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Timed Instrumental Activities of Daily Living Tasks: Relationship to Cognitive Function and Everyday Performance Assessments in Older Adults

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Key Words
Aging · Everyday task performance · Cognition · Visual processing speed · Memory · Reasoning

Abstract
Background: We live in a world where information is presented in a time-limited fashion and successful adaptation is dependent on time-limited responses. Slowed visual-processing speed is common among older adults. Its impact on everyday task performance is not clearly understood. ***Objective:*** The goal was to determine whether visual-processing speed, as well as memory and inductive reasoning, are independently associated with the time required by older adults to complete instrumental activities of daily living typical of everyday life. ***Methods:*** Five timed instrumental activities of daily (TIADL) tasks were administered to 173 older adults (ages 65–90 years) along with assessments of visual-processing speed, memory, and inductive reasoning. The dependent variable was the time required to perform the task (e.g., finding a telephone number, making change, finding and reading the ingredients on a can of food, finding food items on a shelf, reading instructions on medicine container). Medical and functional comorbidities known to affect task performance were measured in order to adjust for their impact on the dependent variable. Other measures of everyday task competence (Everyday Problems Test, Observed Tasks of Daily Living, questionnaire on IADL difficulties) were also administered in order to determine to what extent existing measures of everyday performance are associated with TIADL performance. Test-retest reliability of the TIADL score was assessed in a separate sample. ***Results:*** Although memory and reasoning were crudely related to the time needed to perform the TIADL tasks, only processing speed was independently associated with TIADL scores. Those older adults with slow processing speed were more likely to require longer times to complete everyday tasks. Previously developed measures of everyday task competence (e.g., Everyday Problems Test, Observed Tasks of Daily Living) based on accuracy scoring did not strongly predict TIADL performance. ***Conclusion:*** These results suggest a unique role for an everyday competence test that focuses on the timely completion of everyday tasks, rather than on an assessment of accuracy alone. TIADL measures may prove useful in evaluating the everyday effectiveness of cognitive interventions targeted at increasing information-processing speed.

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Introduction

A key aspect of functional independence and quality of life is the ability to perform instrumental activities of daily living (IADL) [1]. IADL involve many domains in everyday life including communication, financial management, meal preparation, shopping, medication management, housekeeping, and transportation. Functional impairments in older adults negatively impact IADL performance [2, 3]. Traditionally IADL function in older adults has been assessed by self-report measures using questionnaires such as the Multilevel Assessment Instrument [4], the SF-36 [5], and the OARS Multidimensional Functional Assessment Questionnaire [6]. More recently, there has been interest in developing actual performance tasks of IADL as outcome measures, rather than solely relying on self-report instruments in research studies [7].

This trend stems from concerns that some subpopulations of older adults may not validly evaluate their everyday abilities, implying that a direct assessment of behavioral competence is merited [8, 9]. For instance, healthy, community-dwelling older adults and those with mild cognitive impairment tend to overestimate their functional abilities [9], whereas depressed older adults tend to underestimate their abilities [10, 11]. A population-based study on visual function in older adults found that about 10% of persons had a significant discrepancy between their self-reported reading difficulty and measured reading speed [8]. Similarly, visually impaired persons experienced more difficulty in everyday task performance than was expected from their self-reported visual abilities [12]. Studies on older drivers indicated that self-reported crash involvement for a recent time period often disagreed with actual crash involvement as indicated from state records [13, 14]. Self-report measures in general can be prone to memory inaccuracies and/or the influence of social desirability. Furthermore, in cases where proxy reports are used (e.g., family member), responses may be influenced by the relationship between the proxy and the target subject. A further advantage of performance-based measures is that one can directly assess changes in actual performance subsequent to an intervention and thereby facilitate a more thorough evaluation of changes in functional outcomes and the efficacy of an intervention.

Substantial progress has been made in recent years in the development of test batteries of everyday tasks with documented psychometric properties. Cognitive performance tasks recently developed include the Everyday Problem Test (EPT) [15], the Observed Tasks of Daily Living (OTDL) [16], and the Direct Assessment of Functional Status [17]. In the realm of visual activities, a few batteries have been described [18–21]. However, the validity, reliability, and responsiveness of these visual performance batteries have not been clearly established.

In all the above cognitive batteries, task performance is assessed in terms of competence (i.e., performance accuracy), with no scoring distinctions made for the time needed by the person to complete that accurate performance. In other words, the person who takes 3 min to correctly look up a number in a phone directory would receive the same score as the person who takes 30 s to complete this task correctly. In the course of everyday life, there are clear advantages to rapidly performing tasks. Accuracy in task performance is obviously relevant, but the time taken to complete the task is also an important performance dimension. We live in a world where information is presented in a time-limited fashion and successful adaptation is dependent on time-limited responses. While performing tasks at a slower rate may be a suitable compensatory strategy in some situations, long completion times may be a source of frustration, inconvenience, and even embarrassment for the person. Slow performance could also have negative consequences for the workplace such as the inability to complete goals in expected timeframes. The phenomenon of age-related slowing is perhaps the best-documented and least-contested of any in the field of aging and cognition [22, 23]. Measures of age-related slowing typically involve laboratory measures of information-processing speed, whose relationship to the actual performance of IADL tasks is not clearly established. The tasks described in this article combine the advantages of objective, performance-based assessments of IADL with an assessment of the speed with which these tasks can be accomplished. A measure based on time may better reflect the extent of deficits than a pass/fail competency measure. Finally, using a time continuum is more likely to preclude the occurrence of basement and ceiling effects characteristic of other performance-based measures and therefore allow normal and impaired populations to be assessed with the same instrument.

Here we describe five IADL tasks where the rapid and efficient completion of the tasks would be an advantage in daily life. Task performance is primarily defined in terms of the time required by the person to complete a set of IADL tasks. The component tasks come from the domains of telephone communication, financial abilities, nutrition, shopping, and medication usage. In selecting these tasks we had three criteria. First, we chose functional outcome measures basic to independent living that were commonplace during daily life for most people regardless of gender, ethnicity, or socioeconomic status. For example, in the domain of financial management we selected the task of making change, rather than assessing one's ability to balance a check book. Second, we chose tasks that have a strong cognitive component and whose decline may cause a loss of independence. In a previous study on older adults having a range of visual and cognitive abilities, we showed that timed performance on over a dozen tasks was significantly related to a general cognitive status score, even after adjustment for comorbid medical and functional problems [24]. Those older adults who had poorer cognitive status were more likely to require more time to complete common IADL such as reading the ingredients on a can of food, reading the directions on a medicine bottle, finding a number in a phone directory, and locating an item on a crowded shelf. Third, we chose tasks that were brief, amenable to accurate timing, and whose ease of administration could be easily standardized.

The specific aims of this study are as follows: (1) to describe five timed IADL tasks (hereafter called TIADL tasks), their administration protocol and scoring procedure; (2) to determine whether various aspects of cognitive function are associated with TIADL performance, after adjustments for the impact of comordid medical conditions, functional problems (e.g., acuity, reading ability, physical functioning) and demographic variables. We specifically focus on how TIADL performance relates to three cognitive domains – memory, reasoning, and visual processing speed – since these skills are the targets of interventions being evaluated in an ongoing, multi-site cognitive intervention trial on older adults sponsored by the National Institutes of Health (see below), and (3) to examine to what extent other, existing measures of everyday performance (OTDL, EPT, self-reported IADL difficulty, and complex reaction time) predict TIADL performance. The data were collected as part of a multi-site pilot study carried out prior to the formal start of the cognitive intervention study described below.

Methods

Subjects

Participants were recruited as a preliminary sample for the Advanced Cognitive Training for Independent and Vital Elderly clinical trial (ACTIVE), which is sponsored by the National Institute on Aging and the National Institute for Nursing Research in the US. ACTIVE is a randomized, controlled, single-masked clinical trial designed to determine whether cognitive-training protocols can affect cognitively based measures of daily functioning [25]. The purpose of the ACTIVE preliminary study was to evaluate the feasibility of the ACTIVE protocol in terms of respondent and administrator burdens, and to determine whether the measures selected (and sometimes developed or modified for the ACTIVE trial) were of an appropriate level of difficulty for the proposed study population. Participants were recruited from the population of adults aged 65 years and older who are living largely independent of formal care, but who are at risk for loss of functional independence due to advanced age, lower educational attainment, lower SES, or health decline. Participants (n = 173) were drawn from six field sites in Birmingham Ala., Boston Mass., Indianapolis Ind., Baltimore Md., north central Pennsylvania, and Detroit, Mich.

The following were exclusion criteria for the ACTIVE pilot study: (1) age <65 at initial screening; (2) significant cognitive problems (defined as a score of 22 or less on the mini-mental State Examination (MMSE) [26] or a self-reported diagnosis of Alzheimer's disease); (3) substantial functional decline (self-report of needing extensive assistance with dressing, personal hygiene, or bathing); (4) medical conditions that would likely predispose participants to imminent functional decline (e.g., stroke), or that would be likely to result in mortality before the 2-year follow-up phase of the trial had been completed (e.g., certain cancers), or currently undergoing chemotherapy/radiation treatment; (5) severe sensory losses such that participants would not be able to participate in the testing protocol, even with substantial accommodations (e.g., self-report of extreme difficulty reading ordinary newspaper print); (6) communication difficulties so substantial that they would prevent persons from effectively participating in the highly interactive study protocol (based on an interviewer's rating of a person's ability to be understood and to understand others); (7) recent (or current) participation in cognitive training studies, or (8) unavailability during any phase of the study. All variables included in addressing the specific aims in this study were from the screening and baseline assessments of ACTIVE prior to the cognitive intervention protocol. Informed consent procedures followed the requirements of the Institutional Review Board for Human Use at each field site.

Procedures

Because data collection took place at the six different field sites, standardization of data collection procedures was ensured through a variety of training and quality-control procedures as described in detail elsewhere [25]. Four types of measurements were collected: demographic, medical/functional, cognitive, and everyday performance assessments.

Demographic and Medical/Functional Variables

Demographic information (age, gender, race, education) was confirmed through interview. With respect to medical/functional information, distance visual acuity using habitual correction (binocular viewing) was measured using the Goodlite chart presented at 3.5 m following the protocol described by Rubin and Salive [27]. Scores were expressed as the number of letters read correctly. Reading ability was assessed using the WRAT 3 Reading Subtest [28]. In this task the participant is presented with a series of 42 words to read and pronounce, with the possible total score ranging from 0 to 57. The physical function subscale of the SF-36 was used to estimate physical functioning capabilities [5]. Subscale scores can range from 0 to 100 with lower numbers indicating increased disability. The presence of depressive symptoms was evaluated using the Centers for Epidemiological Studies – Depression Scale [29]. Total scores can range from 0 to 60 with a higher number indicating the presence of more depressive symptoms. A review of 18 chronic medical conditions was also carried out through interview, with subjects indicating the presence or absence of each condition.

Cognitive Variables

The three cognitive domains of memory, reasoning, and speed of processing were assessed. For memory, the Rey Auditory-Verbal Learning Test (AVLT) provided an index of the participant's ability to form and retain new verbal memories [30]. The AVLT measure used in this study consisted of five learning and recall trials. Participants heard a 15-item word list that was read aloud by the tester with an 8-second pause between each word. They were then asked to write down in any order as many words as they could remember, including any words recalled correctly on previous trials. Two minutes were allowed for writing down the words they recalled. This was repeated five times. The participants' responses were then scored for total number of words correctly recalled for each of the five trials (0–15 for each trial), with total scores potentially ranging from 0 to 75.

Inductive reasoning ability was examined using the Word Series test [31]. In this test an item consisted of a series of days of the week or months of the year, and the subject determined how the series progressed, in order to select the next day/month in the series from among five choices. After working through and explaining several examples the subject was presented with a total of 30-word series and told he/she had a 6-min time limit. The total number of reasoning items completed correctly in the time allowed (possible scores of 0–30) was the score.

Speed of processing was assessed with the Useful Field of View (UFOV®) test (Visual Awareness, Inc.) [32, 33]. This test provided an index of the stimulus duration needed to perform a variety of visual search tasks of increasing cognitive complexity at 75% correct. Each subtest (stimulus identification alone, divided attention, and selective attention) had a possible range from 16 to 500 ms, with the total score ranging from 48 to 1,500 ms. This measure was selected as a marker for speed of processing in the ACTIVE study because (1) performance on the UFOV test has been shown to be highly sensitive to the speed of processing intervention with training effect sizes of 1–3 standard deviations [25, 32]; (2) performance on the UFOV test has been found to be related to everyday performance measures [13, 34, 35], and (3) improvements on the UFOV test have been related to improved performance on everyday abilities [36]. While the UFOV test does measure speed of processing under a variety of cognitive demands, and therefore may not be a pure measure of speed of processing, it has been shown to be highly related to other speeded measures including complex reaction time, digit symbol substitution, trails A & B, letter and pattern comparison tasks, and many others [25, 32, 34, 36]. Thus it is primarily a marker for speed.

Everyday Performance Variables

Four measures of IADL functioning in everyday life were administered. A shortened version of the EPT [15], specifically developed for ACTIVE, assessed problem solving and reasoning in practical situations as performed by older adults. Subjects were presented with high-contrast, enlarged printed materials using 14 everyday stimuli (e.g., medication labels, transportation schedules). Two questions were asked about each stimulus. Participants took as much time as they wanted to complete the test. Scores represented the number of correct answers generated, and ranged from 0 to 28. The EPT has been shown to have high internal consistency, test-retest reliability and structural stability [15]. The tester also recorded the time needed to complete the EPT test.

The OTDL [16], also developed for older adults, was administered and consisted of nine tasks, with a total of 13 questions addressing three IADL domains (medications, phone usage, financial management). An example task is allowing the subject to examine three medication containers with pharmacy labels attached and then asking him/her how many days will a refill of a given medication last or which medications might cause drowsiness. Testers were required to indicate the correctness of each response by circling 'yes' or 'no' and then writing verbatim responses in the space allowed. Furthermore, testers indicated whether or not it was necessary to prompt the participant. Performance on the OTDL measure was scored by a certified scorer. The possible range of scores on this task was 0–28.

The third everyday performance measure utilized was self-reported difficulty in the performance of 19 IADL tasks (e.g., financial management, housework), drawn from the Minimum Data Set questionnaire [37] and was interviewer-administered. Participants were asked, 'in the last 7 days, how much of the activity did you do on your own?', and then asked 'how difficult was it (or would it have been) to do on your own?' Responses ranged from 'not difficult,' to 'great difficulty', and total scores on the difficulty scale ranged from 19 to 57.

The final everyday performance measure was a complex reaction time (CRT) test that measured how quickly an individual recognized that one of four possible traffic signs had changed relative to the other three signs. This test was adapted from the cue recognition film of the Doron Driving Simulator (Doron Precision Systems, Inc., Binghamton, N.Y.) as an index of reaction time to dynamic traffic stimuli. Four international road signs (pedestrian, bicycle, left-, and right-turn arrows) were used. With detailed instructions and practice, participants were told to move the computer mouse in the direction of the arrow or to make a mouse click in response to the pedestrian or bicycle signs. These responses are only to be made when the sign appears without a red slash (the international symbol for 'no') through it. The number of stimuli on the screen at any given time ranged from three to six signs. Within a trial, the number of stimuli was held constant, although the positions of the signs changed throughout the frames. Initially all stimuli had the red slash through them and therefore were to be ignored. At a variable frame number, one of the signs appeared without the red slash through it. This screen remained visible until the participant made the appropriate response. Response time (RT) was defined as the time between the onset of the target stimulus and the correct response of the participant. At the end of the test, standard deviations were calculated for all trials with a given number of distractors. All trials in which the RT was >2 SD above the mean were discarded, as well as trials in which the RT was <0.5 s. Discarded trials typically represented from 1 to 3% of the total number of trials in this task. Average times were then calculated for the remaining trials.

TIADL Tasks

The TIADL measure consisted of tasks sampling five common activities of daily living. Four of the tasks were taken, or adapted, from a previous version of this measure [24] developed for a study on vision impairment in older adults. In that previous study, the time needed to complete each task was associated with general cognitive status. The tasks are described in table 1 and address the following five IADL domains: (1) communication; (2) finance, based on a task

Table 1. TIADL tasks

IADL domaine	Task description	Task materials	Instructions to subject	Time starts when	Time ends when	Examples of minor errors	Time limit, min
Communication	Finding a telephone number	Real, residential phone directory (Birmingham, Ala.)	I will give you the name of a person I want you to look up in the phone book. When you find the number, I want you to say it out loud so I can hear you. The name of the person I want you to look up is John F. Nash. That's n-a-s-h. Will you repeat that name back to me? (If correct, proceed; if incorrect, name is repeated). Here is the phone book. Go ahead and look up the number for John F. Nash for me. Remember, when you find the number, call it out loud so I can hear you.	Subject opens book	Subject calls out last digit	Misreads a digit	3
Finances	Making change	3 quarters, 4 dimes, 5 nickels, 4 pennies	Are you left-handed or right-handed? Now I am going to give you a handful of coins. I want you to place 67 cents in change on the table so I can see it. Let me know as soon as you are finished. How much did I say you should place on the table? (If correct, proceed. If incorrect, repeat the amount). Ok, here are the coins. Remember, let me know when you are finished putting 67 cents on the table.	Coins are placed in subject's nondominant hand	Subject signals verbally or nonverbally that finished	Target total off by a few cents	2
Food	Reading the first 3 ingredients on a can of food	3 cans of food	Now I am going to give you 3 different cans of food.[a] I want you to read the ingredients on each can of food. It will say the word 'ingredients' on there. For each can, I want you to read the first 3 items listed under ingredients. Here is the first can. Read the first 3 ingredients listed out loud so I can hear you.	Can is handed to subject	Subject reads 3rd ingredient label	Slight reading error or initially read other information	2 (per can)
Shopping	Finding 2 items on a shelf	A shelf of assorted food items (fig. 1) built into the TIADL kit	Now I am going to show you a shelf full of food items. I want you to find 2 food items. The items I want you to find are a can of tomato soup and a box of macaroni and cheese. Show me you have found the items by touching them with your finger. Don't try to take them out, just touch them with your finger. It doesn't matter which of the two you touch first. What items will you be looking for? (If correct, proceed. If incorrect, repeated the 2 target items).	Kit is opened	Subject touches the second item	Selected wrong item before finding targets	2
Medicine	Reading the directions on a medicine bottle	Two medicine containers with real prescription label affixed. Tiny mints rather than actual pills inside bottle	I want you to read the directions on 2 medicine containers.[a] Please read the directions on this container out loud so I can hear you.	Container is handed to subject	Subject finishes last word of the directions	Minor reading errors or initially read other information	2 (per medicine container)

[a] Only the first food can task and the first medicine container task were used in constructing the TIADL score used in the data analysis. See text.

from the DirectAssessment of Function Scale (DAFS) [17, 27, 38, 39]; (3) cooking; (4) shopping, and (5) medicine. Stimulus materials for all of the tasks were organized into a 'kit' to facilitate portability and ease of administration since many of the ACTIVE data collection sites were located in community settings. Figure 1 is a photograph of the TIADL kit. All tasks made use of actual everyday objects, not simulated, enlarged or pictured stimuli. To minimize memory load in cases where a target was to be located (e.g., telephone number, food items on shelf), standard instructions dictated that the test administrator ensured that the participant knew what the target item was. To minimize the effects of any motor deficits, stimulus materials were placed in the subject's hand (e.g., coins placed in the nondominant hand not left on the table). Prior to administration, the phone book, purse with coins, food cans, and medication containers were removed from the box and the box was closed. Since all tasks involved near vision, the testers ensured that the participant used the visual correction that he/she typically used for near vision activities (if he/she in fact used such a correction). General directions to the subject were as follows: 'Now I want you to perform 5 different types of tasks for me. These are similar to tasks you might do in your everyday activities. You might think that some of them are very easy, and you might find others more challenging. I will be timing you in each of these activities, so please stay focused on the task.' For all tasks, the examiner used a digital stop watch to record the time taken (to one-tenth second) to perform the task. Table 1 lists the instructions to subjects for each individual task. Each task had a preset maximum time as listed in table 1; if the subject did not complete the task within this time period, testing on that item was terminated. The tester also recorded whether the subject committed any errors in performing the tasks. There were three types of error codes: (1) task was com-

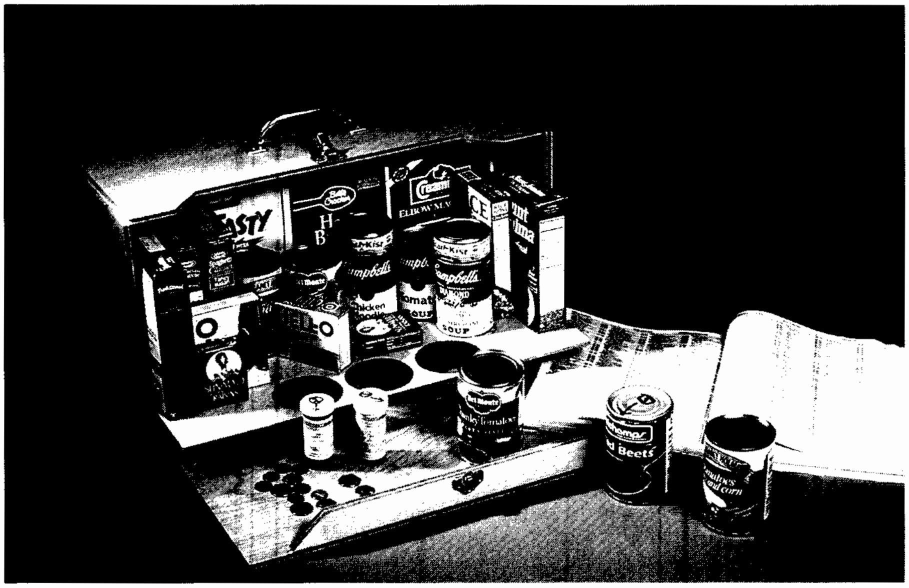

Fig. 1. TIADL kit. The photograph shows the components of the TIADL kit. In the foreground are the three food cans, the two medicine containers, the telephone directory, and the coins. Note that the shelf containing the affixed array of food items is pulled out for purposes of illustration only. For actual administration protocol, see text and table 1.

pleted correctly within the time limit with no errors; (2) task was completed within the time limit with a minor error, and (3) task was either not completed in the time limit or completed with a major error. All instructions and materials were presented to the subject in a standardized way (table 1).

A single TIADL score for each subject was generated in the following fashion. Preliminary analysis indicated that the time data from cans 2 and 3 were highly correlated with the result from can 1, and similarly medicine container 2 was correlated with the first medicine container. Thus, for simplicity sake, all further analyses on the can and medicine tasks involved only can 1 and medicine container 1 leaving one task for each domain assessed. For each task there was a completion time and an error code which were combined as follows. Subjects with a major error code on a given item were assigned the maximum time allotted on that item. For those with a minor error code, a time penalty was added to their completion time; this penalty was defined as 1 SD based on the data from all participants who had completed that item without error.

Preliminary analysis of the data also indicated that different tasks in the TIADL measure required different amounts of time. We wanted to combine all task scores into a single composite measure, but wanted to avoid unequal weighting of the five component tasks. Therefore, Z scores were computed for each of the five tasks. The TIADL score is an average of the five Z scores. This is the dependent variable used in the analyses described below. The TIADL score has good test-retest reliability (Pearson correlation coefficient 0.85), with the test and retest sessions occurring 7–8 weeks apart. The 47 older adults used to compute test-retest reliability were very similar to the overall study sample in that they were of a similar age range (mean age 74, range 65–90) and met the eligibility criteria as discussed earlier.

Statistical Analysis

Descriptive statistics (i.e., means, proportions) were calculated for demographic, medical, functional, cognitive performance, and timed IADL tasks. For purposes of preliminary empirical analyses, t tests and Pearson correlation coefficients were calculated for the association between the TIADL score and categorical and continuous variables, respectively, for variables from each of the 4 domains (i.e., demographic, medical/functional, cognitive, everyday task performance).

Linear regression was used to determine the independent association between cognitive variables and the TIADL score. The first step in this set of analyses was a preliminary analysis to identify variables from the demographic and medical/functional having independent associations with the TIADL score. Variables from the demographic and medical/functional domains were entered into two separate multivariable regression models and a stepwise selection procedure was used to select only those variables with an independent association with the TIADL score at the $\alpha = 0.10$ level. The second step in this set of analyses was to use linear regression to estimate the univariate association between each of the cognitive ability variables (AVLT, Word Series, and UFOV) and the TIADL score. (Due to the large range for the UFOV variable (142 to 1,353), an ordinal version of this variable was created based upon deciles of the original distribution). Third, for each of the cognitive ability variable models constructed in step 2, the variables selected in step 1 were included. This allowed for the estimation of the association between the TIADL score and each cognitive ability variable independent of demographic and medical characteristics known to impact IADL performance. The final step in this process involved the creation of a multivariable model that included the demographic and medical variables from step 1 as well as each of the cognitive ability variables.

A similar procedure was employed to determine the independent association between everyday task performance variables (EPT score, OTDL score, MDS IADL score, and CRT) and the TIADL score. Inspection of residuals and influence and leverage statistics was conducted to evaluate difficulties with model fit.

Table 2. Demographic and medical/functional characteristics of sample

Variable	n	%			
Demographic					
Gender					
Female	140	82.8			
Male	29	17.2			
Race					
African American	94	55.6			
White	67	39.6			
Other[a]	8	4.7			
	n	Mean	SD	Minimum	Maximum
Age, years	167	74	6	65	90
Education, years	169	12	3	4	20
Medical/functional					
Acuity[b]	169	71	13	27 (20/68)	89 (20/16)
Reading ability[c]	169	45.1	5.6	22	56
Physical functioning[d]	157	68	25	5	100
Depression[e]	159	6.5	6.1	0	30
Number of medical conditions	169	3.5	2.8	1	12

[a] Includes Hispanic, Asian, Native American, and unspecified categories.
[b] Number of letters identified correctly on Goodlite chart, with corresponding Snellen equivalent in parentheses.
[c] Score on the WRAT.
[d] Physical functioning score on SF-36.
[e] Score on CES-D.

Table 3. Characteristics of sample on cognitive and everyday performance independent variables

Variable	n	Mean	SD	Minimum	Maximum
Cognitive abilities					
Useful field of view[a]	167	557	275	142	1,353
AVLT[b]	167	44.2	10.6	15	67
Word Series[c]	166	6.6	4.5	0	21
Everyday performance measures					
OTDL[d]	169	16.2	5.7	0	27
EPT[e]	161	13.7	6.5	0	27
MDS IADL subscale[f]	168	21.1	3.1	19	38
CRT[g]	152	2.42	0.96	1.17	7.0

[a] Measure of visual processing speed in a divided attention task (in ms).
[b] Measure of verbal memory.
[c] Measure of inductive reasoning ability.
[d] Observed Tasks of Everyday Living test score.
[e] Everyday Problems Test score.
[f] Self-reported difficulty in IADL using the Minimum Data Set instrument.
[g] Measure of complex reaction time to visual stimuli (in s).

Table 4. TIADL scores (in seconds): descriptive statistics for each task

Task	n	Mean	SD	Minimum	Maximum	Subjects with minor error	Subjects with major error
Finding phone number	172	72.3	52.6	18.1	180.0	7	20
Making change	171	13.9	9.0	3.0	72.4	5	0
Reading can	172	32.3	31.2	2.0	138.6	15	8
Finding items on shelf	172	17.0	13.1	3.4	80.1	26	0
Reading medicine bottle	172	17.4	12.4	1.5	110.1	12	0

Results

Table 2 lists the characteristics of the ACTIVE pilot sample with respect to demographic and medical/functional variables. There were 173 persons in the total sample, however, some specific variables had less than the total number because of missing data (as listed in tables 2–4). The majority of the sample was female (82.8%). Over half the subjects were African American (55.6%) and about one third (39.7%) were white of non-Hispanic origin, with less than 5% falling into other ethnic/racial categories. Participants represented a wide range of older ages from 65 to 90 years, averaging 74 years old. The mean binocular acuity score for the sample was 71 letters correct, corresponding to a Snellen fraction of 20/25 (range 20/16 to 20/68).

A range of cognitive abilities and everyday performance capabilities was also present in the sample, as listed in table 3. For the three cognitive domains of memory, reasoning, and speed of processing, test performance spanned nearly the entire range of possible values. Performance on the everyday performance measures also varied greatly and spanned the entire potential range of values, with mean performance falling approximately midway through the scale.

Table 4 is a description of the sample's performance in the five TIADL tasks used to derive the summary TIADL score described earlier. Some tasks were completed on average in a matter of a few seconds, while other tasks had average completion times between a half to a full minute. Within a task, there was substantial inter-subject variability. However, it is noteworthy that the vast majority of subjects (85%) were able to complete all five tasks without error or only minor error. In summary, these were tasks that most subjects were able to do successfully; what varied across subjects was the time taken to perform them.

Table 5 (top) presents the results of the linear regression analysis for the cognitive ability variables with the TIADL score as the dependent variable. All three measures (UFOV, AVLT, Word Series) demonstrated significant crude associations with the TIADL score (first column of results in table 5) indicating that deficient performance on each cognitive measure was crudely associated with more time to complete tasks. Following adjustment for demographic and medical variables (middle columns), only UFOV demonstrated a significant independent association; however, the magnitude of the parameter estimate was reduced ($\beta = 0.126$ vs. 0.054). After additional adjustment for the remaining cognitive measures (last columns), which allows for the assessment of the role of UFOV independent of the other cognitive domains, the UFOV association remained virtually unchanged. The other cognitive measures were still not significantly associated with the TIADL score after adjustment.

Table 5 (bottom) presents the results of the regression models for the association between everyday performance measures and the TIADL scores. CRT and MDS demonstrated positive crude associations while OTDL and EPT had negative crude associations; as the scores on the CRT and MDS increase (slower RT and more self-reported difficulty in performing IADL, respectively) so did TIADL scores (slower task completion times); whereas, as scores on the OTDL and EPT increase (more items completed correctly) the TIADL scores decrease (faster task completion times). Following adjustment for demographic and medical variables, only CRT and OTDL remained significant, however, the strength of the association was reduced by nearly one half. When associations were further adjusted for the other everyday performance measures, there was little change in the association between TIADL score and OTDL, whereas the association between CRT and the TIADL score was slightly reduced and became only borderline statistically significant ($p = 0.07$). We also examined the relationship between the duration it took to complete the EPT battery and TIADL. Although EPT duration and TIADL were crudely associated ($\beta = 0.012$,

Table 5. Coefficients and R^2 from linear regression model evaluating the associations between TIADL score and cognitive variables (top) and everyday performance variables (bottom)

	β (SE) Unadjusted	R^2	β (SE) Adjusted for demographic/medical variables[c]	Partial R^2	β (SE) Adjusted for demographic/medical variables[c] and other variables in that section of table	Partial R^2
Cognitive						
Useful Field of View (decile)	0.126 (0.015)[a] (n = 166)	0.287	0.054 (0.017)[a] (n = 144)	0.069	0.055 (0.018)[a] (n = 142)	0.071
AVLT	−0.023 (0.004)[a] (n = 166)	0.140	−0.003 (0.005) (n = 144)	0.002	−0.001 (0.005) (n = 142)	0.001
Word Series	−0.066 (0.010)[a] (n = 165)	0.212	−0.021 (0.011)[b] (n = 144)	0.025	−0.012 (0.012) (n = 142)	0.008
Everyday performance						
OTDL	−0.070 (0.007)[a] (n = 168)	0.348	−0.035 (0.009)[a] (n = 146)	0.093	−0.033 (0.010)[a] (n = 127)	0.083
EPT	−0.052 (0.007)[a] (n = 160)	0.278	−0.014 (0.008) (n = 140)	0.021	0.002 (0.009) (n = 127)	0.000
CRT	0.317 (0.048)[a] (n = 151)	0.224	0.158 (0.052)[a] (n = 132)	0.072	0.102 (0.052)[b] (n = 127)	0.034

[a] $p < 0.05$.
[b] $0.05 < p < 0.10$.
[c] Demographic variables adjusted for are age, gender, race, education. Medical/functional variables adjusted for are acuity, reading ability, physical functioning, depression, and number of medical conditions.

SE = 0.004, $p < 0.05$), this association disappeared after adjustments for the confounding influences of medical/functional variables.

Discussion

We have described the rationale behind assessing IADL performance in terms of the time required to perform the task, rather than performance accuracy. Our earlier work found that those older adults who had poorer scores on a short cognitive screener took longer to complete the tasks, as compared to those with better scores [24]. The present study examined what cognitive domains play a role in this association; specifically we examined how speed of processing, verbal memory, and inductive reasoning related to performance on the TIADL measure. While all three of these cognitive measures were related to TIADL performance, only visual-processing speed was an independent predictor after adjusting for demographic and medical/functional variables. Visual-processing speed appears to be a more direct assay of the cognitive speed skills required by these types of everyday tasks than are memory and reasoning.

It is not surprising that verbal memory was not an independent predictor of TIADL performance because the administration protocol for the TIADL measure minimizes reliance on memory. Likewise, inductive reasoning (Word Series) had a significant, unadjusted association with TIADL performance but its contribution disappeared after controlling for demographic and medical/functional variables. The component tasks of the TIADL measure do not demand high levels of inductive reasoning about verbal material. This is not to say that memory and reasoning are irrelevant cognitive skills in finding phone numbers, reading medicine containers and so on. Rather, the suggestion is that assessed ability in verbal memory and inductive reasoning is not a significant predictor of one's time-sensitive efficiency in performing these everyday tasks.

As noted earlier, several objective measures of everyday competence are already in existence, such as the EPT [15] and the OTDL [16]. There are also self-reported IADL questionnaires such as the MDS [37]. An obvious question therefore is whether the current TIADL measure is redundant with these extant measures of everyday competence. If the TIADL measure provides information largely redundant with existing competency measures, then this would obviate the need to introduce a new measure. While all three measures (EPT, OTDL, and MDS IADL Difficulty Scale) were crudely related to TIADL performance, only the OTDL measure was a significant predictor after adjusting for demographic and medical/functional variables, accounting for about 9% of the TIADL variance. Those who exhibited lower levels of accuracy on the OTDL were more likely to take longer times to perform the TIADL takss. This finding may stem from similarities in these two tests. Both the OTDL and the TIADL require the behavioral execution of specific everyday tasks. There are some similarities between specific TIADL and OTDL tasks; for example, both ask subjects to locate a phone number in a directory and make change, although the actual task elements are different in the TIADL and OTDL. Unlike the TIADL, the OTDL does not measure completion time for each task; however, test administrators do provide specific prompts if the subject fails to respond to the task's demands. In the scoring system used in the ACTIVE pilot study, subjects receiving these prompts receive no credit for performing the tasks, and thus, in this indirect fashion, lengthy response periods are penalized in the OTDL scoring. Although the association between OTDL and TIADL is statistically significant, there is a substantial portion of TIADL variance (>90%) not accounted for by the OTDL score.

The association between the EPT and the TIADL measure disappeared after adjusting for demographic and medical/functional variables. The EPT is a self-paced, pencil and paper measure, not a test that requires subjects to execute behavioral task responses as in the OTDL and TIADL. In addition, the EPT-scoring system does not make distinctions between those who completed the measure quickly versus those who did not. The EPT's items pose specific problems to participants which require rather sophisticated analytical and reasoning skills. There was also an absence of a relationship between the TIADL and the MDS IADL difficulty scale after adjusting for other factors. Recall that the MDS IADL Difficulty Scale reflects self-acknowledged problems in performing IADL tasks. It appears that the rapidity with which tasks are performed is not a major psychological dimension that guides respondents in answering this MDS scale.

The other performance measure examined in relation to TIADL performance was another timed task, CRT. Recall that in this task participants responded as quickly as possible to the changed status of a traffic sign, with one of three responses depending on the sign. The changing location and dispersion of the signs on the screen demanded active visual searching for the target stimulus and the generation of the appropriate response upon target detection. This computer-based measure of information-processing speed was associated with TIADL performance after adjusting for demographic and medical/functional variables, but this relationship was weakened with subsequent adjustment for EPT, OTDL and MDS variables. While one might view the CRT as a relatively pure measure of information-processing speed, it accounts for a very small percentage of TIADL score variance (3%), suggesting that the TIADL measure taps into much more than visual-response speed as assessed in a complex reaction time test. In summary, then, the TIADL measure provides information about everyday competence in older adults, over and above that provided by existing everyday performance assessments and laboratory-based measures of response speed.

The field of gerontology is becoming increasingly engaged in developing and evaluating interventions to prevent declines in everyday competence, including the development of cognitive interventions. While there are promising findings supporting the efficacy of training cognitive skills in older adults [40–42], a major question remains whether such training transfers to everyday functional outcomes and whether it enhances functional independence. The ACTIVE trial [25] is an example of a large-scale effort to examine these questions. One of the skills being intervened upon in this trial is speed of information processing, since laboratory studies have shown that visual-processing speed in some older adults can be improved through training [32, 33, 41]. A question of interest is whether increases in processing speed in older adults have any impact on everyday competence. Given that processing speed is a key component in the time needed to perform tasks typical of everyday life, TIADL tasks may be a useful way to demonstrate generalizability of speed of processing training to everyday life, an issue specifically being investigated in ACTIVE.

Cognitive abilities, especially processing speed, are integral to the rapid and efficient performance of everyday activities, as is evident from the data presented here.

It is also important to acknowledge that other functional abilities are certainly relevant to the time needed to perform daily tasks, such as vision, hearing, and physical functioning. Our purpose in stressing the cognitive domain here sprang from the need to identify everyday tasks that would likely reflect the benefits of cognitive training. However, an equally interesting question is what other ability domains (e.g., vision, motor, hearing, as well as cognitive) contribute to TIADL performance. Sample size limitations in the ACTIVE preliminary study precluded us from validly addressing this question; however, the ACTIVE trial [25] with an enrollment of over 2,800 older adults will allow the evaluation of the role of many domains on timed task performance.

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References

1 Kovar MG, Lawton MP: Functional disability: Activities and instrumental activities of daily living. Annu Rev Gerontol Geriatr 1994;14:57–75.
2 Carabellese C, Appollonio I, Rozzini R, Bianchetti A, Frisoni GB, Frattola L, Trabucchi M: Sensory impairment and quality of life in a community elderly population. J Am Geriatr Soc 1993;41:401–407.
3 Lawton MP, Brody EM: Assessment of older people: Self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179–186.
4 Lawton MP, Moss M, Fulcomer M, Kleban MH: A research and service oriented Multi-level Assessment Instrument. J Gerontol 1982;37:91–99.
5 Ware JE Jr, Sherbourne CD: The MOS 36-item short-form health survey (SF-36): I. Conceptual framework and item selection. Med Care 1992;30:473–483.
6 Fillenbaum GG: Multidimensional Functional Assessment of Older Adults: The Duke Older Americans Resources and Services Procedures. Hillsdale, Erlbaum, 1988.
7 Diehl M: Everyday competence in later life: Current status and future directions. Gerontologist 1988;38:422–433.
8 Friedman SM, Munoz B, Rubin GS, West SK, Bandeen-Roche K, Fried LP, SEE Project Team: Characteristics of discrepancies between self-reported visual function and measured reading speed. Invest Ophthalmol Vis Sci 1999;40:858–864.
9 Rubenstein LZ, Schairer C, Wieland GD, Kane R: Systematic biases in functional status assessment of elderly adults: Effects of different data sources. J Gerontol 1984;39:686–691.
10 Kiyak HA, Teri L, Borson S: Physical and functional health assessment in normal aging and in Alzheimer's disease: Self-reports vs. family reports. Gerontologist 1994;34:324–330.
11 Kuriansky J, Gurland B, Fleiss JL, Cowam D: The assessment of self-care capacity in geriatric psychiatric patients by objective and subjective methods. J Clin Psychol 1976;32:95–102.
12 Wright SE, McCarty CA, Burgess M, Keeffe JE, The Steering Committee for the RVIB Employment Survey: Vision impairment and handicap: The RVIB Employment Survey. Aus NZ J Ophthalmol 1999;27:204–207.
13 Ball K, Owsley C: Identifying correlates of accident involvement for the older driver. Hum Factors 1991;33:583–595.
14 McGwin G Jr, Owsley C, Ball K: Identifying crash involvement among older drivers: Agreement between self-report and state records. Accid Anal Prev 1998;30:781–791.
15 Willis SL: Everyday cognitive competence in elderly persons: conceptual issues and empirical findings. Gerontologist 1996;36:595–601.
16 Diehl M, Willis SL, Schaie KW: Everyday problem solving in older adults: Observational assessment and cognitive correlates. Psychol Aging 1995;10:478–491.
17 Loewenstein DA, Amigo E, Duara R, Guterman A, Hurwitz D, Berkowitz N, Wilkie F, Weinberg G, Black B, Gittelman B, Eisdorfer C: A new scale for the assessment of functional status in Alzheimer's disease and related disorders. J Gerontol 1989;44:P114–P121.
18 Alexander MF, Maguire MG, Lietman TM, Snyder JR, Elman MJ, Fine SL: Assessment of visual function in patients with age-related macular degeneration and low visual acuity. Arch Ophthalmol 1988;106:1543–1547.
19 Ebert EM, Fine AM, Markowitz J, Maguire MG, Starr JS, Fine SL: Functional vision in patients with neovascular maculopathy and poor visual acuity. Arch Ophthalmol 1986;104:1009–1012.
20 Worrall L, Hickson L, Barnett H, Lovie-Kitchin J: The performance of older people on everyday visual tasks. Clin Exp Optom 1993;76:127–135.
21 Turco PD, Connolly J, McCabe P, Glynn RJ: Assessment of functional vision performance: A new test for low vision patients. Ophthal Epidemiol 1994;1:15–25.
22 Earles JL, Salthouse TA: Interrelations of age, health, and speed. J Gerontol B Psychol Sci Soc Sci 1995;50:P33–P41.
23 Salthouse TA: Speed mediation of adult age differences in cognition. Dev Psychol 1993;29:722–738.
24 Owsley C, McGwin G Jr, Sloane ME, Stalvey BT, Wells J: Timed instrumental activities of daily living (TIADL) tasks: Relationship to visual function in older adults. Optom Vis Sci 2001;78:350–359.
25 Jobe J, Smith DM, Ball K, Tennstedt SL, Marsiske M, Rebok GW, Morris JN, Willis SL, Helmers K, Leveck MD, Kleinman K: ACTIVE: A cognitive intervention trial to promote independence in older adults. Control Clin Trials 2001;22:454–479.
26 Folstein MF, Folstein SW, McHugh PR: 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
27 Rubin GS, Salive ME: Vision and hearing; in Guralnick JM, Fried LP, Simonsick EM, Kasper JD, Lafferty ME (eds): The Women's Health and Aging Study. Bethesda, National Institute on Aging, NIH 95-4009, 1995, pp 152–161.
28 Wilkinson GS: Manual for the Wide Range Achievement Test. Wilmington, Wide Range, 1993.
29 Radloff LS, Teri L: Use of the Center for Epidemiological Studies: Depression Scale with older adults; in Brink TL (ed): Clinical Gerontology: A Guide to Assessment and Intervention. New York, Haworth Press, 1986, pp 119–136.
30 Rey A: L'examen psychologique dans les cas d'encéphalopathie traumatique. Arch Psychol 1941;28:21.

31 Gonda J, Schaie KW: Schaie-Thurstone Mental Abilities Test: Word Series Test. Palo Alto, Consulting Psychologists Press, 1985.
32 Ball K, Beard BL, Roenker DL, Miller RL, Griggs DS: Age and visual search: Expanding the useful field of view. J Opt Soc Am A 1988;5:2210–2219.
33 Ball KK, Roenker DL, Bruni JR: Developmental changes in attention and visual search throughout adulthood: in Enns JT (ed): The Development of Attention: Research and Theory. Amsterdam, Elsevier Science, 1990, pp 489–507.
34 Ball K, Owsley C, Sloane ME, Roenker DL, Bruni JR: Visual attention problems as a predictor of vehicle crashes in older drivers. Invest Ophthalmol Vis Sci 1993;11:3110–3123.
35 Owsley C, Ball K, McGwin G Jr, Sloane ME, Roenker DL, White MF, Overley ET: Visual processing impairment and risk of motor vehicle crash among older drivers. JAMA 1998;279:1083–1088.
36 Ball K, Owsley C: Increasing mobility and reducing accidents of older drivers: in Schaie KW, Pietrucha M (eds): Mobility and Transportation in the Elderly. New York, Springer, 2000, pp 213–250.
37 Morris JN, Morris SA: Assessment measures for use with frail elders: in Teresi JA, Lawton MP, Holmes D, Ory M (eds): Measurement in Elderly Chronic Care Populations. New York, Springer, 1997.
38 Loewenstein DA, Ardila A, Rosselli M, Hayden S, Duara R, Berkowitz N, Linn-Fuentes P, Mintzer J, Norville M, Eisdorfer C: A comparative analysis of functional status among English and Spanish speaking patients with dementia and elderly controls. J Gerontol 1992;47:P389–P394.
39 Loewenstein DA, Duara R, Rubert MP, Argueeles T: Deterioration of functional capacities in Alzheimer's disease after a 1-year period. Int Psychogeriatr 1995;7:495–503.
40 Willis SL: Cognitive training and everyday competence. Annu Rev Gerontol Geriatr 1987;7:159–188.
41 Sekuler R, Ball K: Visual localization: Age and practice. J Opt Soc Am A 1986;3:864–867.
42 Yesavage JA: Nonpharmacologic treatments for memory losses with normal aging. Am J Psychiatry 1985;142:600–605.