What do Driving Accident Patterns Reveal about Age-related Changes in Visual Information Processing?

By

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In K.W. Schaie & M. Pietrucha (Eds.), Mobility and transportation in the elderly, New York: Springer, 2000 (pp. 207-211).
Bryer’s (this volume) analysis of automobile crash data in the State of Pennsylvania is consistent with previous epidemiological studies of the relationship between advancing adult age and driving safety (e.g., Cerrelli, 1989). Most noteworthy among his conclusions are that: (1) Older drivers are more likely to die in automobile accidents due to their increasing physical frailty; and (2) the lack of reliable risk exposure data greatly limits our ability to interpret age-related trends in the accident data base. Bryer’s does an excellent job presenting the case for these conclusions. Especially interesting is his statistical manipulation of risk exposure by limiting some of his analyses to accidents occurring between 9 AM and 4 PM – the time of day when most middle-aged persons are at work and when older drivers tend to be over represented as vehicular occupant and drivers. However, there is another major conclusion one can draw from Bryer’s analysis that is somewhat understated in his report. Namely, there is evidence in his data that the causes of accidents among older drivers is shifting away from reckless behaviors such as speeding and alcohol consumption to a new set of causes characterized by limitations in drivers’ visual information processing efficiency.

Based upon the percentage of total accidents experienced by an age group, Bryer’s older drivers are less likely to be involved in freeway, single-vehicle or nighttime crashes (all classes of accidents heavily influenced by reckless behaviors on the part of the driver). On the other hand, these same older drivers are more likely to be involved in multi-vehicle and/or intersection accidents (classes of accidents heavily influenced by failures of visual information processing). The trivial interpretation of this trend is that older drivers are not really suffering from the effects of limited visual information processing
efficiency. Instead, the percentage of their accidents that involve multi-vehicle and/or intersection collisions has become artificially inflated due to the fact that they are under involved in single-vehicle and mid-block accidents. However, there is important new evidence in Bryer’s report that argues for the “information processing deficit” interpretation of this shift in the types of accidents experienced by older drivers.

The data in Figure 1 are taken from Table 7 in Bryer’s report. This figure depicts age-related trends for percent accident involvement at intersections (Stop Sign and Signalized) versus non-intersections (midblock). As already noted, there is an obvious shift in relative accident frequency from non-intersection to intersection accidents. More
interesting, however, is the difference in the age-trends for the Stop Sign controlled versus the traffic light controlled (Signalized) intersections. As the driving population ages form 51 to 85, there is no apparent change in the relative number of accidents occurring at intersections controlled by traffic lights. However, there is a sharp age-related increase in the relative number of accidents occurring at intersections controlled by stop signs. This pattern of results appears to be highly diagnostic. The visual information processing demands required of the driver to safely negotiate an intersection are greatly reduced when external decision-making aids such as traffic lights are present. However, intersections controlled with stop signs (especially 2-way stop signs) place great demands upon the visual information processing capacity of the driver. This selective shift in the relative frequency of accidents from midblock to stop sign controlled intersections strongly suggests that age-related declines in visual information processing efficiency may mediate a large number of accidents among older drivers.

What type of age-related information processing deficit might account for the increased likelihood of an accident at an intersection controlled by a stop sign? In an analysis of drivers age 65 and older, Hakamies-Blomqvist (1993) reported that “Older drivers typically collided in an intersection with a crossing vehicle, which they did not notice at all, or saw so late that they did not have enough time to try an avoiding maneuver” (p. 19). These older drivers apparently looked, but didn’t see the opposing vehicle(s). Evidence from studies conducted by Karlene Ball and her colleagues (e.g., Ball and Owsley, 1991) suggest that deficits involving low-level visual processes – such as the failure of preattentive (i.e., automatic) acquisition of targets in the near peripheral field of
vision - may predispose many older drivers toward such “looked but didn’t see” type accidents.

Recent results reported by Rensink, O’Regan and Clark (1997) serve to underscore the significance of low-level preattentive (i.e., perceptual) processes in real-world visual search tasks such as scanning an intersection for approaching vehicles. Participants in their experiments were presented with a picture of a typical outdoor scene on a computer display. The scene was presented for 240 msec and then the screen was blanked to gray for 80 msec before a slightly altered version of the same scene was presented again for 240 msec. This cyclic presentation of the 240 msec exposure of the scene image and the 80 msec blanking interval continued while the participants searched the scene image for any changes. Every other time that the scene image was presented a critical object in the scene was deleted. For example, an observer could be looking at a picture of a traffic scene with a pedestrian about to step into the street then the screen would be blanked and then the original scene would reappear only this time the pedestrian would be missing from the scene. Next, the screen would go blank and then the image would reappear with the pedestrian in its original position. The disappearance and reappearance of the pedestrian – separated by the 80 msec blanking interval – continues repeatedly while the participant searches the screen looking for any noticeable changes. Rensink and his colleagues found that observers had to search such displays for prolonged periods of time (i.e., many object appearances and disappearances) before they noticed the change in the images separated by the blanking interval. It was as if the blanking interval had induced a state of “change blindness”. When the cyclic presentation of the same scenes with and
without the critical object was presented without the separating blanking interval, observers immediately noticed and accurately reported the change at the very first transition of the images.

The Rensink “change blindness” paradigm described above demonstrates the importance that bottom-up preattentive perceptual processes may play in our real-time search of complex visual environments such as a roadway intersection. There is evidence that the low-level visual mechanisms that may mediate preattentive “popout” phenomena in peripheral vision decline differentially with advancing adult age (see Kline and Schieber, 1981). That is, older adults may not need to be exposed to Rensink, et al.’s “blanking interval” in order to experience occasional failures of the bottom-up perceptual mechanisms that redirect attention to “transient” events in the visual array. The potential significance of the failure of such “bottom-up” processes in visual search has been ignored for too long by modern cognitive psychology in favor of hierarchical “top-down” mechanisms such as “selective” or “divided” attention. The fascinating results obtained using Rensink, et al.’s “change blindness” paradigm may provide the impetus as well as the means to re-examine the potential role of low-level perceptual mechanisms in our pursuit of understanding age-related changes in driving capacity and safety.

References


