = 17.66, p < .001; D = 63\%$ white, $R = 74\%$ white). There were no significant differences in marital status.

Measures

Table 1 lists study measures by domain, published source, and estimates of reliability.

Covariate measures—Demographic information, including age, gender, and years of education was collected at baseline. Furthermore, participants were administered the Mini-Mental State Exam (Folstein, Folstein, & McHugh, 1975) as part of the study screening procedures (Jobe et al., 2001). At each occasion of assessment, participants also completed self-report measures of depression, Center for Epidemiological Studies Depression-12 (CES-D; Radloff, 1977), and physical functioning, MOS 36-Item Short Form (SF-36; Ware & Sherbourne, 1992). Visual acuity was measured by performance on Good-Lite LD-10 eye chart from a distance of 10 feet (Mangione et al., 1992). Finally, vocabulary from the Kit of Factor-References cognitive tests, Revised (Ekstrom, French, Harman, & Derman, 1976) was also included as a measure of crystallized intelligence.

Basic cognition—Each cognitive domain was tested as follows: Verbal memory was assessed using the Hopkins Verbal Learning Test, Related Word Lists (HVLRT; Brandt, 1991); Rey Auditory-Verbal Learning Test, Unrelated Word Lists (AVLT; Rey, 1941); and the Rivermead Behavioral Memory Test, Paragraph Recall task (RBMT-PR; Wilson, Cockburn, Baddeley, 1985). Inductive reasoning was assessed using the Letter Sets, Letter Series, and Word Series tasks (Gonda & Schaie, 1985; Thurstone & Thurstone, 1949; Ekstrom et al., 1976, respectively). Visual-spatial perceptual speed was assessed via the Useful Field of View (UFOV; Ball, Owsley, Sloane, Roenker, & Bruni, 1993) tasks 2 and 3. Tasks 1 and 3 were also assessed; however they were excluded from analyses due to floor and ceiling effects that limited their variance (Ball et al., 2002).

Everyday cognition—This domain was assessed with the Everyday Problems Test (EPT; Willis & Marsiske, 1993), the Observed Tasks of Daily Living (OTDL; Diehl, et al., 2005), and the Timed Instrumental Activities of Daily Living (tIADL; Owsley, Sloane, McGwin, & Ball 2002). For all everyday cognitive measures, participants were presented with everyday stimuli directly drawn from IADL domains (e.g., medication labels, transportation

schedules, cake mix ingredients, phone book) and asked to answer questions (e.g., to calculate the number of days the supply of medication will last, find a phone number in the phone book).

Self-Reported IADL—A self-report measure drawn from the Minimum Data Set methodology (Morris et al., 1997) was used to assess this domain. Questions on the measure elicited self-reported capacity and difficulty in performing IADL, such as preparing meals, housework, managing finances, managing health care, shopping, telephone use, and travel. The present analyses employed the difficulty (capacity) scale responses, as this sub-scale has been the primary outcome in other ACTIVE studies (e.g., Ball et al., 2002; Willis et al., 2006). Responses on the difficulty scale ranged from ‘not difficult,’ to ‘great difficulty’, on a 5-point Likert-type scale. Reliability of the scale, expressed as weighted Kappa, was 0.76 (Morris et al., 1997).

Analyses

Raw data for some variables (e.g., MMSE, Visual acuity, UFOV, self-reported IADL, AVLT) was significantly skewed and thus violated assumptions of normality. To facilitate more robust analyses, all data were Blom transformed (Blom, 1958) prior to analyses, producing more normally distributed scores. For all cognitive domains, composite variables were computed by averaging across constituent measures. For those measures assessed at each occasion (i.e., depression, physical function, reasoning, memory, speed, vocabulary and everyday cognition), two predictor variables, one consisting of the baseline value, and another representing the participant’s change from baseline at each occasion (person-mean centered), were utilized in analyses. All variables were converted to z-scores (centered on the mean across occasions) to facilitate interpretation of coefficients in standardized metric.

Analyses employed multistep multilevel modeling (MLM) using the MIXED function in SPSS 17.0. MLM allows for the study of change over time the separation of between- and within-person effects, and the study of individual differences in within-person processes (Bryk & Raudenbush, 1992; Singer & Willett, 2003). Furthermore, MLM allows for the examination of fixed and random effects. Technical specifications regarding the MLM models and additional details regarding their interpretation are provided in the Appendix. Analyses were conducted under the missing-at-random assumption (i.e., attrition associated with measured covariates; see below). The model analyzed was an occasion-basis model. While occasion basis models can ignore the heterogeneity associated with age (e.g., very old individuals might experience faster five-year longitudinal decline in self-reported IADL than young-old individuals), we addressed this potential shortcoming by controlling for the cross-sectional effect of age, and allowing chronological age to moderate the five-year change observed.

Nested multilevel models were estimated using the maximum likelihood (ML) method. Models included predictors of inter-individual (i.e., cross-sectional) differences at baseline, including demographic and cognitive variables that are associated with attrition in this sample (Wolinsky et al., 2009), so that analyses could be conducted under the missing-at-random assumption. Model A examined the fixed and random effect of all time-varying predictors, except everyday cognition (i.e., depression, physical function, reasoning, memory, speed, & vocabulary). This model examined the extent to which basic cognitive abilities predict level and change in self-reported IADL, controlling for the effects of attrition, time, and relevant covariates. Model B included baseline level and centered per-occasion everyday cognition and the random effects of the centered variable. This model allowed us to examine the unique contribution of everyday cognition in predicting level and change in self-reported IADL, above and beyond all other predictors.

Criteria for the Evaluation of Models

For each model, relative goodness of fit was assessed via an examination of the reduction in deviance ($-2 \log\text{-likelihood}$; denoted $\Delta\chi^2$), as well as via changes in Akaike's Information Criterion (AIC), & the Schwartz Bayesian Information Criterion (BIC). Improvements in the predictive value of a modeling step were evaluated by the extent to which the modeling step explained the within- and between- person variance, relative to the criterion model, in the present case an unconditional model which included predictors of attrition (Bryk & Raudenbush, 1992). Decreases in the intercept related and residual variance, represent a proportional reduction of the prediction error, which is analogous to R^2 (denoted *pseudo- R^2*), and used as an estimate of effect size (Singer & Willett, 2003).

Results

Preliminary Analyses: Bivariate Relationship between Everyday Cognition and Self-Reported IADL

Prior to conducting the main nested model analyses, the bivariate relationship between everyday cognition and self-reported IADL was investigated. In a model with everyday cognition predicting IADL, the fixed effects of both baseline level (estimate = .189, $SE = .028$, $p < .001$) and centered per-occasion everyday cognition (estimate = .080, $SE = .034$, $p = .018$) were significant. The centered per-occasion effect of everyday cognition also varied significantly between individuals (random variance = .122, $p < .001$). Everyday cognition alone accounted for approximately 23% of within-person, 18% of between-person, and 28% of total variance in self-reported IADL¹.

Time-Varying Predictors of Self-Reported IADL Function

Visual inspection of the longitudinal data suggested both linear and quadratic time trends. Furthermore, prior longitudinal work in aging suggests that quadratic decline in abilities is a common trajectory of change (Grady & Craik, 2000; Lindenberger & Ghisletta, 2009; MacDonald et al., 2011; Schaie, 1994; however see Salthouse, 2010). As shown in Table 3, Model A, self-reported IADL evidenced a negative quadratic longitudinal trend, suggesting initial increased followed by accelerated decline, above and beyond re-sampling (e.g., responding to familiar questions in a similar manner, responding in a socially desirable way; Carstensen & Cone, 1983), linear decline, as well as age-moderated linear decline over time (Figure 1).

With regard to the contribution of time-varying predictors, examined controlling for attrition and temporal trends, in order of magnitude, self-reported physical function, memory, and depression, emerged as significant time-varying concurrent predictors of self-reported IADL. The results suggested that overall, on occasions where individuals reported lower physical functioning and more depressive symptoms, they also reported more IADL difficulty. On occasions where individuals performed better on memory they reported less IADL difficulty. Across models, baseline physical functioning had the largest standardized coefficient suggesting that older adults' perceptions of their physical functioning were

¹To determine the predictive variance in the IADL that was unique to, and shared among, everyday cognition, basic cognition and our collection of covariates, communality analyses were performed (Hertzog, 1989; Pedhazur, 1982). In these analyses, all of the covariates, excluding vocabulary) represented the first single block, all of the basic cognitive tasks, which included vocabulary, represented the second block, and everyday cognition was the third block. Estimates of the unique and shared variance components were obtained by allowing all possible combinations of covariates, basic cognition, and everyday cognition to predict IADL, while maintaining the predictive paths from the covariates, basic and everyday cognitive blocks. According to these analyses, of the 54% variance in IADL described by all three blocks of predictors (covariates, basic cognition and everyday cognition), 14% was unique to covariates, 20% was unique to basic cognition, and only 1% was unique to everyday cognition. All three predictor blocks shared 37% of the variance.

closely related to their perceptions of the difficulty associated with performance of IADL. Model fit and variances explained are shown in Table 2, Model A, and standardized parameter estimates, standard errors, and significance levels are shown in Table 3. With regard to random effects, only re-sampling bias, age x linear time (from Model B), and physical functioning (from Model C) evinced significant intra-individual differences in their effects on self-reported IADL function.

Unique Contribution of Everyday Cognition

Despite the many covariates controlled in earlier steps, adding baseline and time-varying everyday cognition further improved the fit of the model predicting self-reported IADL difficulty. Baseline everyday cognition was a significant unique positive predictor of self-reported IADL. In Model D, once everyday cognition was added, small residual negative effects of baseline reasoning and vocabulary emerged. With regard to time-varying everyday cognition, on those occasions where individuals performed better on everyday cognition, they also reported better IADL function. Model fit and variance explained are shown in Table 2, Model B, and standardized parameter estimates, standard errors, and significance levels are shown in Table 3, Model B. Relative to Model A, adding everyday cognition explained an additional 5% of the between-person variability, but no additional within-person variability (despite the fact that the parameter estimate for time-varying everyday cognition was significantly greater than zero).

Discussion

The present study tested the hypothesis that everyday cognition, conceptualized as a more proximal predictor (i.e., conceptually closer to IADL than basic cognitive predictors), would improve the prediction of self-reported IADL above-and-beyond what could be achieved with basic cognitive variables, controlling for demographic and other relevant covariates. Covariates included age, gender, years of education, mental status, and vision as well as baseline level and time-varying depression, and physical functioning.

With regard to the prediction of self-reported IADL difficulty over time, as illustrated in Table 3, among all predictors, the most important was older adults' physical functioning at baseline. In Model B, the coefficient of baseline physical functioning was roughly double that of the next three largest predictors (i.e., baseline everyday cognition, centered physical function, and baseline depression). Given that both physical function and IADL were assessed with self-report, the prominence of physical function as a predictor likely reflects a convergence in older adults' evaluation of their overall functional status (Johnson & Wolinsky, 1993; Lee, 2000). Measurement issues notwithstanding, the importance of intact physical functioning for maintaining IADL performance is again supported, which is consistent with substantial prior research (see Stuck et al., 1999 for a review).

With regard to the contribution of everyday cognition, in initial analyses, everyday cognition alone was a significant predictor of baseline level and occasion-to-occasion self-reported IADL difficulty, accounting for approximately 23% of within-person, 18% of between-person and 28% of total variance. When this is compared with the final model (Model B), where 38% of within-person, 28% of between-person and 40% of total variance were explained, this suggests that the majority of the predictable variance in self-reported IADL could be explained parsimoniously with everyday cognition alone.

When added to a model which controlled for attrition, re-sampling bias, effects of time, and basic cognitive abilities (Model B), the estimates for baseline and time-varying everyday cognition were significant and exceeded those for memory, reasoning, speed, and vocabulary. Everyday cognition contributed primarily to the explanation of between-person

variance in self-reported IADL. This can be interpreted to indicate that individuals who exhibited less decrement in performance on everyday cognitive tasks at a given occasion, also reported less IADL difficulty at that time. These findings support the conceptualization of everyday cognition as a more proximal predictor of individual differences in self-reported IADL. At the same time, everyday cognition did not contribute significantly to the explanation of within-person effects in the current model (although the parameter estimate reached significance), likely reflecting general multicollinearity in change trajectories among all the basic and everyday cognitive independent variables (e.g., Tucker-Drob, 2011).

While the present study augments the knowledge base on the relationship between cognition and self-reported IADL in older adults, a number of limitations must be considered. First, the chief outcome in this study is a self-reported measure of IADL difficulty, prone to both ceiling effects and self-perception biases (Tucker-Drob, 2011; Willis, 1996). A more fully-rounded functional assessment, including multiple measures of self-report with a broader range of outcomes, proxy-assessment, and behavioral observation would be ideal. This would yield a functional composite score of maximal reliability and sensitivity to individual differences. At the same time, the present study adheres to common practice, and the multi-assessment approach advocated by Willis (1996) in that it examines longitudinal relationships among different methods of assessment of older adults' IADL functioning.

Second, our sample experienced selective attrition. That is, as in most longitudinal studies of older adults, those who were older, less educated, male, and reporting worse physical functioning, were less likely to be reassessed at subsequent occasions. This likely contributed to the slightly higher levels of self-reported IADL seen at the second and third time of measurement in this study. Specifically, those retained in the study were more likely to report better IADL functioning. Retained individuals might also be more likely to develop positive demand characteristics, in which they report higher levels of functioning since they are in an ongoing research study that explicitly measures functioning. By using full information maximum likelihood, and adjusting for predictors of selective attrition (Wolinsky et al., 2009), parameter estimates in this model should have been relatively unbiased by selective dropout.

Last, the current study battery was limited to verbal memory, inductive reasoning, visual processing speed, and vocabulary, because these were the clinical endpoints or theoretically derived covariates of the ACTIVE intervention. A broader neuropsychological battery, including measures of executive function, subtypes of memory (e.g., nonverbal, episodic, semantic, working memory, etc.), and cognitive processing speed (e.g., symbol search) would likely provide additional insight regarding the cognitive contribution to self-reported IADL.

In summary, the innovations of the current study include the characterization of the 5-year trajectory of change in self-reported IADL in healthy older adults, the examination of predictors of self-reported IADL in a more fully-specified, time-varying model, and the examination of a more psychometrically-variable everyday cognitive predictor than typically utilized in the literature. In our final model, self-reported level of physical functioning, everyday cognition, self-reported depressive symptomatology, reasoning and vocabulary predicted individual differences in baseline level of self-reported IADL, consistent with Willis' (1996) conceptualization of the multidimensionality of IADL. Physical function, everyday cognition, depressive symptomatology, and memory evinced correlated occasion-to-occasion change with self-reported IADL. Everyday cognition showed significant unique between- and within-person associations. At the same time, in part because of its multicollinearity with these many other predictors, its unique contribution was small. Present analyses suggest that everyday cognition alone could explain most of the variance

associated with basic cognitive predictors (as well as other covariates). This would argue for the utility of including everyday cognition measures in functional assessment batteries, particularly under circumstances where elders' IADL skills are of primary clinical interest.

Future research must extend our understanding of whether the association between everyday cognition and self-reported IADL difficulty obtained in this healthy older-adult sample would also hold in older adults with diagnoses of mild cognitive impairment and dementia. In such samples, self-report may need to be augmented with proxy- or clinician report, but the wider range of both cognitive and everyday functioning in such samples would likely reveal even stronger relationships. In such samples, the face validity and parsimony of everyday cognitive measures might be particularly attractive, in light of potential fatigue and testing burden factors.

Given the small but persistent unique association between everyday cognition and self-reported IADL (especially in understanding between-subject differences), even after many covariates are controlled, the current results might also speculatively suggest that future intervention research aimed at improving everyday cognition might be an additional, and hitherto uninvestigated, route to improving elders' perceived IADL functioning. Thus far, most cognitive interventions have been aimed at basic cognition, with relatively little evidence of transfer to everyday cognition (Willis et al., 2006; Hertzog, Cramer, Wilson & Lindenberger, 2008).

Acknowledgments

This work was supported by the National Institute on Aging (S.S., AG034002). The ACTIVE Cognitive Training Trial was supported by grants from the National Institutes of Health to six field sites and the coordinating center, including: Hebrew Senior-Life, Boston (NR04507), the Indiana University School of Medicine (NR04508), the Johns Hopkins University (AG14260), the New England Research Institutes (AG14282), the Pennsylvania State University (AG14263), the University of Alabama at Birmingham (AG14289), and the University of Florida (AG014276). Ms. Yam was supported by an Institutional Training Grant (T32 AG020499). Dr. Marsiske is also ACTIVE Site Principal Investigators and member of the ACTIVE Steering Committee. Dr. Marsiske has received support from Posit Science in the form of site licenses for the Insight program (derived from the ACTIVE Useful Field of View training) for a different research project. The opinions expressed here are those of the authors and do not necessarily reflect those of the funding agencies, academic, research, governmental institutions, or corporations involved.

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Appendix

Description of Multilevel Model Features

Fixed effects refer to the “average” effects, or effects that hold true across all individuals.

Random effects test whether there are significant individual differences in the obtained fixed effects. For example, with respect to the effects of time, fixed effects would illustrate whether the longitudinal data across individuals can be characterized by growth, decline or a combination of the two. A random effect of time would illustrate whether this slope of change varies significantly between individuals (i.e. some individuals improve or decline

faster or slower than others). Furthermore, MLM analyses permit the examination of predictors that interact with the dependent variable at separate levels. For example, *time-invariant* predictors, such as baseline age and gender, are referred to as between-person variables that predict individual differences in intercept (in the present case, baseline value of the dependent variable) and reside at Level 2. On the other hand, *time-varying* predictors, which change within persons from occasion-to-occasion of assessment, are referred to as within-person variables and reside at Level 1.

Statistical Equations for Multilevel Models

The Level 1 model

The Level 1 model represents the estimated within-person change over time for the outcome variable, and the effect of time-varying predictors on this change. Using notation from Singer and Willett (2003), the general form of the Level 1 model can be described as follows:

$$Y_{ij} = \pi_{0i} + \pi_{1i} \text{TIME}_{ij} + \pi_{ni} X_{nij} + \varepsilon_{ij}$$

Y_{ij} is the predicted outcome for person i at time j , π_{0i} is the value of Y when time is zero and all time-varying predictors are also zero, π_{1i} is the slope of the change trajectory for person i , TIME_{ij} is the value of linear time for person i at time j , π_{ni} is the unique effect of X on Y , where X represents the matrix of time-varying predictors (e.g. memory, reasoning, speed, everyday cognition) and ε_{ij} represents the within-person error term. Within-person variance in initial status is denoted as $\sigma\varepsilon^2$ and the between-person variance in initial status is denoted as σ_0^2 . Finally, σ_1^2 denotes variance in the change trajectory.

Level 2 model

At Level 2, the parameters estimated at Level 1 are the outcome variables of new equations and the time invariant variables are the predictors. The general form of the final Level 2 is:

$$\begin{aligned}\pi_{0i} &= \gamma_{00} + \gamma_{01} Z_i + \zeta_{0i}, \\ \pi_{1i} &= \gamma_{10} + \gamma_{11} Z_i + \zeta_{1i} \\ \pi_{ni} &= \gamma_{n0} + \gamma_{n1} Z_i + \zeta_{2i}\end{aligned}$$

Here, γ_{00} , γ_{10} , and γ_{n0} are the Level 2 intercepts and are the estimates of the Level 1 parameters π_0 , π_{1i} , and π_{ni} when all time-invariant predictors are zero. The Level 2 intercepts γ_{01} , γ_{11} , and γ_{n1} are the effects of the time invariant predictors (e.g. age, gender, years of education, MMSE, etc.), which are represented by Z . Finally, ζ_{0i} , ζ_{1i} , and ζ_{2i} represent individual differences in the Level 1 parameters that are not explained by the Level 2 predictors.

Figure 1.
Five-year longitudinal change in self-reported IADL. Model predicted values.

Table 1

Measures by Domain

Domain	Measures	Published Source	Reliability
Memory	Hopkins Verbal Learning Test, Related words (HVLT);	Brandt, 1991;	0.73
	Rey Auditory Verbal Learning Test, Unrelated words (AVLT);	Rey, 1941;	0.78
	Rivermead Behavioral Memory Test, Paragraph recall (RPRT)	Wilson et al., 1985	0.60
Reasoning	Letter Sets; Letter Series; Word Series	Gonda & Schaie, 1985; Thurstone & Thurstone, 1949; Ekstrom et al., 1976;	0.69 0.86 0.84
Speed	Useful Field of View (UFOV), Tasks 2 & 3	Ball et al., 1993;	0.80
Everyday Cognition	Everyday Problems Test (EPT);	Willis & Marsiske, 1993;	0.87
	Observed Tasks of Daily Living (OTDL); Timed IADL (tIADL)	Diehl et al., 2005; Owsley et al., 2001;	0.75 (Cronbach's α)
Self- Reported IADL	Activities of Daily Living and IADL functioning Minimum Data Set -IADL perceived degree of difficulty	Morris et al., 1997	0.64
Covariate Measures	Vocabulary from Kit of Factor-References cognitive tests, Revised; Mini-Mental State Exam (MMSE); Physical Functioning from MOS 36-Item Short Form (SF-36); Center for Epidemiological Studies Depression- 12 (CES-D); Visual Acuity	Ekstrom, French, Harman, & Derman, 1976; Folstein & Folstein, 1975; Ware & Sherbourne, 1992; Radloff, 1977; Mangione et al., 1992	0.80 (Cronbach's α)

Note. All reliability estimates are test-retest correlations, except where noted (Ball et al., 2002).

Table 2

Fit Statistics And Variances Explained For Nested Multilevel Models Examining Longitudinal Predictors Of Older Adults' Self-Reported IADL Function

Fit Statistics	Model A	Model B
Deviance		5352.32
#parameters (fixed/random)		33 (24/9)
$\Delta\chi^2$		26.86**
Δdf		3.00
AIC	5439.17	5418.32
BIC	5612.00	5608.43
Total pseudo-R ²	0.42	0.40
Δ between pseudo-R ²	0.16	0.20
Δ within pseudo-R ²	0.38	0.38

Note. Deviance: $-2 \log$ -likelihood; $\Delta\chi^2$: change in deviance from prior model; Δdf : change in degrees of freedom/# of parameters from prior model; AIC: Akaike's Information Criterion;

BIC: Schwartz Bayesian Criterion; Total *pseudo-R*²: total outcome variance explained; Δ between *pseudo-R*²: change in between-person variance explained relative to model A; Δ within *pseudo-R*²: change in within-person variance explained relative to an intercept only model (not shown)..

**
 $p < .001$

Table 3

Results of Nested Multilevel Models Examining Longitudinal Predictors of Older Adults' Self-Reported IADL Function

Parameter	Model A	Model B
Fixed Effects		
Initial Status		
Age	-.031 (.030)	-.015 (.030)
Gender	.049* (.025)	.040 (.024)
Education	-.025 (.028)	-.032 (.028)
Vision	.036 (.028)	.012 (.028)
MMSE	.025 (.025)	.016 (.025)
Baseline Depression	-.124*** (.027)	-.112*** (.027)
Baseline Physical Function	.353*** (.026)	.353*** (.026)
Baseline Reasoning	-.021 (.035)	-.083* (.037)
Baseline Memory	.024 (.033)	-.009 (.034)
Baseline Speed	.032 (.031)	.013 (.031)
Baseline Vocabulary	-.052 (.031)	-.082* (.032)
Baseline Everyday Cognition		.184*** (.042)
Change in Depression	-.047* (.018)	-.044* (.018)
Change in Physical Function	.135*** (.022)	.133*** (.022)
Change in Reasoning	.021 (.019)	.010 (.019)
Change in Memory	.050* (.020)	.040* (.020)
Change in Speed	.014 (.018)	.007 (.018)
Change in Vocabulary	.023 (.017)	.016 (.017)
Change in Everyday Cognition		.078*** (.020)
Rate of Change		
Re-sampling	.036* (.016)	.035* (.016)
Linear Time	-.043** (.016)	-.040* (.016)
x Age	.007 (.018)	.008 (.018)
Quadratic Time	-.026 (.015)	-.024 (.015)
Random Effects		
Level 1		
Within-Person	.350*** (.026)	.353*** (.027)
Level 2		
Initial status	.198*** (.020)	.189*** (.019)
Re-sampling	.037*** (.010)	.037*** (.010)
Linear Time	.012 (.010)	.009 (.010)
x Age	.020* (.008)	.021* (.008)
Quadratic Time	.007 (.008)	.005 (.008)

Parameter	Model A	Model B
Change in Physical Function	.033** (.012)	.033** (.012)
Change in Reasoning	.007 (.009)	.004 (.009)
Change in Everyday Cognition		.003 (.009)

Note. Values are standardized parameter estimates associated with each predictor, standard errors are in parentheses; Predictors of Initial Status are cross-sectional; Change predictors are longitudinal

*
 $p < .05$;

**
 $p < .01$;

 $p < .001$