

# Near-Vision Acuity Levels and Performance on Neuropsychological Assessments Used in Occupational Therapy

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## KEY WORDS

- aging
- cognition
- mental process
- neuropsychological tests
- vision, low
- visual acuity

We investigated how induced blur affects performance on the Trail Making Test and Digit Symbol Test routinely used in occupational therapy cognitive evaluations. The study used a factorial design with both age (young and old adults) and simulated blur levels of near visual acuity (20/50 and 20/100) manipulated between participants. A sample of 124 healthy, community-living adults was used in the final analysis. Significant differences ( $p < .05$ ) were found in performance for young participants between 20/50 and 20/100 blur level as well as between 20/20 and 20/100 blur level for the Digit Symbol Test. Scores for old participants decreased as a function of blur but were not significant. This study illustrates that cognitive evaluations used throughout the lifespan may require the appropriate visual acuity level to maximize performance. Occupational therapists' understanding of client factors and their effect on performance is fundamental to the client evaluation process.

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Assessments of psychometric intelligence and cognition may include measurements of orientation, memory, attention, language skills, and spatial abilities. The use of these tests may assist in determining abilities in everyday activities, deciding a diagnosis, or understanding the effects of medication. Sometimes these assessments provide clues that may determine whether an individual can safely and independently participate in an activity (e.g., driving, working, cooking, managing finances) or whether some assistance is warranted. In addition, neuropsychologists and cognitive scientists may ask whether intellectual performance changes with advancing age; scientists may explore the staging of a disease such as Alzheimer's disease by assessing people with psychometric tests. Thus, a wide variety of investigators may rely on the same psychometric intelligence and cognitive assessments that health care professionals use.

The prevalence of visual impairment increases significantly in older adults; cataracts, macular degeneration, and glaucoma are the leading causes of visual impairment (Podgor, Leske, & Ederer, 1983; Quigley & Vitale, 1997; Rubin, Roche, Prasad-Rao, & Fried, 1994). However, even in the absence of ocular disease, normal, age-related changes in visual function may affect performance on cognitive assessments. With age, the lens becomes yellow and less transparent (Klein, Klein, & Linton, 1992), the pupil becomes smaller and loses its ability to dilate in reduced illumination (Winn, Whitaker, Elliott, & Phillips, 1994), changes in the lens and capsule affect accommodation (Heron, Charman, & Gray, 1999), and neural pathways may be altered (Ahmad & Spear, 1993; Bassi & Lehmkuhle, 1990). These changes lead to decreased contrast sensitivity (Owsley, Sekuler, & Siemsen,

1983), reduced visual acuity caused by presbyopia (Weale, 1999), and decreased visual processing speed (Sekuler & Ball, 1986). However, review of the literature shows that neither researchers nor most clinicians assess visual performance before administering cognitive assessments. The assessment of higher cortical function requires accurate psychometric testing. Many of the tests currently used by clinicians and psychometrists rely on intact vision to accomplish this purpose. Cortical function tests are commonly used in clinical and research settings to formulate conclusions about the mental status of older adults. The validity and accuracy of these tests are inherently dependent on adequate function of the precortical visual system. People having visually significant eye pathology or refractive error will receive distorted visual input, altering test conditions and potentially biasing test results. Bullimore, Bailey, and Wacker (1991) demonstrated this effect when finding that participants with advanced age-related macular degeneration could not recognize photographed faces as well as normal participants until the photograph subtended a visual angle much greater than that necessary for accurate performance by normal participants. Bertone, Bettinelli, and Faubert (2007) found that a visual acuity of 20/40 can have a significant effect on the performance of certain nonverbal tests. Warren (1993a, 1993b) proposed a framework, the Hierarchical Model, to be used for perceptual evaluations. This model emphasizes the importance of evaluating a client's visual acuity before perceptual assessments. Clearly, occupational therapists must consider preexisting impairments, such as impaired visual acuity, which may negatively affect a client's performance on assessment outcomes.

The current study built on this model and aimed to examine the following hypotheses:

1. Impaired visual acuity negatively affects performance on specific neuropsychological tests.
2. Young and old participants are affected differentially by impaired visual acuity.

## Method

### *Research Design*

The study used a factorial design with both age (young and old adults) and simulated blur levels of near visual acuity (20/50 and 20/100) manipulated between participants. A between-subjects measures design was used; a within-subjects design could not be used because the outcome measures (Trail Making Test and Digit Symbol Test) may have practice effects when given repeatedly at a single point in time. A sample of 124 healthy, community-living adults was used in the final analysis. This study was approved by the institu-

tional review boards of Maryville University, University of Missouri–St. Louis, and Washington University. All participants provided informed consent.

### *Participants*

The study was performed with 90 young adults (ages 19 to 30 years), all of whom were Maryville University students recruited from the occupational therapy and physical therapy programs through flyers and announcements in courses, and 36 older adults (ages  $\geq 65$  years) who were university staff and faculty members (recruited from flyers) or who were recruited by phone from the Washington University Psychology Department's Aging and Development Project, which targeted healthy older adults. Written informed consent was obtained from each participant after the nature and purpose of the study had been fully explained, with the option to withdraw from the study at any time.

All participants were in good ocular health (participant report) and had near-vision acuity of 20/30 or better (screened during data collection). None of the participants had physical limitations; all were screened for cognitive deficits using the Short Blessed Test (Katzman et al., 1983). The Short Blessed Test assesses memory, sequencing, and orientation through interview. Physical limitations and cognitive impairments were exclusion criteria. Data were collected by Linda A. Hunt.

Both age groups, young adults and older adults, had a control condition (20/30 or better visual acuity) and two experimental groups (20/50 and 20/100 visual acuity). These visual acuity levels were selected because of their functional implications. At 20/50, licensing agencies in some states may begin to place restrictions on drivers (e.g., no nighttime driving or no driving past 45 miles per hour). In addition, visual acuity below the level of 20/40 may be considered cause for referral. At 20/100, people may have functional limitations in activities of daily living. At this level of reduced near visual acuity, people may demonstrate lack of interest in reading, difficulty with writing tasks, squinting, and avoidance of visual tasks. An attempt was made to have a third experimental blur group consisting of 20/200 visual acuity. When the degradations were produced on the outcome measures, the blurred tests were impossible to read.

### *Simulations*

Three simulations of visual impairment—20/50, 20/100, and 20/200—were used with a baseline condition of 20/20. These three conditions were made for the following neuropsychological tests: Digit Symbol Test (DS; Wechsler, 1997) and Trail Making Test (TMT) Parts A and B (Reitan, 1992; see Figure 1). Each assessment was scanned onto a disk by a

color scanner with a true optical resolution of 2,400 × 1,200 pixel resolution (ppi). The scanned images were modified by a software program (Adobe Photoshop, Version 5.5, Adobe Systems, Inc.). Blur was used to match the visual acuities identified (20/50, 20/100, and 20/200) by blurring the acuity line from the Sloan Letters Chart (Good-Lite Co., Forest Park, IL) for each experimental condition. To ensure the validity and reliability of the levels of blur, 6 people masked to the purpose of the study were asked to read the chart at the blurred levels (20/50, 20/100, and 20/200) on the computer screen to establish thresholds. From these data, which established thresholds for each stimulus type under each of the three vision conditions, the final conditions for blur were determined. For example, in the 20/50 condition, the participant looked at the visual acuity chart on the computer screen, which had been blurred so that the line for 20/50 was readable for 3 of 5 letters, but the line for 20/40 was not readable. Participants were positioned as prescribed by the chart's criteria so that the chart was read at a right angle to the line of vision, at 16 in. viewing distance. For 20/50, blur was established at a level of 4.0 pixels (i.e., the letter was blurred to a depth of 4 pixels around the edges); for 20/100, blur was established at 7.5 pixels; and for 20/200, blur was established at 15 pixels. Copies of DS and TMT A and B were blurred to levels of 4.0, 7.5, and 15 pixels, respectively, and then scanned onto a high-resolution printer on white Xerox paper, with an 84 brightness level. Each testing sheet was printed rather than copied to ensure that the contrast

remained constant across participants tested. Font size was measured at 20 points for the DS and 28 points for TMT Parts A and B, which matches the original test copies. These procedures contributed to this study's validity because they allowed the assessments to be administered to participants as they normally would be, as paper-and-pencil tasks. Moreover, these procedures allow this study to be easily replicated.

For the younger adults, each blur condition had 30 participants ( $n = 90$ ) and for the older adults, each condition had 12 participants—except for the control group, which had 10 participants because participants failed to meet inclusion criterion ( $n = 34$ ). An effort was made to recruit equal numbers of men and women for each experimental group.

### Role of Participants

All groups completed paper-and-pencil and visual construction tasks for standardized assessments with best visual acuity, corrected or uncorrected (20/20 to 20/30). Participants used their own habitual correction either in the form of glasses or contact lenses. Participants were randomly selected for each group (control, 20/50, 20/100, or 20/200). Younger adults completed the research protocol in approximately 30 min, whereas older adults required up to 60 min. The same lighting conditions were used for establishing the testing materials and for giving the assessments to participants as established by a light meter. All data collection occurred at one location.

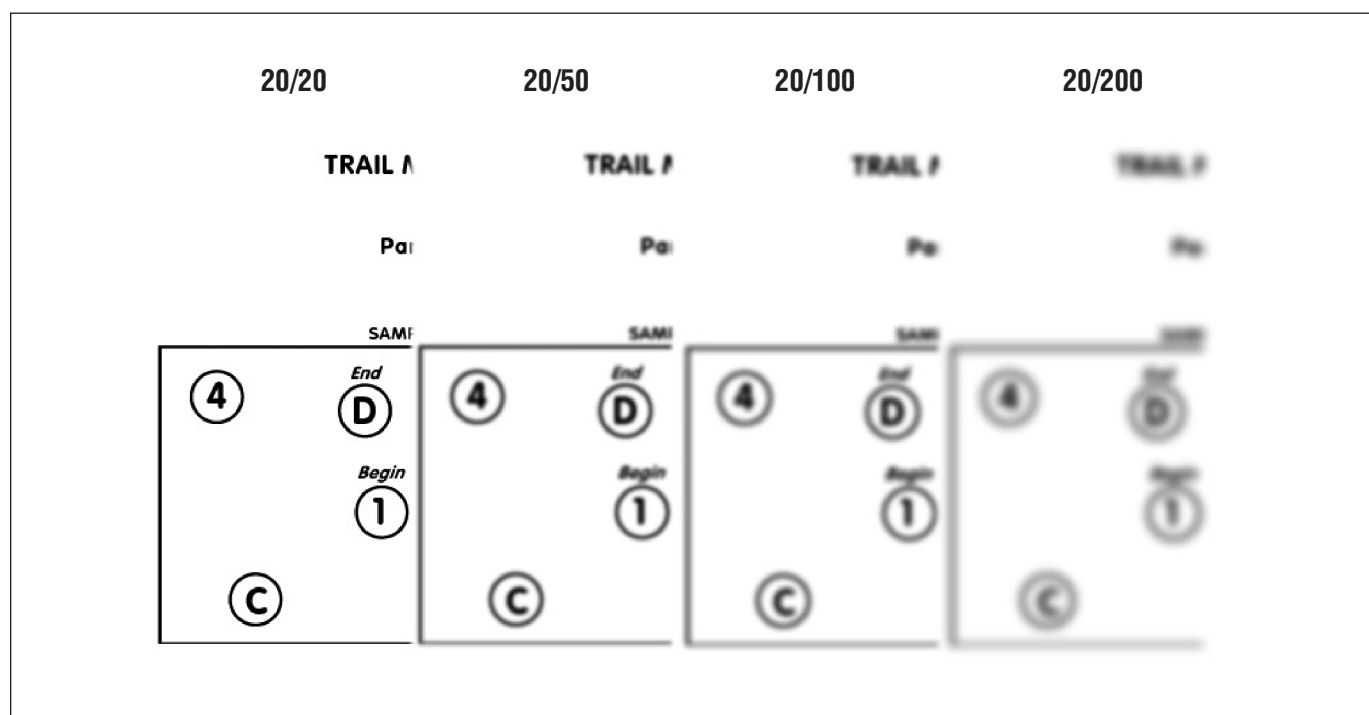


Figure 1. Blurred conditions Trail Making Test B by visual acuity level.

## Visual Battery

The vision tests were administered in the order in which they are listed in the following sections. All were performed with binocular vision in the same room location.

**High-Contrast Near Visual Acuity.** Participants were instructed to hold the Sloan Letters for 40 cm Chart at right angles to the line of vision at a distance of 40 cm. Participants were instructed to read the letters to the left of the 20/20 mark. If participants missed more than two, they were then asked to read the line above and so forth until the line was read with a minimum of two incorrect responses. The chart was evenly illuminated at all times at 617 lux.

**Pupil Size.** Pupil size was assessed using the Rosenbaum Pocket Vision Screener (Colvard, 1998). Participants were requested to face the investigator. The investigator then held the screener up to the participant's face to measure pupil size by the examples provided, measured in millimeters.

**Contrast Sensitivity.** Contrast sensitivity was determined using the Pelli–Robson Chart (Elliott, Sanderson, & Conkey, 1990; Pelli, Robson, & Wilkins, 1988). Participants were required to identify the letters and continue until two or more errors were made in a group. Nil responses were not permitted, and participants were encouraged to guess because scoring depended on a forced-choice paradigm. Letter contrast sensitivity was determined in which each letter counted as 0.05 log units. The Vistech VCTS6500 Contrast Sensitivity Wall Chart (Ginsburg, 1984) was also used to measure spatial contrast sensitivity. The chart was wall mounted so that mean background luminance fell into the prescribed range of 100 to 240 candela per square meter (cd/m<sup>2</sup>) detected by a light meter that accompanied the test (actual value = 401 lux). Each circular test patch subtended a visual angle of 1.4° at the viewing distance of 3 m. The Vistech system uses a four-choice alternative procedure to assess contrast sensitivity at 1.5, 3, 6, 12, and 18 cd.

Spatial frequencies were tested in an ascending order. Starting with the lowest spatial frequency at the top of the chart, contrast decreased from left to right across eight sine-wave grating patches; the ninth and final patch for each row was blank. Each horizontal row is titled so that the lowest frequency at the top of the chart is called CSA, followed by CSB, CSC, CSD, and CSE, which is the highest spatial frequency (range of spatial frequencies = 1.5, 3, 6, 12, and 18 cd gradings, respectively). Before testing, participants were first shown examples across the bottom of the chart of the three possible orientations (tilted left, vertical, and tilted right) and a blank patch. The participants were instructed to read across each row and to report the orientation of each patch. If the participant reported that the patch was blank,

he or she was encouraged to guess at the orientation of the stripes. The contrast of the last patch for which orientation was correctly reported was used as the threshold contrast for that frequency.

## Cognitive Assessments Used

The assessments used for this study were the TMT (available from Reitan Neuropsychology Laboratory, South Tucson, AZ) and a subtest of the Wechsler, the DS Adult Intelligence Scale (Psychological Corporation, San Antonio, TX). These tests were chosen because they require the characteristics of fine detail that require near visual acuity skills, and they are commonly used in geriatric clinics to screen for cognitive problems. Published standard procedures were followed for TMT and DS. It was not feasible to evaluate participants under the 20/200 visual acuity condition. Participants made numerous mistakes or simply could not decipher the numbers and letters at all and became extremely frustrated with the test. Therefore, this blur condition was dropped after it was piloted on 10 participants (see Table 1 for demographics).

## Data Analysis

Statistica 2000 (Version 5.5; StatSoft, Inc., Tulsa, OK) was used to analyze the data. The control group and the experimental groups were analyzed for group differences through analysis of covariance (ANCOVA). A 2 × 2 ANCOVA was used to analyze the effects of two levels of blur in two age groups with visual acuity, pupil size, and contrast sensitivity (Pelli–Robson Chart and the Vistech VCTS6500) used as covariates in the analyses to control for the intergroup differences on the variables studied. These differences include a range of near visual acuity of 20/20 to 20/30 and differences noted in pupil size. A separate analysis was conducted on each performance measure measuring the main effects of age and blur level. All significant effects reported here were evaluated at the  $\alpha = .05$  level. Where there were interactions, ad hoc tests were performed using Tukey's Protected (Portnoy & Watkins, 1993) *t* tests ( $p < .05$ ). Correlations were performed on blur and performance using Pearson *r* for the DS ( $p < .001$ ).

## Results

The testing condition of 20/200 was later excluded from the study because participants ( $n = 10$ ) could not read the letters on the DS and TMT. The DS was completely illegible. The investigator had to cue participants to identify the letters and numbers printed on the TMT, which deviated from standard assessment instructions. In addition, the cueing

**Table 1. Demographic Data: Means (*M*s) and Standard Deviations (*SD*s)**

	Men/Women ( <i>n</i> )	Age		SBE		Pupil Size		PR	
		<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )	<i>M</i>	( <i>SD</i> )
Younger adults									
Control participants ( <i>n</i> = 30); 20/20 to 20/30	6/24	22.43	(2.37)	0.33	(0.922)	3.17	(0.556)	1.89	(0.092)
Group 1 ( <i>n</i> = 30); 20/50	5/25	22.40	(3.62)	0.47	(1.250)	3.73	(0.583)	1.94	(0.038)
Group 2 ( <i>n</i> = 30); 20/100	8/22	22.70	(3.53)	0.73	(1.220)	3.46	(0.681)	1.95	(0.109)
All groups ( <i>n</i> = 90)	19/71	22.51	(3.19)	0.51	(1.144)	3.61	(0.612)	1.91	(0.086)
Older adults									
Control participants ( <i>n</i> = 10); 20/20 to 20/30	2/8	73.50	(5.30)	1.00	(1.410)	2.90	(0.567)	1.62*	(0.209)
Group 1 ( <i>n</i> = 12); 20/50	4/8	70.41	(6.05)	1.00	(1.590)	2.91	(0.288)	1.76	(0.113)
Group 2 ( <i>n</i> = 12); 20/100	5/7	71.41	(2.96)	0.17	(0.577)	2.33*	(0.651)	1.77	(0.125)
All groups ( <i>n</i> = 34)	11/23	71.67	(4.96)	0.71	(1.290)	2.70	(0.578)	1.72	(0.162)

Note. SBE = Short Blessed Exam, PR = Pelli–Robson Chart.

\* $p < .05$ .

distracted participants while they were attempting to complete the tests.

The means and standard deviations of various demographic and vision variables (age, score on Short Blessed Test, pupil size, and contrast sensitivity measured by the Pelli–Robson Chart) as well as the final sample size are presented in Table 1. In the final analysis, 2 participants from the control group of the older participants were released from the study because of a Short Blessed Test score of 8, which may indicate cognitive impairment, an exclusion criteria variable. The Short Blessed Test mean score for all older adults ( $n = 34$ ) was .705, where the test ranges from 0 to 28, with a score of 0 indicating no impairment. In the young adult group, there were no significant differences among the experimental blur groups for age, Short Blessed Test score, pupil size, contrast sensitivity, visual acuity, or gender. In the older adult group, there were significant differences ( $p < .05$ ) for pupil size in the 20/100 experimental group and for contrast sensitivity (Pelli–Robson Chart) for the control group compared with other older participant blur groups. No other significant differences were found among the older adult experimental groups for descriptive data collected.

In the final analysis, pupil size and contrast sensitivity were excluded as an effect on cognitive performance for all participants. Contrast sensitivity (high spatial frequency ranges) declines with decreasing visual acuity, and older people are known to have impairments in the high spatial frequency ranges (Owsley et al., 1983). The results for older adults in the current study showed a trend in this direction using the Vistech VCTS6500 Contrast Sensitivity Wall Chart, although only 34 participants were tested.

In general, the older participants performed slower than younger participants on all neuropsychological tests, as expected. Blur at the levels of 20/50 and 20/100 did not

significantly affect performance for both age groups' performance on the TMT. Effects of blur were only significant for the young participants on the DS. The following sections present the specific results for each outcome measure.

### Trail Making Test

For the TMT Parts A and B, a two-way ANCOVA was conducted for the following: control, 20/50, and 20/100 and age group (young and old) both entered as between-subjects factors. As shown in Figures 2 and 3, older participants required more time than younger participants to complete the task. For TMT A (Figure 2), there was a main effect of age ( $F[1, 110] = 24.68$ , mean square error [ $MSE$ ] = 61.08,  $p < .001$ ). Neither the main effect of blur nor the interaction between blur and age was significant.

TMT B shows a main effect of age ( $F[1, 110] = 21.28$ ,  $MSE = 558.58$ ,  $p < .001$ ; see Figure 3). There was no effect of blur ( $F < 1.00$ ), but the interaction between the two factors approached significance ( $F[2, 220] = 2.92$ ,  $p < .06$ ).

### Digit Symbol Test

Figure 4 shows that younger participants' scores fell at a greater rate than older participants' scores, especially between the blur levels of 20/50 and 20/100. For the DS, a three-way ANCOVA was conducted with blur group (control, 20/50, and 20/100) and age group (young and old) both entered as between-subjects factors. The ANCOVA resulted in a significant main effect of blur group ( $F[2, 110] = 6.16$ ,  $MSE = 79.46$ ), and a significant main effect of age ( $F[1, 110] = 42.34$ ). The interaction between the two factors was not significant ( $F < 1.00$ ). Younger participants were able to complete significantly more test items (mean [ $M$ ] = 69.73, standard deviation [ $SD$ ] = 10.05) than were older participants

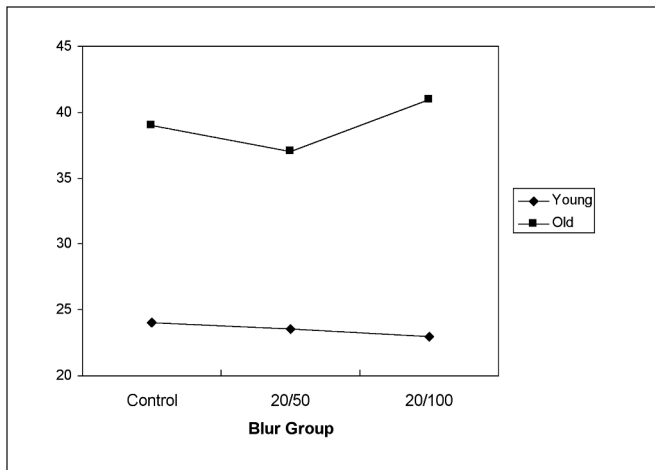


Figure 2. Trail Making Test Part A.

( $M = 47.03$ ,  $SD = 8.44$ ) with less variability. Yet, across blur levels, performance decreased with increasing blur at a higher rate of decline in the younger participants versus the older participants. Post hoc tests (Tukey's Protected  $t$  tests,  $p < .05$ ) revealed that the control group ( $M = 62.42$ ,  $SD = 8.62$ ) performed significantly better than the 20/100 group ( $M = 53.93$ ,  $SD = 8.55$ ). The 20/50 group ( $M = 59.03$ ,  $SD = 8.40$ ) also performed significantly better than the 20/100 group. There was no difference between the control group and the 20/50 group. Correlations showed that with increasing blur, there was a significant decline in performance scores (Pearson  $r = -.314$ ,  $p < .001$ ,  $N = 124$ ).

#### Other Data

An interesting finding occurred while examining the DS after the 20/100 blur group (young and old) had finished the test. Because of the blur at this level, some participants copied the symbols incorrectly. For example, the symbol “^”

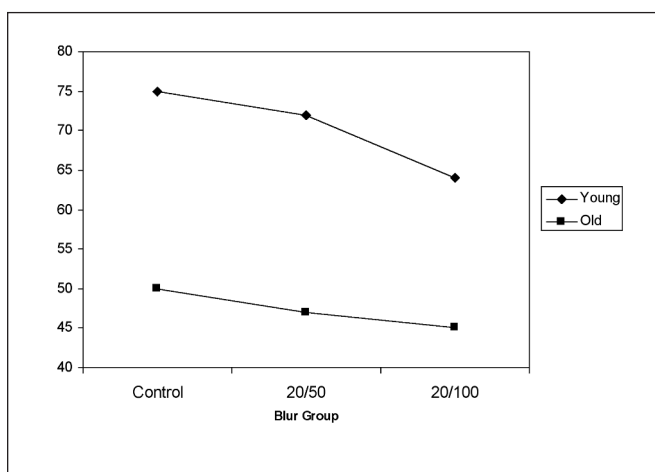


Figure 4. Digit Symbol Test.

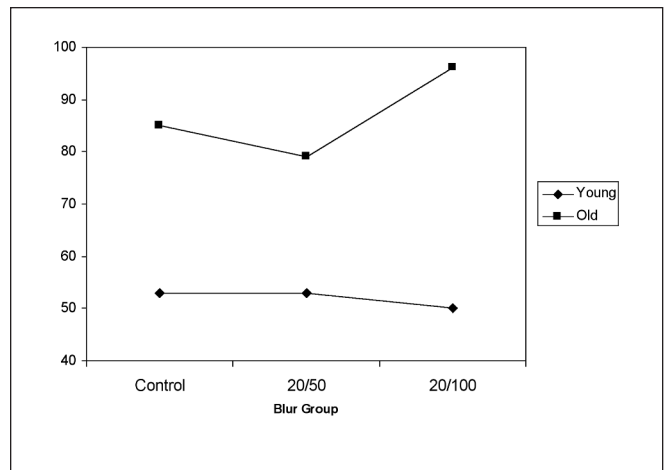


Figure 3. Trail Making Test Part B.

was copied as “A,” and the symbol “=” was copied as “≡”. In the 20/100 blur group, 20% of the young participants and 66% of the old participants miscoded the symbols. The effect of blur on interpretation and accuracy is explored in the Discussion section.

## Discussion

Some neuropsychological tests require adequate functioning of the precortical visual system for higher visual processing. This study provides documentation that diminished visual acuity is associated with significantly reduced scores on some, but not all, neuropsychological tests. In addition, this study suggests that younger and older participants are affected differentially by blur on the DS. Moreover, another interesting finding was that people who have 20/100 visual acuity may participate in the TMT and their low vision will not affect their performance. These data demonstrate for the first time that some psychometric tests can be identified in which the time needed by people to successfully perform these tests is linked to the level of near visual acuity independent of the effects of pupil size, contrast sensitivity, and cognitive health.

The findings show an effect of age but not of level of blur (20/50 and 20/100) on TMT performance. Older participants performed more slowly on TMT A and TMT B than did younger participants. Although Figures 2 and 3 show a trend for performance to decrease with increased blur in the older participants, this trend was not statistically significant. The TMT may not have yielded significant effects for blur at the levels used in this experiment because of the size of the letters and the boldness of the print. Although contrast was lost at the 20/100 level, the size of the letters and numbers helped readability. This finding suggests that

people who have visual acuity to 20/100 can still be administered this test, and the results will provide an accurate performance score.

DS was the only measurement in which younger participants slowed differentially because of blur more than older participants. Moreover, it was the only measurement in which blur affected performance in both young and old participants negatively. For this measurement, the blur levels probably had a greater effect because of the font size of the test, the scanning of blurred symbols required, and the sensory memory component. Not only was the timed performance slow but also the symbols were copied incorrectly. Here, the results suggest that impairment at the level of visual acuity may slow down speed of processing information as well as impair the perception of the information presented. Blur may affect memory as well.

In response to the younger participants being more impaired by blur than the older participants, which was not predicted in the hypothesis, several theories may be explored. Unfortunately, refractive data were not gathered from the study population. However, if the assumption is made that the older adults are already accustomed to blur when not wearing their corrective lenses, then they may be desensitized to performing a task under blurred conditions. Assuming that the younger participants were not myopic, young adults with 20/20 vision may be unable to adapt quickly to blur. Therefore, the condition of blur may affect their performance. Rosenfield and Abraham-Cohen (1999) explored blur sensitivity in people with myopia. They compared the ability of people with myopia and emmetropia to subjectively detect the presence of retinal defocus and found that those with myopia are less sensitive to the presence of blur.

Moreover, because performance slowed in both age groups with greater blur, then blur may have caused participants to spend more time generating a recognizable mental depiction of the symbol to be copied. Processing time may have increased while participants tried to decipher the symbols. During data collection, it appeared that the 20/100 group was more cautious in its copying approach than the control group. The initial symbols may not have been readily encoded into memory because of blur, and consequently participants may have had to scan the symbols more frequently. Other studies assessing the effects of visual acuity on neuropsychological test performance drew similar conclusions. Bertone et al. (2007) suggested that the precision of the cognitive assessment and subsequent diagnosis are significantly biased when vision is not optimal. Bruce, Bruce, and Arnett (2007) found visual tests of attention are sensitive to mild primary visual disturbances in people with multiple

sclerosis. By contrast, Skeel, Schutte, van Voorst, and Nagra (2006) found that visual acuity was only weakly related to neuropsychological test performance. Likewise, Anstey et al. (2007) concluded that visual improvement after cataract surgery was not strongly associated with an improvement in neuropsychological test performance in otherwise healthy adults. DS and TMT were not part of the neuropsychological test battery, and tests used consisted of other visual properties such as face recognition.

The current study had several strengths. First, it presents age-comparative work as called for by Lindenberger and Baltes (1994) to better understand how young and old participants are affected differentially by blur. Participants were screened for cognitive impairments and randomized into experimental groups. The current study examined the effects of temporary sensory impairment on younger and older participants and found that younger participants may be more affected by blur than older participants on some tests. More important, some tests, such as TMT, may be given to older people with near vision impairments and the tests results will not be significantly affected by blur. This finding reinforces the validity and reliability of this particular neuropsychological test.

In addition, this study removed covariates (visual acuity, pupil size, and contrast sensitivity) so that the unique effects of blur could be examined. This methodology allowed examination of the effect of visual acuity on performance without confounding factors. This had not been done in previous studies (e.g., Baltes & Lindenberger, 1997; Kempen, Kritchevsky, & Feldman, 1994; Lindenberger & Baltes, 1994).

Another strength is the focus on the duration it takes to complete a test rather than an emphasis on accuracy alone. As mentioned earlier, for the TMT the time allowed for completion was extended beyond the standardized time allowed. People with moderate, as opposed to severe, vision impairment may be able to successfully perform a test but may require a longer time than a normally sighted person to complete it. The data bear this out. As discussed previously, most participants had no problem completing the tests with near-perfect accuracy; however, they required more time. Lindenberger, Scherer, and Baltes (2001) found that people invest more effort under conditions of reduced sensory acuity to compensate for a supposedly challenging experimental condition. Slow performance could have several 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 (Owsley, McGwin, Sloane, Stalvey, & Wells, 2001).

Moreover, the psychometric tests chosen are commonly used in evaluations quantifying cognitive performance, especially in the area of driver evaluation. They represent characteristics such as varying font size, spacing, and contrast, which may be disturbed by impaired visual acuity. These strengths may contribute to the long-term goal of establishing a battery of neuropsychological tests that may be appropriately administered to people with near vision impairment. This study showed that the TMT could probably be administered to these people without near vision impairments affecting their scores. Fine and Rubin (1999) found that participants required larger print to read when simulated cataracts were experimentally induced. When reading large letters, the cataract had no effect. Those with visual acuity impairments may respond to written materials appropriately when the font size promotes their ability to read the print.

### Limitations

Limitations include failing to collect refractive information on each participant. Near vision acuity was assessed, but it was not assessed without corrective lenses. In addition, the sample size for the older adult group was small—34 participants. Because there was a trend for greater impairment with blur, a larger sample size may have shown significant results in higher decline of performance on the DS.

### Future Research Directions

The findings from this study are the beginnings of developing a battery of neuropsychological tests that are appropriate for the low vision population. Moreover, it would be interesting to examine actual DSs that have been given in geriatric assessment centers to explore the relationship between blur, misinterpretation, and errors when copying details that are blurred. Some “errors” may be the result of clients’ copying what they actually believed they saw.

This research has implications for educational systems. There is a current move to increase standardized testing in grade schools. This study shows that small levels of blur may negatively affect performance for young adults. Likewise, children may be impaired by blur. Before providing children with standardized tests, children need to be screened for visual impairments and provided with the necessary corrective lenses. Moreover, teachers must stress the necessity of children wearing their glasses during class and when taking tests.

Finally, the question “is it vision or cognition that affects performance?” may need to be rephrased. Do healthy older adults who have vision problems use their cognitive health to compensate for visual loss? Do people with dementia have poorer performance when visual acuity is impaired because they are unable to strategize and compensate for visual loss? This broader issue is worthy of further investigation.

## Summary

Eye disorders such as glaucoma, cataracts, age-related macular degeneration, and refractive error commonly cause visual impairment, and they are especially common in older adults. Moreover, younger people who have various developmental disabilities may also have visual impairments. They, too, may be assessed using visually dependent test measures. Nonetheless, published articles reporting psychometric test results usually do not discuss the visual status of the participants involved, suggesting that visual impairment might sometimes go unrecognized as a confounding factor in neuropsychological testing sessions.

In addition, geriatric assessment centers typically evaluate clients with repeated measures to assess whether performance changes over time. Visual performance (acuity, contrast sensitivity, and visual fields) may also change or decrease over time. This alteration in visual performance may exacerbate a decline in cognitive performance.

Helping older adults remain as independent as possible begins with accurate evaluation. This study suggests that an accurate cognitive evaluation begins with a visual screening. Visual acuity charts (near and distant) and contrast sensitivity charts should be part of the evaluation process. When impairments are noted, then referrals to eye care professionals may assist with further assessments and proper intervention.

The results of this study should suggest to clinicians that when clients complain that written material looks blurry, the clinician should not simply provide a nonprescribed magnifying device. This may only enlarge the blur. Instead, clinicians need to administer assessments that are suitable for those with visual impairments. The DS will not be appropriate if someone has a visual acuity lower than 20/100. However, the TMT may still be an appropriate test to administer. Those working in the school systems, too, need to be made aware that children’s performance on tests may be impaired by low levels of blur. The inability to finish a test may not be because of lower intelligence but rather impaired vision slowing the speed of processing written information. Computerized assessments (Cherbuin & Anstey, 2008) in the future may feature the ability to enlarge print, thereby tailoring the assessment to the individual’s visual acuity level. ▲

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