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ORIGINAL ARTICLE

Timed Instrumental Activities of Daily Living Tasks: Relationship to Visual Function in Older Adults

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ABSTRACT: *Purpose.* To identify instrumental activities of daily living (IADL) tasks whose completion time is related to visual function in older adults. *Methods.* Visual function (acuity, contrast sensitivity, and useful field of view) and the time to complete 17 visual tasks of everyday life were measured in a sample of 342 older adults (mean age 71 years, range 56 to 86) recruited from eye clinics. The timed IADL (TIADL) tasks included a variety of visual activities such as reading ingredients on cans of food and instructions on medicine bottles, finding a phone number in a directory, locating items on a crowded shelf and in a drawer, and using a screwdriver. *Results.* Multiple regression analysis indicated that poorer scores for acuity, contrast sensitivity, and useful field of view were independently associated with longer times to complete visual TIADL tasks, even after adjusting for age, educational level, depression, and general health. Cognitive status also had a significant, independent association with timed task performance. *Conclusions.* Older adults' timed performance in everyday tasks is related to various aspects of visual function independent of the influences of other functional and health problems and advanced age. This suggests that TIADL tasks may eventually be useful as performance outcomes in intervention evaluations targeted at reversing vision impairment or minimizing its impact. To understand the relationship between vision impairment and TIADL task performance in older adults, cognitive impairment needs to be taken into account because it has a relatively strong and independent relationship with visual TIADL task performance. (Optom Vis Sci 2001;78:350–359)

Key Words: IADL, aging, vision impairment, cognitive impairment, visual performance

Functional independence in older adults is facilitated by the ability to perform the instrumental activities of daily living (IADL).[1] IADL's involve many domains in everyday life including social interactions, financial management, shopping, managing health issues (e.g., medications and doctor's appointments), and information-gathering activities or entertainment (e.g., reading and watching TV). Traditionally, IADL function in older adults has been assessed by self-report measures using questionnaires. Examples of commonly used IADL questionnaires in the older adult population are the Multilevel Assessment Instrument,[2] the SF-36,[3] and the OARS Multidimensional Functional Assessment Questionnaire.[4] Many IADL's critically depend on vision, and thus it is not surprising that vision impairment in older adults is linked to IADL difficulty.[5–8] Questionnaires that specifically target visual instrumental activities have grown in number in recent years (e.g., VF-14,[7] ADVS,[8] VAQ,[9] NEI-VFQ,[10] VQOL,[11] and DLTV[12]). These instruments are not only useful for characterizing domains in which visually impaired adults encounter difficulty, but can potentially serve as patient-centered outcome measures in clinical trials examining the impact of treatments and rehabilitation strategies.

More recently, there has been interest in developing actual performance tasks of IADL's as outcome measures, rather than solely relying on self-report instruments.[13] The move toward supplementing self-report with performance-based measures stems, in part, from findings that some subpopulations of older adults do not validly evaluate their everyday abilities.[14, 15] For example, healthy, community-dwelling older adults and those with mild cognitive impairment tend to overestimate their functional abilities,[14] whereas depressed older adults tend to underestimate their abilities.[16, 17] A population-based study on visual function in older adults found that about 10% of individuals have a substantial discrepancy between their self-reported reading difficulty and measured reading speed.[15]

Substantial progress has been made in the cognitive and physical functioning domains toward creating test batteries of everyday tasks with documented psychometric properties. Examples of cognitive performance batteries recently developed include the Everyday Problems Test,[18] the Observed Tasks of Daily Living,[19] and the Direct Assessment of Functional Status.[20] The primary dependent measure in these tasks is accuracy of performance. In addition, physical performance measures for use with the older adult population have been developed and used in intervention evaluations (e.g., Performance Oriented Mobiliry Assessment,[21] Duke Progressive Mobility Test,[22] and Get Up and Go Test[23]; see also Duncan and Studenski[24]). The dependent measure in these batteries is time taken to perform a physical movement and/or the quality with which one carries out the physical maneuver.

In contrast to the considerable progress in constructing cognitive and physical performance batteries, there has been relatively less effort toward developing performance tasks specifically targeted at visual IADL's. Tests of reading performance have been developed[25, 26] and are related to the extent of vision impairment, but these tests are based on text devised especially for the test situation, not on actual everyday reading materials (e.g., magazines, food containers, and medicine bottles). Several groups have developed visual performance test batteries for use with older patienrs having low vision with acuity of 20/100 or worse. Task performance is largely evaluated on the basis of whether the task was completed accurately. Ebert et al.[27] demonstrated a correlation between visual acuity and task performance (e.g., currency discrimination, color recognition, clock reading, and large-text reading). Alexander et al.[28] developed five everyday tasks (e.g., reading a large-print magazine, telling time, identifying colored handkerchiefs and common household objects, and recognizing facial expressions) and found that accuracy of performance was related to both visual acuity and contrast sensitivity. Turco et al.[29] constructed a battery of tasks focused on reading (spot reading, text reading, identifying paper currency, and clock reading), which were associated with near visual acuity. A problem with these prior studies is that associations were not adjusted for the confounding effects of cognitive impairment, depression, and general health, all of which are common in older adults and are known to influence older adults' performance of IADL's.[1] Thus, it remains to be determined whether vision impairment has an independent impact on IADL performance.

This article describes our initial steps toward the long-term goal of identifying tasks that could eventually have potential for use as outcome measures in studies evaluating treatments for eye conditions or rehabilitation strategies to minimize the impact of vision loss. The first step in the development of such a battery of tasks is to determine whether vision impairment is independently related to task performance. In taking these initial steps, we had several priorities. First, a broad range of visual tasks were included that are commonplace in the course of everyday life for most people regardless of gender, ethnicity, or socioeconomic status. These tasks represent many of the major IADL domains (e.g., food preparation, financial management, and medication management) as described in the IADL literature.[1–5] Second, our interest was in developing tasks where the quick and efficient completion of the tasks was an advantage in everyday life. Accuracy in task performance is obviously relevant, but if a person is accurate but takes a long time to complete a task, the task becomes a source of frustration, inconvenience, and even embarrassment. Thus, rhe rime taken to successfully perform the task was the primary dependent variable in our analysis of task performance. Third, we were interested in identifying tasks where even moderate levels of vision impairment would have a measurable negative influence on performance. Prior work on developing IADL performance tasks has been limited to examining patients with severe vision impairment,[27–29] mostly from macular disease. However, a large segment of the older adult population have vision impairments that are not as severe as 20/100 or worse,[30] but nevertheless cause functional problems and lead them to seek ophthalmic treatments.

The specific aims of this study were to examine whether IADL tasks could be identified where time to complete the tasks has a significant relationship to visual function and to examine whether such relationships remain after adjustment for medical comorbidities, cognitive status, depression, and demographic variables.[1]

METHODS

Subjects

The sample consisted of subjects previously enrolled in a prospective study on the Impact of Cataracts on Mobility (ICOM) as described earlier.[31, 32] Because a long-term goal was to develop a way to measure visual task performance as discussed above, we took the opportunity at the second annual visit in ICOM to examine older adults' performance on timed IADL (TIADL) tasks and to evaluate the relationship between TIADL performance and visual function. There were 342 enrollees who returned for the second annual visit (mean age 71 years, range 56 to 86); subjects were split evenly between males and females, with 85% white and 15% black. Subjects were recruited through eye care clinics in the Birmingham, Alabama area as described in detail previously.[31, 32] About 29% of the subjects (N = 99) had good eye health in that at enrollment (1 year before the second annual visit) they had 20/25 or better acuity in both eyes and no ocular diagnoses in their medical record other than refractive error. About 29% of subjects (N = 100) had cataracts (99% bilateral) with acuity in one eye of 20/40 or worse (best-corrected, distance) at enrollment. About 42% of subjects (N = 143) also had cataracts at enrollment (98% bilateral), but by the time of the second annual visit, 36% of these persons were bilaterally pseudophakic and 64% were unilaterally pseudophakic. Exclusion criteria included diagnoses of dementia, Parkinson's disease, psychosis, or any illness that precluded annual follow-up visits for the 3 years of the ICOM project. In addition, persons were excluded if eye conditions other than refractive error or cataract were the primary causes of their vision impairment.

As described previously,[31] information on key variables was obtained over the phone from those who chose not to participate in the ICOM project to facilitate the generalizability of the findings. "Refusers" were more likely to have worse acuity and to have poorer health than those who enrolled.[31]

Protocol

The study protocol was approved by the Institutional Review Board for Human Use at the University of Alabama at Birmingham. After the purpose of the srudy was explained, each subject was asked to sign a document of informed consent at each annual visit.

Three aspects of visual function were measured during conditions of habitual correction for the viewing distance used in each test. Habitual correction, rather than best correction, was selected because we were interested in each subject's performance during typical, everyday circumstances. Distance acuity was measured for each eye separately using the ETDRS letter chart (Lighthouse Products) and its standard protocol and expressed as log minimum angle resolvable.[33, 34] Contrast sensitivity was measured for each eye separately with the Pelli-Robson Contrast Sensitivity Chart (Haag-Streit) using the standard protocol with the letter-by-letter scoring procedure and expressed as log contrast sensitivity.[35, 36] The UFOV test (Visual Awareness) was used to measure the size of the useful field of view.[37, 38] In this test, subjects are asked to discriminate two briefly presented targets in central vision during binocular viewing and must also radially locate a peripheral target (up to 30° eccentric from fixation) presented simultaneously. The test is scored on a scale from 0 to 90 (good to poor performance) and is a summary measure of visual processing speed and visual attentional capabilities. Cognitive function was also assessed because cognitive impairment can have potent influences on IADL performance. General cognitive status was evaluated by the Mattis Organic Mental Syndrome Screening Examination (MOMSSE),[39] which is specifically designed to assess cognitive function in elderly people. This 20-min test, described in detail in our prior work,[40] provides a composite score of mental status that reflects performance in 14 domains of cognitive functioning. Scores range from 0 to 28, with lower scores representing higher functioning.

General health and depression were assessed because of their role as confounding factors in understanding the relationship between timed IADL performance and visual function. General health was assessed by a questionnaire, adapted from earlier work,[7, 31] asking subjects if they have problems in 17 areas (e.g., heart, cancer, and digestive) and, if so, to what extent they are bothered by the condition on a 3-point scale of "bothersomeness." To generate a comorbidity index, each medical condition present was weighted by the bothersomeness score and all were summed. Lower numbers indicate fewer comorbid conditions. The presence of depressive symptoms was assessed by the Center for Epidemiological Studies–Depression Scale (CES-D).[41] Patients were asked to use a response scale to rate 20 items based on how often they felt that way in the last week. Total scores range from 0 to 60, with a higher number indicating more depressive symptoms.

Table 1 lists the 17 IADL tasks evaluated and the instructions to subjects. Before beginning the first task, the examiner stated "Now I will ask you to do a few tasks." All tasks made use of actual everyday objects, not simulated stimuli, and were performed at whatever viewing distance the subject preferred and with whatever correction the subject normally used at that distance. For example, reading the ingredients on a can of food involved presenting the subject with a can of food purchased from a supermarket. Finding scissors in a drawer involved the subject opening an actual drawer and locating scissors situated among many other objects typically found in a household drawer located in a kitchen or utility room cabinet. Reading the directions on a medicine bottle involved an actual prescription medicine bottle with an affixed printed label from a real pharmacy. For all tasks, the examiner used a digital stop

TABLE 1.
Timed IADL tasks with instructions.

Tasks	Instructions
Reading ingredients on a can of food (for each of 3 cans)	'Read the ingredients on this can of food out loud.'
Reading directions on a prescription medicine bottle (for each of 3 bottles)	'Read the directions on this medicine bottle out loud and tell me how many pills you need to take in 1 day (24 h).'
Finding a name and number in telephone book	'I want you to look up a person in this telephone book and read the number out loud to me. John F. Nash.'
Reading a newspaper article	'Read this newspaper article out loud to me.'
Threading a needle	'Thread this needle.'
Using a screwdriver to turn a screw	'Use the screwdriver to turn this screw.'
Finding a pair of scissors in a crowded drawer	'Find a pair of scissors in this drawer.'
Finding a flashing on a crowded shelf	'Find a flashlight on this shelf.'
Judging which of two small figurines (height 2 in) is closer. (The two figurines were offset in depth by their 1-in diameter bases. One was yellow, and one was brown.	'Which one of these two objects on the desk is closer to you?'
Inserting a key in a lock and turning it	'Put this key in the lock and turn the key.'
Dialing a number on a touch-tone telephone	'Dial this number on the telephone.' (Phone number is written on a card presented to the subject.)
Finding a pair (bundled together) of black socks in a laundry basket (filled with many dark-colored socks)	'Find the pair of black socks.'
Finding a pair (bundled together) of blue socks in a laundry basket (filled with many dark-colored socks)	'Find the pair of blue socks.'

watch to record the time taken (to one-tenth second) to perform the task and also determined whether the task was completed accurately, with minor error, with major errors, or whether the subject failed to complete the task for any reason. In many of the nonreading tasks, performance was either accurate or the subject failed to complete the task. In the reading tasks, examples of minor errors were slightly mispronouncing a word or skipping a minor word (e.g., "the") in a sentence. A major error consisted of misidentifying a series of words. Examiners collecting the timed IADL data were masked with respect to results on the visual measures and other evaluations described above.

Statistical Analysis

Because preliminary analysis indicated that most variables were normally distributed, variables were characterized for descriptive purposes by mean, standard deviation, and minimum/maximum values, and parametric statistical tests were used to examine relationships among variables. For the purposes of analysis, acuity was defined by the eye with better acuity, and contrast sensitivity was defined by the eye with better contrast sensitivity. The primary aims of the study were to determine whether there was an association between vision and the task performance in this sample and, if so, whether this association was independent of other potentially confounding influences. To meet this goal, the relationships between each visual function measured (acuity, contrast sensitivity, and useful field of view) and performance in each timed IADL task were assessed by multiple regression. The role of each visual function (acuity, contrast sensitivity, and useful field of view) was evaluated in separate models, where each visual function served as the independent variable and timed IADL performance as the dependent variable. An analogous approach was used to address the role of cognitive status in timed IADL performance because prior work has reported potent influences of cognitive status on the ability to perform IADL's.[18-20] These models were run in three ways: (1) with the visual function (acuity, contrast sensitivity, and useful field of view) as the only independent variable to examine the unadjusted association between the visual function and timed IADL performance; (2) with the visual funcrion and other variables (age, comorbidity score, depression, and education) entered simultaneously to look at the role of the visual function adjusted for these other potentially confounding variables; and (3) as described in 2, but with the inclusion of the remaining visual function variables and cognitive status as independent variables to look at the contribution of the specific vision variables independent of contributions from other vision variables and cognitive status. Only those subjects who completed a task accurately or with a minor error were included in the main analyses of the timed IADL tasks. Those who completed the task with no errors or minor errors were defined as being able to complete the task successfully. The models described above used these data. Those who made a major error or failed to complete the task for any reason were defined as failing to complete the task accurately. Logistic regression was used to determine whether demographic, comorbidities, and visual/cognitive measures were associated with failure to complete at least one of the four most commonly failed tasks.

RESULTS

Table 2 provides a summary of the sample characteristics with respect to all independent variables. Visual acuity in the better eye averaged 20/30, although there was a wide acuity range represented in the better eye, from 20/10 to 20/150. Similarly, contrast sensitivity and useful field of view scores ranged from excellent to severely impaired. Cognitive status, general health, and depression revealed values that are typical of community-dwelling older adults, with subjects ranging from high functioning to having moderate problems.

A description of how the sample performed in the timed IADL tasks is listed in Table 3. It is obvious that some tasks could be completed in a few seconds, whereas others, especially the reading tasks, required much longer. What is particularly striking is the broad variability in times subjects required even within a task. For example, although some subjects appeared to locate the scissors in the drawer very quickly, within a few seconds, others searched up to a minute before locating the item. Table 3 also shows the number of subjects who exhibited task failures. The vast majority of subjects could complete each task. Thirteen of the 17 tasks had almost no failures (≤2% of subjects failed). For the four other tasks, specifically locating and reading the ingredients on the three food cans and reading a newspaper article, the failure rate was 6% to 16%. We examined what functional and medical variables were associated with failure to complete at least one of these four tasks and found that a deficit in cognitive status was the strongest independent predictor ($p < 0.0001$), followed by contrast sensitivity impairment ($p = 0.011$). No other functional/medical problems were associated with task failure.

Table 4 provides information about whether there is a significant association between acuity and each timed IADL task, as indicated by whether the R^2 value was statistically significant. The first columns list the R^2 and p value when acuity is entered alone as the only independent variable in the regression model. In the middle set of columns are the corresponding values for acuity when adjusted for age, comorbid health problems, education, and depression, and finally in the last columns, the corresponding values

TABLE 2.
Characteristics of sample (N = 342) on independent variables.

Variable	Mean	SD	Minimum	Maximum
Age (yr)	70	6	55	85
Education (yr)	13	3	1	20
Acuity[a]	0.09	0.16	−0.26	0.80
Contrast sensitivity[b]	1.47	0.15	0.55	1.90
Useful field of view[c]	32.8	12.6	5	80.0
Cognitive status[d]	4.6	2.9	0.0	18.5
General health[e]	6.8	4.9	0	25
Depression[f]	6.6	8.0	0	49

[a] LogMAR, better eye.
[b] Pelli-Robson score, better eye.
[c] Score representing reduction of 30° radius field.
[d] MOMSSE score.
[e] Comorbidity score.
[f] CES-D score.

TABLE 3.
Performance of subjects on time IADL tasks (in seconds).

Task	Mean	SD	Minimum	Maximum	No. of Subjects Failing Task
Reading can #1	61.2	26.5	3.4	200.2	22
Reading can #2	36.1	24.8	7.4	185.6	56
Reading can #3	26.8	19.4	7.4	134.1	37
Reading medicine bottle #1	11.8	6.9	3.9	52.3	6
Reading medicine bottle #2	13.1	4.9	6.5	47.3	8
Reading medicine bottle #3	4.3	1.8	1.1	13.1	1
Finding phone number	52.5	53.4	11.1	410.4	7
Reading newspaper	61.2	16.9	35.4	160.5	32
Threading needle	17.2	18.9	2.8	182.1	6
Using screwdriver	4.7	2.0	1.1	16.1	1
Finding scissors in drawer	12.6	9.1	1.9	53.2	2
Finding flashlight on shelf	12.7	12.3	2.3	77.9	2
Judging closer of 2 objects	5.4	3.2	1.0	21.2	0
Inserting key in lock	8.4	7.4	1.4	47.9	0
Dialing phone number	10.4	5.0	3.6	38.9	3
Finding black sock	8.1	6.4	1.4	41.1	2
Finding blue sock	7.4	6.2	1.8	54.1	3

[a] Subjects who completed the task successfully (see text) were utilized to compute mean, standard deviation, minimum, and maximum values.

for acuity adjusted not only for age, comorbid health problems, education, and depression, but also the other visual functions (contrast sensitivity and useful field of view) and cognitive status. Tables 5 through 7 are the analogous results for contrast sensitivity, useful field of view, and cognitive status, respectively. All significant results were in the direction of slower timed IADL task performance being associated with impairment in the function being studied.

As shown in Table 4, acuity is related to timed performance in almost all tasks even after adjusting for age, comorbidities, education, depression, and other visual/cognitive variables (contrast sensitivity, useful field of view, and cognitive status). Acuity had no adjusted associations with finding the flashlight, inserting a key, and finding a black socks. In fact, finding the black sock was not related to acuity even at the unadjusted level.

Contrast sensitivity (Table 5) had widespread unadjusted associations with all tasks except for finding the scissors, inserting the key in the lock, and finding the black socks. Many of these associations remained significant after adjusting for nonvisual variables (middle columns); however, when adjusted for other visual/cognitive functions, about half of the associations between contrast sensitivity and task performance became nonsignificant. The associations with contrast sensitivity that remained significant after adjusting for all variables (right columns) were reading medicine bottles (#1 and #2), threading a needle, using a screwdriver, judging the closer of two objects, and finding a blue sock.

Useful field of view (Table 6) had unadjusted associations with all tasks except finding the black or blue socks. Many of these associations remained after adjusting for nonvisual variables (middle columns). After adjusting for other visual/cognitive variables, four tasks had significant relationships with useful field of view—reading ingredients on a can, reading a newspaper article, finding scissors in a drawer, and inserting a key in a lock.

Two general comments are in order. First, for each visual function assessed (acuity, contrast sensitivity, and useful field of view), there are tasks for which vision is independently associated with task performance (i.e., after adjusting for comorbid functional/health problems and other aspects of visual function). Second, the percentage of TIADL performance accounted for by vision alone is low.

Like the visual function variables, cognitive status was crudely associated with the majority of tasks, the exceptions being inserting the key in the lock and finding the black pair of socks. The majority of these associations remained significant after adjusting for age, comorbidities, education, and depression (middle columns), and 10 of the original 15 remained significant after adjusting for the visual variables as well. It is noteworthy that the percentage of variance (R^2) accounted for by cognitive status, even after adjusting for potentially confounding variables, tended to be larger than that for the visual variables. For example, even in the fully adjusted models (far right columns in Table 7), cognitive status had an R^2 value of 10% to 11% for four tasks (reading can #2; reading medicine bottle #3; finding a phone number in the telephone directory; and dialing a phone number).

To examine the combined association of all three visual function variables (acuity, contrast sensitivity, and useful field of view) with TIADL performance, Table 8 lists the R^2 for all three aspects of visual function combined into a single model. Column 1 in Table 8 is the R^2 for the unadjusted association between the combined vision variables and each IADL task, column 2 is the R^2 when the association is adjusted for other demographics and other medical/functional variables, and column 3 is similar to column 2 except that the association is also adjusted for cognitive status. As was also apparent in Tables 4 through 6, as one moves across the columns, the R^2 for the vision variables decreases as other factors are taken into account. However, even after statistical adjustments are made, visual function was significantly associated with TIADL task performance.

TABLE 4.
Percentage of variance in timed IADL tasks accounted for by acuity, with and without adjustments for other variables.[a]

Task	Unadjusted		Adjusted for age, Comorbidities, Education, and Depression		Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Functions	
	R^2	p Value	R^2	p Value	R^2	p Value
Reading can #1	0.062[b]	<0.0001	0.030[b]	0.0019	0.017[b]	0.0201
Reading can #2	0.094[b]	<0.0001	0.030[b]	0.0036	0.021[b]	0.0095
Reading can #3	0.058[b]	<0.0001	0.020[b]	0.0130	0.012	0.0543
Reading medicine bottle #1	0.120[b]	<0.0001	0.069[b]	<0.0001	0.024[b]	0.0047
Reading medicine bottle #2	0.130[b]	<0.0001	0.072[b]	<0.0001	0.029[b]	0.0019
Reading medicine bottle #3	0.059[b]	<0.0001	0.027[b]	0.0025	0.014[b]	0.0282
Finding phone number	0.049[b]	<0.0001	0.019[b]	0.0118	0.012[b]	0.0465
Reading newspaper	0.090[b]	<0.0001	0.052[b]	<0.0001	0.040[b]	0.0005
Threading needle	0.051[b]	<0.0001	0.037[b]	0.0004	0.015[b]	0.0262
Using screwdriver	0.089[b]	<0.0001	0.045[b]	<0.0001	0.017[b]	0.0156
Finding scissors in drawer	0.026[b]	0.0031	0.022[b]	0.0061	0.015[b]	0.0241
Finding flashlight on shelf	0.013[b]	0.0387	0.006	0.1675	0.001	0.6882
Judging closer of 2 objects	0.130[b]	<0.0001	0.081[b]	<0.0001	0.050[b]	<0.0001
Inserting key in lock	0.024[b]	0.0038	0.011	0.0556	0.012	0.0458
Dialing phone number	0.107[b]	<0.0001	0.050[b]	<0.0001	0.025[b]	0.0039
Finding black sock	0.008	0.1102	0.001	0.6703	0.001	0.8885
Finding blue sock	0.030[b]	0.0015	0.014[b]	0.0315	0.003	0.3139

[a] Models were based on those subjects who completed each task successfully.
[b] $p < 0.05$ (two-tailed).

TABLE 5.
Percentage of variance in timed IADL tasks accounted for by contrast sensitivity, with and without adjustments for other variables.[a]

Task	Unadjusted		Adjusted for Age, Comorbidities, Education, and Depression		Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Functions	
	R^2	p Value	R^2	p Value	R^2	p Value
Reading can #1	0.044[b]	0.0002	0.015[b]	0.0277	0.001	0.5046
Reading can #2	0.067[b]	<0.0001	0.012	0.0706	0.002	0.4159
Reading can #3	0.045[b]	0.0002	0.011	0.0676	0.002	0.4319
Reading medicine bottle #1	0.156[b]	<0.0001	0.096[b]	<0.0001	0.048[b]	<0.0001
Reading medicine bottle #2	0.147[b]	<0.0001	0.086[b]	<0.0001	0.041[b]	0.0002
Reading medicine bottle #3	0.037[b]	0.0004	0.010	0.0619	<0.001	0.6915
Finding phone number	0.027[b]	0.0024	0.005	0.1877	<0.001	0.7985
Reading newspaper	0.051[b]	<0.0001	0.018[b]	0.0174	<0.001	0.4745
Threading needle	0.058[b]	<0.0001	0.044[b]	0.0001	0.020[b]	0.0107
Using screwdriver	0.126[b]	<0.0001	0.073[b]	<0.0001	0.043[b]	0.0001
Finding scissors in drawer	0.009	0.0797	0.007	0.1344	<0.001	0.9066
Finding flashlight on shelf	0.026[b]	0.0031	0.015[b]	0.0261	0.007	0.1396
Judging closer of 2 objects	0.090[b]	<0.0001	0.045[b]	<0.0001	0.013[b]	0.0396
Inserting key in lock	0.008	0.0993	0.001	0.9418	0.004	0.2251
Dialing phone number	0.087[b]	<0.0001	0.030[b]	0.0015	0.006	0.1502
Finding black sock	0.010	0.0622	0.002	0.4218	0.002	0.4251
Finding blue sock	0.046[b]	<0.0001	0.025[b]	0.0035	0.016[b]	0.0213

[a] Models are based on those subjects who completed each task successfully.
[b] $p < 0.05$ (two-tailed).

TABLE 6.
Percentage of variance in timed IADL tasks accounted for by useful field of view, with and without adjustments for other variables.[a]

Task	Unadjusted		Adjusted for Age, Comorbidities, Education, and Depression		Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Functions	
	R^2	p Value	R^2	p Value	R^2	p Value
Reading can #1	0.063[b]	<0.0001	0.028	0.0026	0.015[b]	0.0323
Reading can #2	0.035[b]	0.0014	0.001	0.6647	0.006	0.2051
Reading can #3	0.046[b]	0.0002	0.0103	0.0792	0.001	0.5700
Reading medicine bottle #1	0.090[b]	<0.0001	0.043	0.0001	0.0112	0.0547
Reading medicine bottle #2	0.056[b]	<0.0001	0.014	0.0339	0.0001	0.6300
Reading medicine bottle #3	0.038[b]	0.0003	0.0104	0.0613	<0.001	0.9706
Finding phone number	0.060[b]	<0.0001	0.034	0.0007	0.009	0.0864
Reading newspaper	0.059[b]	<0.0001	0.039	0.0005	0.017[b]	0.0251
Threading needle	0.014[b]	0.0306	0.006	0.1438	0.001	0.6221
Using screwdriver	0.043[b]	0.0001	0.010	0.0709	0.004	0.2363
Finding scissors in drawer	0.026[b]	0.0031	0.023	0.0046	0.015[b]	0.0232
Finding flashlight on shelf	0.030[b]	0.0013	0.019	0.0122	0.008	0.1113
Judging closer of 2 objects	0.026[b]	0.0027	0.002	0.4520	<0.001	0.09628
Inserting key in lock	0.058[b]	<0.0001	0.038	0.0003	0.034[b]	0.0007
Dialing phone number	0.071[b]	<0.0001	0.022	0.0062	0.002	0.4628
Finding black sock	0.002	0.4595	0.002	0.4739	0.002	0.4257
Finding blue sock	0.002	0.3740	0.001	0.5395	0.006	0.1480

[a] Models were based on those subjects who completed each task successfully.
[b] $p < 0.05$ (two-tailed).

TABLE 7.
Percentage of variance in timed IADL tasks accounted for by cognitive status, with and without adjustments for other variables.[a]

Task	Unadjusted		Adjusted for Age, Comorbidities, Education, and Depression		Adjusted for Age, Comorbidities, Education, Depression, and Visual Functions	
	R^2	p Value	R^2	p Value	R^2	p Value
Reading can #1	0.090[b]	<0.0001	0.034[b]	0.0010	0.017[b]	0.0223
Reading can #2	0.195[b]	<0.0001	0.113[b]	<0.0001	0.111[b]	<0.0001
Reading can #3	0.116[b]	<0.0001	0.063[b]	<0.0001	0.051[b]	<0.0001
Reading medicine bottle #1	0.190[b]	<0.0001	0.105[b]	<0.0001	0.075[b]	<0.0001
Reading medicine bottle #2	0.142[b]	<0.0001	0.070[b]	<0.0001	0.054[b]	<0.0001
Reading medicine bottle #3	0.167[b]	<0.0001	0.119[b]	<0.0001	0.104[b]	<0.0001
Finding phone number	0.254[b]	<0.0001	0.141[b]	<0.0001	0.115[b]	<0.0001
Reading newspaper	0.175[b]	<0.0001	0.064[b]	<0.0001	0.045[b]	0.0002
Threading needle	0.037[b]	0.0004	0.022[b]	0.0072	0.011	0.0551
Using screwdriver	0.015[b]	0.0215	0.001	0.5379	<0.001	0.8823
Finding scissors in drawer	0.012[b]	0.0413	0.013[b]	0.0347	0.004[b]	0.2284
Finding flashlight on shelf	0.024[b]	0.0044	0.026[b]	0.0029	0.016[b]	0.0226
Judging closer of 2 objects	0.026[b]	0.0027	0.007	0.1269	0.002	0.3801
Inserting key in lock	0.010[b]	0.0649	0.008	0.1093	0.001	0.5506
Dialing phone number	0.237[b]	<0.0001	0.131[b]	<0.0001	0.106[b]	<0.0001
Finding black sock	0.005	0.2058	0.001	0.8538	<0.001	0.9450
Finding blue sock	0.019[b]	0.0112	0.011	0.0528	0.011	0.0543

[a] Models were based on those subjects who completed each task successfully.
[b] $p < 0.05$ (two-tailed).

TABLE 8.
Percentage of variance in timed IADL tasks accounted for by the three visual functions combined (acuity, contrast sensitivity and useful field of view), with and without adjustments for other variables.[a]

Task	Unadjusted (R^2)	Adjusted for Age, Comorbidities, Education, and Depression (R^2)	Adjusted for Age, Comorbidities, Education, Depression, and Cognitive Status (R^2)
Reading can #1	0.069	0.047	0.033
Reading can #2	0.081	0.027	0.028
Reading can #3	0.061	0.026	0.016
Reading medicine bottle #1	0.135	0.108	0.084
Reading medicine bottle #2	0.119	0.082	0.071
Reading medicine bottle #3	0.048	0.027	0.015
Finding phone number	0.064	0.048	0.021
Reading newspaper	0.089	0.076	0.058
Threading needle	0.041	0.042	0.036
Using screwdriver	0.091	0.064	0.064
Finding scissors in drawer	0.030	0.038	0.031
Finding flashlight on shelf	0.027	0.023	0.015
Judging closer of 2 objects	0.089	0.065	0.062
Inserting key in lock	0.059	0.056	0.050
Dialing phone number	0.096	0.054	0.033
Finding black sock	0.006	0.004	0.004
Finding blue sock	0.031	0.024	0.025

[a] Models were based on those subjects who completed each task successfully.

DISCUSSION

These data demonstrate for the first time that everyday visual tasks can be identified where the time needed by older adults to successfully perform these tasks is linked to the level of visual function independent of the effects of age, general health, educational level, and depression. These comorbid demographic, medical and functional variables are known to influence older adults' IADL performance,[1–4] and it is thus critical to take their contribution to IADL measures into account when determining the independent role of vision. Prior efforts to develop visual tasks for use in clinical eye studies[27–29] did not partial out the contributions of these coexisting influences when examining the impact of vision impairment on task performance. Therefore, our results are a critical step toward determining the potential of TIADL tasks as outcome measures in clinical trials to reverse vision impairment or in evaluations of rehabilitation strategies. Furthermore, our analyses indicate that duration of task performance may be more useful when studying the moderately visually impaired than is accuracy because the vast majority of subjects performed the tasks accurately or with only minor errors. Although a great deal of psychometric work remains to determine the validity, reliability, and responsiveness of TIADL measures, our findings clearly indicate that visual function is independently related to TIADL performance.

Our results also demonstrate the significant influence of cognitive status in older adults' timed IADL performance. This is consistent with previous studies showing cognitive impairment, even at mild to moderate levels, has a significant impact on the performance of everyday tasks,[13, 18–20] an issue we will address in detail elsewhere (Owsley C, unpublished data). Thus, in future studies using IADL measures as outcomes in studies on visual interventions in older patients, it is imperative that the cognitive capabilities of the subjects being studied be assessed and controlled for in statistical analyses.

Acuity appeared to be independently related to more IADL tasks than either contrast sensitivity or useful field of view. This does not mean that acuity is necessarily a more critical skill in the visual activities of daily living than is contrast sensitivity or useful field of view. Rather, this pattern of results could have simply emerged by the choice of tasks, i.e., tasks that involved detailed vision were heavily represented in the group of tasks selected for study. For example, many of the tasks involved reading small print. Furthermore, mobility tasks were not represented at all among the tasks studied. Mobility performance has been linked to deficits in contrast sensitivity and/or shrinkage in the useful field of view,[32, 42–44] and thus the absence of mobility tasks may have lead to a more minor role for contrast sensitivity and useful field of view in the analyses.

A strength of this study is the inclusion of a wide range of medical/functional variables, in addition to the vision variables, which allowed for the control of confounding influences on TIADL performance when assessing the presence of associations between vision and task performance. Another strength is our focus on the duration to complete a task, rather than an emphasis on accuracy alone. Individuals with moderate, as opposed to severe, vision impairment may be able to successfully perform a task, but may require a longer time than a normally sighted person to complete the task. Our data bear this out. As discussed previously, most subjects had no problem completing the tasks with near-perfect accuracy; however, they required more time. Slow performance could have a number of negative consequences in everyday life, such as reduced feelings of personal competency, increased frustration and embarrassment, inability to complete goals in expected timeframes, and performance problems in the workplace where "time is money." Because of these considerations, therefore, the focus on performance duration has as much face validity as the focus on accuracy, especially for patient populations with moderate vision impairments.

A limitation of our study is that our sample was assembled for the aims of another study,[31, 32] and we took the opportuniry of this ongoing, prospective study to establish an independent link between vision and daily task performance. Our sample consisted of individuals with cataract, those who recently had undergone cataract extraction, and those free from any eye conditions. Thus, the main cause of vision impairment in this sample was cataract. Although cataract is the most common cause of vision impairment in older adults, cataract is only one of several common vision-impairing eye conditions in the elderly. Obviously it would be worthwhile in the future to explore the interrelationships among vision, other medical/functional comorbidities and TIADL performance in persons with these other eye conditions, including those with central scotomas and peripheral field restrictions. However, our purpose here was focused on the preliminary goal of establishing that visual function and TIADL performance were in fact independently linked; thus, for this purpose, a convenience sample was sufficient. Another limitation of our study is that acuity was measured during distance, not near, conditions, despite the fact that most of the tasks were carried out at near distances. Despite this mismatch, significant associations did indeed emerge between acuity and task performance. However, future efforts to examine the role of acuity in the performance of TIADL tasks should allow for a separate assessment of near acuity.

Visual function is obviously 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, such as cognition, hearing, and physical functioning, impact the time needed to perform daily tasks. That many factors influence the time it takes to perform an everyday task is underscored by our finding that vision accounted for a small portion of the TIADL variance. Our purpose in stressing the visual domain in establishing independent associations with TIADL performance sprang from our long-range goal of identifying performance-based outcome measures for use in studies evaluating treatments for eye conditions or rehabilitation strategies to minimize the impact of vision loss. However, we recognize that an equally interesting question is the broader issue of what other ability domains (e.g., vision, motor, hearing, as well as cognitive) contribute to TIADL performance, an issue worthy of further study.

In summary, we have demonstrated that it is possible to identify visual tasks typical of everyday life whose performance is related to visual function in older adults independent of the influences of other medical and functional problems in older adults. Older adults with deficits in visual function were more likely to require more time to complete the tasks. Cognitive status also has a significant influence on timed performance even though the tasks were not particularly complex and were commonplace activities in the course of daily living, indicating that cognitive factors must be taken into account when studying visual performance in the elderly. Our findings suggest that timed IADL tasks may be worth pursuing as outcome measures when evaluating clinical interventions because they incorporate common visual challenges people face everyday.

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