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 90) 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;78:358–359)

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). IADL tasks involve many domains in everyday life including social interactions, financial management, shopping, managing health issues (e.g., medications and doctor’s appointment), 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 Multidimensional Functional Assessment Instrument (MFI), the SF-36, and the OMBR Multidimensional Functional Assessment Questionnaire. Many IADL’s critically depend on vision, and thus it is not surprising that vision impairment in older adults is linked to IADL difficulty. Questionnaires that specifically target visual instrumental activities have grown in number in recent years (e.g., VF-14, AIDS, VAQ, NEI-VFQ, VQOL, and DLTV). 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. 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. For example, healthy, community-dwelling older adults and those with mild cognitive impairment tend to overestimate their functional abilities, whereas depressed older adults tend to underestimate their abilities. A population-based study on visual functions in older adults found that about 10% of individuals have a substantial

disequilibrium between their self-reported reading difficulty and measured reading speed.}

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,\textsuperscript{15} the Observed Tasks of Daily Living,\textsuperscript{16} and the Direct Assessment of Functional Status.\textsuperscript{17} 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 Mobility Assessment,\textsuperscript{18} Duke Progressive Mobility Test,\textsuperscript{19} and Get Up and Go Test);\textsuperscript{20} see also Duncan and Studenski\textsuperscript{21}). 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 IADLs. Tests of reading performance have been developed\textsuperscript{22}--\textsuperscript{28} 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 patients 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. Eben et al.\textsuperscript{29} demonstrated correlation between visual acuity and task performance (e.g., currency discrimination, color recognition, clock reading, and large-type reading). Alexander et al.\textsuperscript{30} developed five everyday tasks (e.g., reading a large-print magazine, telling time using a large- or identifying colored band-aid packets and common household objects, and recognizing facial expressions) and found that accuracy of performance was related to both visual acuity and contrast sensitivity. Fuoco et al.\textsuperscript{31} constructed a battery of tasks focused on reading (Type 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 IADLs. 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 medications management) as described in the IADL literature.\textsuperscript{15} Second, our first focus 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, the time 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 effect on the performance of the tasks. For example, on developing IADL performance tasks has been limited to examining patients with severe vision impairment.\textsuperscript{32,33} Finally, from a practical point of view, we believe that the availability of the tasks will make them useful for future research and will allow them to be used more broadly in clinical settings.

The specific aims of this study were to examine whether tasks of everyday life, 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.

\section*{Methods}

\textbf{Subjects}

The sample consisted of subjects previously enrolled in a prospective study on the Impact of Cataracts on Mobility (ICOM) as described earlier.\textsuperscript{34} Because a long-term goal was to develop a way to measure visual task performance as discussed above, we took the opportunity to examine the test and retest ability of our test batteries on the ICOM sample and to evaluate the relationship between IADL, 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.\textsuperscript{34} 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 cataracts were the primary cause of their vision impairment.

As described previously,\textsuperscript{34} 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\textsuperscript{34} and to have poorer health than those who enrolled.\textsuperscript{34}
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 study was explained, each subject was asked to sign a statement 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. Manifest correction rather than best correction was selected because it was 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. 5, 6 Contrast sensitivity was measured for each eye separately with the Pelli-Robson Contrast Sensitivity Chart (Haug-Street) using the standard protocol with the lesser-by-letter scoring procedure and expressed as log contrast sensitivity. 7, 8 The LEIOW test (Visual Acuity) was used to measure the size of the useful field of view. 9, 10 In this test, subjects are asked to discriminate two briefly presented images in central vision during binocular viewing and also must rapidly locate a peripheral target (up to 30° eccentric from fovea) 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 significant implications for IADL performance. General cognitive status was evaluated by the Mattis Organic Mental Syndrome Screening Examination (MOMSE). 11 which is specifically designed to assess cognitive function in elderly people. This 20-minute test, described in detail in our prior work, 12 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 they are confounding factors in understanding the relationship between timed IADL performance and visual function. General health was assessed by a questionnaire, adapted from earlier work, 13 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). 14 Patients were asked to use a response scale of 0 to 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 reading 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 ongoing printed label from a real pharmacy. For all tasks, the examiner used a digital stop

<table>
<thead>
<tr>
<th>TABLE 1.</th>
<th>Timed IADL tasks with instructions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks</td>
<td>Instructions</td>
</tr>
<tr>
<td>Reading ingredients on a can of food for each of 3 cans</td>
<td>Read the ingredients on this can of food out loud; tell me how many pills you need to take in 1 day (24 h).</td>
</tr>
<tr>
<td>Reading directions on a prescription medicine bottle for each of 3 bottles</td>
<td>Read the directions on this medicine bottle out loud and tell me how many pills you need to take in 1 day (24 h).</td>
</tr>
<tr>
<td>Finding a name and number in telephone book</td>
<td>Find a number that is not your own.</td>
</tr>
<tr>
<td>Reading a newspaper article</td>
<td>What is the weather like today?</td>
</tr>
<tr>
<td>Threading a needle</td>
<td>Find a needle that is sharp.</td>
</tr>
<tr>
<td>Using a seamstress to turn a screw</td>
<td>Use a screwdriver to turn this screw.</td>
</tr>
<tr>
<td>Finding a pair of scissors in a crowded drawer</td>
<td>Find a pair of scissors.</td>
</tr>
<tr>
<td>Finding a flashing light on a crowd of shells</td>
<td>Find a light that is flashing.</td>
</tr>
<tr>
<td>Multiplication of two small numbers (two 2-item add)</td>
<td>Which one of these two objects on the desk is closest to you?</td>
</tr>
<tr>
<td>Inserting a key in a lock and turning it</td>
<td>Put this key in the lock and turn the key.</td>
</tr>
<tr>
<td>Dialing a number on a touch-tone telephone</td>
<td>Dial the number on the telephone.</td>
</tr>
<tr>
<td>Finding a pair of gloves in a laundry basket filled with many dark-colored socks</td>
<td>Find the pair of black socks.</td>
</tr>
<tr>
<td>Finding a pair of handkerchief in a laundry basket filled with many gray-colored socks</td>
<td>Find the pair of blue socks.</td>
</tr>
</tbody>
</table>

[Reference and citation information not shown]
Table 2 provides a summary of the sample characteristics with respect to 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 local 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 (52% of subjects failed). For the other four tasks, specifically locating and reading the ingredients on the three food cards 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 6 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 value.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>70.6</td>
<td>6.55</td>
<td>85.0</td>
<td></td>
</tr>
<tr>
<td>Education (yr)</td>
<td>13</td>
<td>1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Acuity</td>
<td>0.09</td>
<td>0.16</td>
<td>-0.26</td>
<td>0.80</td>
</tr>
<tr>
<td>Contrast sensitivity$^a$</td>
<td>1.47</td>
<td>0.15</td>
<td>0.55</td>
<td>1.90</td>
</tr>
<tr>
<td>Useful field of view$^b$</td>
<td>12.8</td>
<td>12.6</td>
<td>5</td>
<td>80.0</td>
</tr>
<tr>
<td>Cognitive status</td>
<td>4.6</td>
<td>2.9</td>
<td>0.0</td>
<td>18.5</td>
</tr>
<tr>
<td>General health$^c$</td>
<td>6.8</td>
<td>4.9</td>
<td>0.0</td>
<td>25</td>
</tr>
<tr>
<td>Depression$^d$</td>
<td>6.6</td>
<td>8.0</td>
<td>0.0</td>
<td>29</td>
</tr>
</tbody>
</table>

$^a$ LogMAR, better eye.
$^b$ Pelli-Robson score, better eye.
$^c$ Score representing reduction of 30° radius field.
$^d$ MMSE score.
$^e$ Comorbidity score.
$^f$ CES-D score.
for some adjusted not only for age, numerous health problems, education and depression, but also the other visual functions (contrast sensitivity and visual field of view) and cognitive ability. Tables 5 through 8 are the adjusted results for contrast sensitivity, useful field of view, and cognitive status, respectively. All significant results are in the direction of slower timed IADL task performance being associated with impairments in the function being studied.

As shown in Table 4, activity 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). Activity had no adjusted associations with finding the flashlights, inserting a key, and finding the black socks. In fact, finding the black socks was not related to activity even at the unadjusted level. Contrast sensitivity (Table 5) had widespread unadjusted associations with all tasks except for finding the flashlights, inserting the key in the lock, and finding the black socks. Many of these associations remained significant after adjusting for individual variables (middle column); 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 column) were reading medicine bottles (4 and 2), threading a needle, using a screwdriver, judging the distance of two objects, and finding a blue sock.

Useful field of view (Table 6) had strong associations with all tasks except for finding the black or blue socks. Many of these associations remained after adjusting for non-visual variables (middle column); after adjusting for other visual/cognitive variables, four tasks had significant relationships with useful field of view—reading instructions on a can, reading a newspaper article, finding materials in a drawer, and inserting a key in a lock.

To control the association of all three visual function variables (variability, contrast sensitivity, and useful field of view) with TAIADL performance, Table 8 lists the R2 for all three aspects of visual function combined into a single model. Column 4 in Table 8 is the R2 for the adjusted associations between the combined vision variables and each IADL task, column 2 is the R2 when the association is adjusted for other demographics and other medical/familial variables, and column 3 is similar to column 2 except that the associations also adjusted for cognitive status. As was also apparent on Tables 5 through 8, as one moves across the columns, the R2 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 TAIADL task performance.

### TABLE 4.
Percentage of variance in timed ADL tasks accounted for by acuity, with and without adjustments for other variables.  

<table>
<thead>
<tr>
<th>Task</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Comorbidities, Education, and Depression</th>
<th>Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R²</td>
<td>p Value</td>
<td>R²</td>
</tr>
<tr>
<td>Reading can #1</td>
<td>0.062b</td>
<td>&lt;0.0001</td>
<td>0.03b</td>
</tr>
<tr>
<td>Reading can #2</td>
<td>0.094c</td>
<td>&lt;0.0001</td>
<td>0.030b</td>
</tr>
<tr>
<td>Reading can #3</td>
<td>0.038b</td>
<td>&lt;0.0001</td>
<td>0.023b</td>
</tr>
<tr>
<td>Reading medicine bottle #1</td>
<td>0.120b</td>
<td>&lt;0.0001</td>
<td>0.069b</td>
</tr>
<tr>
<td>Reading medicine bottle #2</td>
<td>0.130d</td>
<td>&lt;0.0001</td>
<td>0.027b</td>
</tr>
<tr>
<td>Reading medicine bottle #3</td>
<td>0.035b</td>
<td>&lt;0.0001</td>
<td>0.027a</td>
</tr>
<tr>
<td>Finding phone number</td>
<td>0.649c</td>
<td>&lt;0.0001</td>
<td>0.019b</td>
</tr>
<tr>
<td>Reading newspaper</td>
<td>0.890d</td>
<td>&lt;0.0001</td>
<td>0.052b</td>
</tr>
<tr>
<td>Threading needle</td>
<td>0.031c</td>
<td>&lt;0.0001</td>
<td>0.021b</td>
</tr>
<tr>
<td>Finding scissors in drawer</td>
<td>0.069c</td>
<td>&lt;0.0001</td>
<td>0.045b</td>
</tr>
<tr>
<td>Finding flashlight on shelf</td>
<td>0.0113</td>
<td>0.0013</td>
<td>0.066</td>
</tr>
<tr>
<td>Judging closer of 2 objects</td>
<td>0.130c</td>
<td>&lt;0.0001</td>
<td>0.04b</td>
</tr>
<tr>
<td>Inserting key in lock</td>
<td>0.024c</td>
<td>0.0013</td>
<td>0.711</td>
</tr>
<tr>
<td>Dulling phone number</td>
<td>0.105c</td>
<td>&lt;0.0001</td>
<td>0.030c</td>
</tr>
<tr>
<td>Finding black sock</td>
<td>0.008</td>
<td>0.1102</td>
<td>0.001</td>
</tr>
<tr>
<td>Finding blue sock</td>
<td>0.030c</td>
<td>0.0015</td>
<td>0.014c</td>
</tr>
</tbody>
</table>

*Models were based on those subjects who completed each task successfully.  
*<i>p < 0.05</i> (two-tailed).

### TABLE 5.
Percentage of variance in timed ADL tasks accounted for by contrast sensitivity, with and without adjustments for other variables.  

<table>
<thead>
<tr>
<th>Task</th>
<th>Unadjusted</th>
<th>Adjusted for Age, Comorbidities, Education, and Depression</th>
<th>Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R²</td>
<td>p Value</td>
<td>R²</td>
</tr>
<tr>
<td>Reading can #1</td>
<td>0.64a</td>
<td>0.0002</td>
<td>0.013c</td>
</tr>
<tr>
<td>Reading can #2</td>
<td>0.066c</td>
<td>0.0001</td>
<td>0.017a</td>
</tr>
<tr>
<td>Reading can #3</td>
<td>0.045b</td>
<td>0.0002</td>
<td>0.011</td>
</tr>
<tr>
<td>Reading medicine bottle #1</td>
<td>0.156c</td>
<td>&lt;0.0001</td>
<td>0.096b</td>
</tr>
<tr>
<td>Reading medicine bottle #2</td>
<td>0.147c</td>
<td>&lt;0.0001</td>
<td>0.080b</td>
</tr>
<tr>
<td>Reading medicine bottle #3</td>
<td>0.017d</td>
<td>0.0004</td>
<td>0.010</td>
</tr>
<tr>
<td>Finding phone number</td>
<td>0.027c</td>
<td>0.0024</td>
<td>0.035</td>
</tr>
<tr>
<td>Reading newspaper</td>
<td>0.031b</td>
<td>&lt;0.0001</td>
<td>0.019b</td>
</tr>
<tr>
<td>Threading needle</td>
<td>0.038b</td>
<td>&lt;0.0001</td>
<td>0.044b</td>
</tr>
<tr>
<td>Finding scissors in drawer</td>
<td>0.126d</td>
<td>&lt;0.0001</td>
<td>0.074b</td>
</tr>
<tr>
<td>Finding flashlight on shelf</td>
<td>0.030c</td>
<td>0.0015</td>
<td>0.015b</td>
</tr>
<tr>
<td>Judging closer of 2 objects</td>
<td>0.090c</td>
<td>&lt;0.0001</td>
<td>0.045b</td>
</tr>
<tr>
<td>Inserting key in lock</td>
<td>0.008</td>
<td>0.0093</td>
<td>0.001</td>
</tr>
<tr>
<td>Dulling phone number</td>
<td>0.086b</td>
<td>&lt;0.0001</td>
<td>0.030b</td>
</tr>
<tr>
<td>Finding black sock</td>
<td>0.010</td>
<td>0.0622</td>
<td>0.002</td>
</tr>
<tr>
<td>Finding blue sock</td>
<td>0.046b</td>
<td>&lt;0.0001</td>
<td>0.021b</td>
</tr>
</tbody>
</table>

*Models were based on those subjects who completed each task successfully.  
*<i>p < 0.05</i> (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.\(^a\)

<table>
<thead>
<tr>
<th>Task</th>
<th>Unadjusted R(^2)</th>
<th>p Value</th>
<th>Adjusted for Age, Comorbidities, Education, and Depression R(^2)</th>
<th>p Value</th>
<th>Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Function R(^2)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading card #1</td>
<td>0.063(^b)</td>
<td>&lt;0.0001</td>
<td>0.028</td>
<td>0.0076</td>
<td>0.015(^c)</td>
<td>0.023</td>
</tr>
<tr>
<td>Reading card #2</td>
<td>0.053(^b)</td>
<td>0.014</td>
<td>0.001</td>
<td>0.0047</td>
<td>0.006</td>
<td>0.0271</td>
</tr>
<tr>
<td>Reading card #3</td>
<td>0.046(^b)</td>
<td>0.002</td>
<td>0.003</td>
<td>0.0792</td>
<td>0.001</td>
<td>0.0706</td>
</tr>
<tr>
<td>Reading medicine bottle #1</td>
<td>0.060(^b)</td>
<td>&lt;0.0001</td>
<td>0.043</td>
<td>0.0001</td>
<td>0.0112</td>
<td>0.0547</td>
</tr>
<tr>
<td>Reading medicine bottle #2</td>
<td>0.056(^b)</td>
<td>&lt;0.0001</td>
<td>0.014</td>
<td>0.0339</td>
<td>0.0001</td>
<td>0.0610</td>
</tr>
<tr>
<td>Reading medicine bottle #3</td>
<td>0.038(^b)</td>
<td>&lt;0.0001</td>
<td>0.001</td>
<td>0.0613</td>
<td>&lt;0.001</td>
<td>0.0976</td>
</tr>
<tr>
<td>Finding phone number</td>
<td>0.060(^b)</td>
<td>&lt;0.0001</td>
<td>0.014</td>
<td>0.0007</td>
<td>0.009</td>
<td>0.0864</td>
</tr>
<tr>
<td>Reading newspaper</td>
<td>0.059(^b)</td>
<td>&lt;0.0001</td>
<td>0.019</td>
<td>0.0005</td>
<td>0.017(^b)</td>
<td>0.0251</td>
</tr>
<tr>
<td>#Reading needle</td>
<td>0.014(^b)</td>
<td>0.006</td>
<td>0.006</td>
<td>0.148</td>
<td>0.001</td>
<td>0.0622</td>
</tr>
<tr>
<td>Using screwdriver</td>
<td>0.045(^b)</td>
<td>0.001</td>
<td>0.010</td>
<td>0.0709</td>
<td>0.004</td>
<td>0.2531</td>
</tr>
<tr>
<td>Finding scissors in drawer</td>
<td>0.026(^b)</td>
<td>0.001</td>
<td>0.023</td>
<td>0.0046</td>
<td>0.015(^b)</td>
<td>0.0232</td>
</tr>
<tr>
<td>Finding flashlight on shelf</td>
<td>0.030(^b)</td>
<td>0.0013</td>
<td>0.059</td>
<td>0.0122</td>
<td>0.008</td>
<td>0.1113</td>
</tr>
<tr>
<td>Judging closer of 2 objects</td>
<td>0.026(^b)</td>
<td>0.0027</td>
<td>0.002</td>
<td>0.320</td>
<td>&lt;0.001</td>
<td>0.09628</td>
</tr>
<tr>
<td>Inserting key in lock</td>
<td>0.058(^b)</td>
<td>&lt;0.0001</td>
<td>0.018</td>
<td>0.0001</td>
<td>0.014(^b)</td>
<td>0.0807</td>
</tr>
<tr>
<td>Dialing phone number</td>
<td>0.057(^b)</td>
<td>&lt;0.0001</td>
<td>0.002</td>
<td>0.0062</td>
<td>0.002</td>
<td>0.4628</td>
</tr>
<tr>
<td>Finding black sock</td>
<td>0.002</td>
<td>0.4955</td>
<td>0.002</td>
<td>0.4734</td>
<td>0.002</td>
<td>0.4257</td>
</tr>
<tr>
<td>Tinding blue sock</td>
<td>0.002</td>
<td>0.3240</td>
<td>0.001</td>
<td>0.5395</td>
<td>0.006</td>
<td>0.4480</td>
</tr>
</tbody>
</table>

\(^{a}\) 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.\(^a\)

<table>
<thead>
<tr>
<th>Task</th>
<th>Unadjusted R(^2)</th>
<th>p Value</th>
<th>Adjusted for Age, Comorbidities, Education, and Depression R(^2)</th>
<th>p Value</th>
<th>Adjusted for Age, Comorbidities, Education, Depression, and Other Visual/Cognitive Function R(^2)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading card #1</td>
<td>0.090(^b)</td>
<td>&lt;0.0001</td>
<td>0.034(^b)</td>
<td>0.0012</td>
<td>0.017(^b)</td>
<td>0.0223</td>
</tr>
<tr>
<td>Reading card #2</td>
<td>0.135(^b)</td>
<td>&lt;0.0001</td>
<td>0.113(^b)</td>
<td>&lt;0.0001</td>
<td>0.111(^b)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Reading card #3</td>
<td>0.116(^b)</td>
<td>&lt;0.0001</td>
<td>0.063(^b)</td>
<td>&lt;0.0001</td>
<td>0.051(^b)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Reading medicine bottle #1</td>
<td>0.109(^b)</td>
<td>&lt;0.0001</td>
<td>0.203(^b)</td>
<td>&lt;0.0001</td>
<td>0.075(^b)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Reading medicine bottle #2</td>
<td>0.142(^b)</td>
<td>&lt;0.0001</td>
<td>0.192(^b)</td>
<td>&lt;0.0001</td>
<td>0.054(^b)</td>
<td>&lt;0.0000</td>
</tr>
<tr>
<td>Reading medicine bottle #3</td>
<td>0.167(^b)</td>
<td>&lt;0.0001</td>
<td>0.193(^b)</td>
<td>&lt;0.0001</td>
<td>0.104(^b)</td>
<td>&lt;0.0000</td>
</tr>
<tr>
<td>Finding phone number</td>
<td>0.254(^b)</td>
<td>&lt;0.0001</td>
<td>0.141(^b)</td>
<td>&lt;0.0001</td>
<td>0.115(^b)</td>
<td>&lt;0.0000</td>
</tr>
<tr>
<td>Reading newspaper</td>
<td>0.175(^b)</td>
<td>&lt;0.0001</td>
<td>0.064(^b)</td>
<td>&lt;0.0001</td>
<td>0.041(^b)</td>
<td>&lt;0.0000</td>
</tr>
<tr>
<td>#Reading needle</td>
<td>0.127(^b)</td>
<td>0.004</td>
<td>0.022(^b)</td>
<td>0.0072</td>
<td>0.013</td>
<td>0.0751</td>
</tr>
<tr>
<td>Using screwdriver</td>
<td>0.055(^b)</td>
<td>0.0215</td>
<td>0.001</td>
<td>0.3739</td>
<td>&lt;0.003</td>
<td>0.0823</td>
</tr>
<tr>
<td>Finding scissors in drawer</td>
<td>0.012(^b)</td>
<td>0.0411</td>
<td>0.013(^b)</td>
<td>0.0347</td>
<td>0.004</td>
<td>0.2784</td>
</tr>
<tr>
<td>Finding flashlight on shelf</td>
<td>0.024(^b)</td>
<td>0.0144</td>
<td>0.026(^b)</td>
<td>0.0029</td>
<td>0.016(^b)</td>
<td>0.0235</td>
</tr>
<tr>
<td>Judging closer of 2 objects</td>
<td>0.026(^b)</td>
<td>0.0027</td>
<td>0.027</td>
<td>0.1369</td>
<td>0.002</td>
<td>0.3800</td>
</tr>
<tr>
<td>Inserting key in lock</td>
<td>0.010(^b)</td>
<td>0.0469</td>
<td>0.008</td>
<td>0.1093</td>
<td>0.001</td>
<td>0.5506</td>
</tr>
<tr>
<td>Dialing phone number</td>
<td>0.213(^b)</td>
<td>&lt;0.0001</td>
<td>0.131(^b)</td>
<td>&lt;0.0001</td>
<td>0.106(^b)</td>
<td>&lt;0.0000</td>
</tr>
<tr>
<td>Finding black sock</td>
<td>0.005</td>
<td>0.2039</td>
<td>0.001</td>
<td>0.8538</td>
<td>&lt;0.001</td>
<td>0.9450</td>
</tr>
<tr>
<td>Tinding blue sock</td>
<td>0.049(^b)</td>
<td>0.0112</td>
<td>0.011</td>
<td>0.0528</td>
<td>0.013</td>
<td>0.0543</td>
</tr>
</tbody>
</table>

\(^{a}\) Models were based on those subjects who completed each task successfully.
\(^{b}\) p < 0.05 (two-tailed).

Optometry and Visual Science, Vol. 78, No. 5, May 2001
TABLE B. 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.*

<table>
<thead>
<tr>
<th>Task</th>
<th>Unadjusted (R²)</th>
<th>Adjusted for Age, Comorbidities, Education, and Depression (R²)</th>
<th>Adjusted for Age, Comorbidities, Education, Depression, and Cognitive Status (R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading, cut #1</td>
<td>0.060</td>
<td>0.047</td>
<td>0.033</td>
</tr>
<tr>
<td>Reading, cut #2</td>
<td>0.081</td>
<td>0.027</td>
<td>0.018</td>
</tr>
<tr>
<td>Reeding, cut #3</td>
<td>0.061</td>
<td>0.026</td>
<td>0.016</td>
</tr>
<tr>
<td>Reading medicine bottle #1</td>
<td>0.135</td>
<td>0.108</td>
<td>0.084</td>
</tr>
<tr>
<td>Reading medicine bottle #2</td>
<td>0.119</td>
<td>0.082</td>
<td>0.071</td>
</tr>
<tr>
<td>Reading medicine bottle #3</td>
<td>0.048</td>
<td>0.027</td>
<td>0.015</td>
</tr>
<tr>
<td>Finding phone number</td>
<td>0.064</td>
<td>0.048</td>
<td>0.021</td>
</tr>
<tr>
<td>Reading newspaper</td>
<td>0.089</td>
<td>0.076</td>
<td>0.058</td>
</tr>
<tr>
<td>Threading needle</td>
<td>0.041</td>
<td>0.042</td>
<td>0.036</td>
</tr>
<tr>
<td>Using screwdriver</td>
<td>0.091</td>
<td>0.064</td>
<td>0.064</td>
</tr>
<tr>
<td>Finding scissors in drawer</td>
<td>0.030</td>
<td>0.038</td>
<td>0.031</td>
</tr>
<tr>
<td>Finding flashlight on shelf</td>
<td>0.027</td>
<td>0.023</td>
<td>0.015</td>
</tr>
<tr>
<td>Bridging closer of 2 objects</td>
<td>0.089</td>
<td>0.065</td>
<td>0.062</td>
</tr>
<tr>
<td>Inserting key in lock</td>
<td>0.059</td>
<td>0.056</td>
<td>0.050</td>
</tr>
<tr>
<td>Dialing phone number</td>
<td>0.096</td>
<td>0.054</td>
<td>0.033</td>
</tr>
<tr>
<td>Finding black sock</td>
<td>0.006</td>
<td>0.004</td>
<td>0.004</td>
</tr>
<tr>
<td>Filling blue sack</td>
<td>0.031</td>
<td>0.026</td>
<td>0.025</td>
</tr>
</tbody>
</table>

*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 issues 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.11,12 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 studies5,13–15 did not partial out the contributions of these coexisting influences when examining the impact of visual impairment on task performance. Therefore, our results are a critical step toward determining the potential of IADL 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 judging moderately visually impaired than it accuracy because the vast majority of subjects performed the tasks accurately or within minor errors. Although a great deal of psychometric work remains to determine the validity, reliability, and responsiveness of IADL measures, our findings clearly indicate that visual function is independently related to IADL 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.15,19,20 In view, we will address in detail elsewhere (Doherty C., unpublished data). "Eyes 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 necessary or 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,32,45–51 and thus the absence of mobility tasks may have led 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 IADL performance when assessing the presence of associations between vision and task performance. Another strength is our focus on the duration is complete a task, rather than an emphasis on accuracy alone. Individuals with stroke, 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 is expected to increase, and performance problems in the workplace where "time is money." Because of these considerations, therefore, the focus on performance duration has much face validity as the focus on accuracy, especially for pattern recognition with moderate visual impairments.

A limitation of our study is that our sample was assembled for the arms of another study. Thus, and we took the opportunity of this ongoing prospective study to establish an independent link between vision and daily task performance. Our sample consisted of indi-viduals with cataract, those who severely had undergone cata- ract extraction and those free from any eye conditions. Thus, the major cause of vision impairment in this sample was cataract.

Although cataract is the most common cause of vision impairment in older adults, it is not only one of several common vision-impaired eye conditions in the elderly. Obviously it would be worth while in the future to explore the interrelationships among vision, other medical/functional comorbidities and TIAAD performance in persons with these other eye conditions, including those with central conusus and peripheral field restrictions. However, our sample here was focused on the primary goal of establishing a relationship between visual function and TIAAD performance; we were in fact independently linked thus, for this purpose, a convenience sample was sufficient. Another limitation of our study is that acuity was mea- sured during distance, near areas, conditions, despite the fact that most of the tasks were carried out at near distances. Despite this and other limitations, significant information did emerge between accuracy and task performance. However, future efforts to examine the role of acuity in the performance of TIAAD 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 an important in that it, other functional abilities, such as cognition, hearing, and physical func-tioning, 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 pos-siton of the TIAAD variance. Our purport in stressing the visual domain in establishing independent associations with TIAAD per-formance sprang from our long-range goal of identifying perform ance-based outcome measures for use in studies evaluating treat-ments for eye conditions or rehabilitation strategies to minimize the impact of visual loss. However, we recognize that an equally important question is the broader issue of what other ability de-mands (e.g., vision, motor, hearing, as well as cognitive) contribute to TIAAD performance, an issue worth of further study. In summary, we have demonstrated that it is possible to identify visual skills typical of everyday life whose performance is affected by visual function in older adults independent of the influences of other medical and functional problems in older adults. Older adult with deficits in visual function were more likely to require more time to complete the tasks. Cognitive status also has a signifi- cant 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 should be taken into account when studying visual performance in the el-derly. Our findings, suggest that timed TIAAD tasks may be worth pursuing as outcome measures when evaluating clinical interven-tions because they incorporate common visual challenges people face everyday.

Acknowledgments
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