Masthead Logo

University of Iowa
Iowa Research Online

Driving Assessment Conference | 2003 Driving Assessment Conference

Jul 23rd, 12:00 AM

Traffic Scene Related Change Blindness in Older Drivers

Sarah Batchelder
University of Iowa, Iowa City

Matthew Rizzo
University of Iowa, Iowa City

Rick Vanderleest
Digital Artefacts, LLC, Iowa City, IA

Sean Vecera
University of Iowa, Iowa City

Batchelder, Sarah; Rizzo, Matthew; Vanderleest, Rick; and Vecera, Sean. Traffic Scene Related Change Blindness in Older Drivers. In: Proceedings of the Second International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, July 21-24, 2003, Park City, Utah. Iowa City, IA: Public Policy Center, of Iowa, 2003: 177-181. https://doi.org/10.17077/drivingassessment.1117

TRAFFIC SCENE RELATED CHANGE BLINDNESS IN OLDER DRIVERS

Sarah Batchelder, Matthew Rizzo, Rick Vanderleest*, Shaun Vecera
Colleges of Medicine, Engineering, and Liberal Arts
Public Policy Center
University of Iowa
*Digital Artefacts, LLC
Iowa City, IA, USA
E-mail: sarah_batchelder@hotmail.com

Summary: The study investigated if a driver's age affects the detection of change in driving-related images. A touch screen computer presented the images for a maximum duration of 10 seconds. Half of the images presented included a gradually changing element, and half remained static. Participants were instructed to identify manually the change on the screen, or to depress the spacebar if no change had occurred. We found that older drivers (N = 13, 54% male, mean age 68.5 years) were less accurate ($t_{36} = 5.445$, $p < .001$), displayed greater response times ($t_{36} = -2.67$, $p < .05$), and produced more false positive responses ($t_{36} = -2.754$, $p < .01$) than younger drivers (N = 25, 68% female, mean age 22.3 years).

The ability to perceive aspects of the visual world and intelligently interact with the environment is taken for granted by most people. This capability guides us through daily activities such as navigating a crowded street or driving an automobile. Further, most individuals believe themselves to be cognizant of their surroundings and assume that changes in the panorama are readily detected. However, the viewer is largely unaware that a substantial amount of information is often not perceived. This lack of perception, or inability to detect large changes in scenes from one view to the next, has been termed change blindness (Rensink, O'Regan, & Clark, 1997; Simons, Franconeri, & Reimer, 2000).

Most studies of change blindness are fundamentally similar: an initial image is presented, a brief visual disruption occurs, and then a changed image is presented (Simons et al., 2000). These visual disruptions include saccades (Rensink, 2002), blank screens (Rensink, 2000), blinks (O'Regan, Deubel, Clark, & Rensink, 2000), 'mudsplashes' (O'Regan, Rensink, & Clark, 1999) and motion picture cuts or changes in camera angle (Levin & Simons, 1997). Historically, change blindness researchers assumed that a visual disruption was necessary to hide the transient (i.e., brief visual phenomenon that grabs a viewer's attention) produced by the changing element. Recently, Simons et al. (2000) published the first study demonstrating that change blindness could occur in the absence of a visual disruption if the transition of the changing image occurred gradually, in small steps below the threshold of detection. In fact, subjects were able to detect *more* changes when a visual disruption was present and had more difficulty detecting changes that were presented gradually. The Simons study has important implications for the field of change detection because most changes encountered *in vivo* are progressive. For example, when driving, another automobile may appear suddenly, but this change is not instantaneous.

The objective of the current study was twofold. We first sought to replicate the finding of Simons et al. (2000) that the transient produced in the flicker paradigm was not necessary to induce change blindness. Additionally, we wanted to investigate whether detection of change in driving-related images is affected by observer age. An extensive review of the literature did not reveal any studies investigating the effects of age on change blindness or the effects of change blindness on older drivers.

Ball, Vance, Edwards, and Wadley (2002) and Jackson and Owsley (2002) demonstrate that normal aging often involves a reduction in visual ability and speed of cognitive processing. The reduction of visual acuity, paired with the slowing of attentional processes, implies that older drivers will perform worse on a change blindness paradigm compared to younger drivers. In this research we hypothesize (1) that older individuals will demonstrate reduced accuracy, (2) that older individuals will display increased reaction times in identifying whether or not a change has occurred, and (3) that older observers will produce more false positive responses compared to younger individuals. As the elderly population continues to increase, it is important to investigate the extent of change blindness in older drivers.

METHOD

Participants

Participants in the experiment were drawn from two populations of drivers: (1) younger adult volunteers (N = 25, 68% female, mean age 22.3 years) and (2) older adult volunteers (N = 13, 54% male, mean age 68.5 years). Visual acuity (Sloane letter chart) was 20/25 or better in all participants. Subjects were compensated $12.50 for their effort and inconvenience in the approximately one-hour-long testing session.

Apparatus

A personal computer controlled the presentation and timing of the experiment. Stimulus images were displayed on a 50 cm (21 in) color monitor positioned approximately 60 cm (2 ft) from the participant. The experiment was conducted in a dimly lit room to reduce the reflection from the removable touch-screen overlying the monitor.

Stimuli

Forty-seven pairs of images were used. Each pair consisted of an original image and a modified original (i.e., an image with a well-defined change to a single object). The images were created from photographs taken from inside a motor vehicle and depicted various driving circumstances (courtesy of Art Kramer). All photographs were resized to 800 x 600 pixels and the modified version of each image was created using Adobe PhotoShop version 5.5. The changes made to the original image did not introduce any anomalies, that is, both images were physically plausible, appeared natural and did not violate logical traffic patterns.

The 47 pairs of images (original plus modified original) were presented with one discrete changing element. The original slide and the modified slide were presented in succession, so that the participant was continuously viewing the same global scene, except for the changing element that was gradually blending in and out. This blending, or melting, appeared continuous and was unobtrusive to the viewer (i.e., there was no flashing element). A complete cycle from the original through the modified image was 4000 ms (2000 ms per image). Each trial contained up to 5 cycles, giving a maximum presentation time of approximately 10 seconds.

Additionally, the original (unmodified) 47 images were used in catch trials where no change occurred in the presentation. These trials were included in order to investigate the occurrence of false positive responses or random guessing. The static images were also presented for a maximum duration of approximately 10 seconds.

Procedure

Two practice sessions were administered before the experiment began. Basic pointing accuracy was assessed by determining if participants could accurately touch a one inch diameter white dot on a black background. The dots were positioned in the center of the monitor and in each of the four corners of the screen, with the location sequence randomized by the computer.

A training session consisted of five randomly sequenced trials: three trials contained a change and two contained no change. Changing images in the practice session were selected based on high salience, and speed and duration of the training trials were the same as in the subsequent experiment. Training session accuracy was 100% prior to commencement of the experiment.

The experiment was self-paced, and participants initiated each trial by touching a clearly demarcated box in the center of the screen. Each participant viewed 94 randomly ordered trials; half contained a change and the other half remained static. Participants were instructed that one aspect of an image might appear, disappear, change location or change color. Participants were also told that an image might not change, but they were not apprised of the frequencies of the two alternatives.

In each trial, participants touched the location on the monitor where they perceived a change. To indicate that no change had occurred, observers depressed the spacebar of the computer keyboard instead of touching the screen. These response options were chosen to eliminate the use of the computer mouse, because younger adults have more experience with this device than do older adults. Further, poor dexterity due to arthritis in older adults was recognized as a potential confound, thus reinforcing the decision to use the touch-screen and keyboard as instruments of response.

RESULTS

Response times less than 500 ms were considered errors and removed from the dataset because previous research indicates that such response times are too short to permit the identification and indication of change (Niedeggen, Wichmann, & Stoerig, 2001). These trials accounted for less than .01% of all trials. Statistical analyses were conducted to assess response accuracy, response time and frequency of false positive responses.

Overall, younger drivers (M = 69.24, SD = 7.68) demonstrated greater accuracy than older drivers (M = 49.31, SD = 15.03); $t_{36} = 5.445$, $p < .001$. The 94 trials were then analyzed in two categories, those images that included a change and those that did not change. Of the 47 trials with a changing element, older individuals correctly identified significantly fewer changes than younger individuals (M = 39.10%, SD = 8.37% vs. M = 62.89%, SD = 7.26%; t_{36} = 9.098, p < .001). An analysis of the images (N = 47) where no change occurred also indicated that older drivers (M = 67.32%, SD = 31.96%) performed below the level of younger drivers (M = 85.28%, SD = 16.61%). Again, these results were significant (t_{36} = 2.294, p < .05). In sum, older drivers displayed significant reductions in accuracy in both change trials and no-change trials.

Response times were evaluated in two ways. If a response was given, the time to respond was recorded. If the participant did not respond after 10 seconds, the trial ended (i.e., 'timed out') and was counted as a non-response. Non-responses occurred on 13.02% of all trials across all participants (465/3572). In general, younger drivers responded more quickly (M = 5.76 s, SD = 1.29) than did older drivers, who had a mean response time of 7.04 s (SD = 1.59). This difference between the two groups was significant (t_{36} = -2.67, p < .05). Further, younger drivers had fewer non-responses (M = 8.00, SD = 9.11) than older drivers (M = 20.38, SD = 22.14); t_{36} = -2.449, p < .05. As expected, younger drivers responded more quickly and more often than older drivers did.

In addition, analyses were conducted investigating whether response behavior differed between change trials and no-change trials. On trials where an element changed, younger drivers (M = 4.62 s, SD = 1.18) had faster response times than older drivers (M = 6.22 s, SD = 1.35; t_{36} = -3.773, p = .001). Further, younger drivers also showed a lower percentage of non-responses when the image changed (M = 4.09%, SD = 5.59%) compared to older drivers (M = 15.77%, SD = 15.40%; t_{36} = -3.418, p < .01). In sum, younger drivers were more likely to respond on change trials and to respond faster than older drivers.

Half of the 94 images (N = 47) did not change. On these trials, participants were asked to indicate 'no change' by depressing the spacebar on the keyboard. Older drivers failed to respond more often (M = 29.82%, SD = 32.25%) than younger drivers (M = 13.02%. SD = 14.31%). This indicates that older individuals had more difficulty deciding that no change had occurred (t_{36} = -2.236, p < .05). When a response was given, response times on the no-change trials did not differ significantly between older and younger drivers (t_{36} = -1.527, p = .136).

Finally, older drivers (M = 4.33%, SD = 5.30%) had a greater percentage of false positive responses than did younger drivers (M = 1.11%, SD = 1.86%; t_{36} = -2.754, p < .01). That is, older participants were more likely to erroneously indicate a change in a non-changing image.

DISCUSSION

The experiment sought to investigate if advanced age reduces the ability to detect change in traffic-related scenes. The results of the study supported our hypotheses that older drivers would show (1) reduced accuracy, (2) increased reaction times, and (3) more false positive responses in identifying change, compared to younger drivers.

Although all participants had normal visual acuity, perceptual difficulties in some older drivers may be attributable to visual abnormalities, such as cataract, glaucoma, or a general yellowing of the lens (Jackson & Owsley, 2003, in press). These anomalies affect visual acuity, contrast sensitivity, color vision, and perception of motion and transient cues, all of which can affect speed and accuracy of change detection, potentially inhibiting safe motor vehicle operation. In addition, Jackson and Owsley (2003, in press) state that even adults free from diagnosable eye diseases often lose the ability to focus on objects presented at near distances (i.e., presbyopia), such as the computer screen in the current experiment. Therefore, it may be useful to assess the effect of distance on change blindness in older drivers by using a full-size driving simulator to increase the distance between the driver and the image (i.e., screen) as well as increase the ecological validity of the study.

In this study, older drivers demonstrated slower response times than did younger drivers. This may be related to the observation that older adults have decreased visual processing speed and reduced visual attention (Ball et al., 2003). Additionally, arthritis, loss of agility and slowed reflexes may contribute to the greater response times of older participants compared to younger participants. The deficits suggested in this study, combined with the elevated inability to detect change (i.e., change blindness) may potentially elevate the risk of car crashes for older drivers.

For older individuals, reductions in vision, cognitive processing and physical dexterity are likely to contribute to poorer performance on our change blindness task. Further research needs to be conducted to evaluate the effects of change blindness on activities of daily living. It is conceivable that change blindness could contribute to perceptual errors during critical tasks such as automobile driving, thereby increasing the risk of vehicular collisions.

ACKNOWLEDGEMENTS

This research was supported by NIA AG 15071 and NIA AG 17717.

REFERENCES

Ball, K.K., Vance, D.E., Edwards, J.D., & Wadley, V.G. (2003, in press). Aging and the brain. In M. Rizzo & P. Eslinger (Eds.), *Principles and practice of behavioral neurology and neuropsychology*. New York: Saunders.

Jackson, G.R., & Owsley, C. (2003, in press). Visual dysfunction, neurodegenerative diseases, and aging. In J. Barton & M. Rizzo (Eds.), *Vision and Brain, Neurologic Clinics of North America*. Philadelphia, PA: Saunders.

Levin, D.T., & Simons, D.J. (1997). Failure to detect changes to attended objects in motion pictures. *Psychonomic Bulletin and Review, 4*, 501-506.

Niedeggen, M., Wichmann, P., & Stoerig, P. (2001). Change blindness and time to consciousness. *European Journal of Neuroscience, 14*, 1719-1726.

O'Regan J.K., Deubel, H., Clark, J.J., & Rensink, R.A. (2000). Picture changes during blinks: Looking without seeing and seeing without looking. *Visual Cognition, 7*, 191-212.

O'Regan, J.K., Rensink, R.A., & Clark, J.J. (1999). Change-blindness as a result of 'mudsplashes.' *Nature, 398*, 34.

Rensink, R.A. (2000). Visual search for change: A probe into the nature of attentional processing. *Visual Cognition, 7*, 345-376.

Rensink, R.A. (2002). Change detection. *Annual Review of Psychology, 53*, 245-277.

Rensink, R.A., O'Regan, J.K., & Clark, J.J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8*, 368-373.

Simons, D.J., Franconeri, S.L., & Reimer, R.L. (2000). Change blindness in the absence of visual disruption. *Perception, 29*, 1143-1870.