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Learning to scan for approaching vehicles efficiently with a visual impairment

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Abstract

Detection of vehicles is a critical skill for students learning to cross streets. Some people with visual impairments who can see approaching vehicles well while attending for them may have difficulty doing so when looking from side to side to check for sufficient clearance to cross. People with severely restricted visual fields may miss seeing vehicles that are very close to them unless they scan sufficiently slowly, and people with severe visual acuity loss may miss seeing vehicles that are approaching from a distance unless they hold their gaze long enough to detect movement.

This article describes in an orderly presentation a training procedure previously presented only in workshops and on websites, and expounds on the possible vision science to describe the problems. The authors put forward a method for horizontal lateral scanning for vehicles at uncontrolled crossings that will increase accessibility of the method to instructors worldwide. The training involves having students face a street and practice turning to look for approaching vehicles, then employing an instructor-led feedback loop, correcting themselves and improving performance. The instructional goal is for students to consistently successfully scan for vehicles that are most challenging for them to detect.

Keywords

Scanning; Vehicles; Restricted Visual Fields; Acuity Loss; Street Crossing

Introduction

In the United States in 2017, nearly 6,000 pedestrians were killed in traffic crashes and approximately 137,000 pedestrians were treated in emergency departments for nonfatal crash-related injuries (National Highway Traffic Safety Administration, 2017). The number of blind and visually impaired included in these statistics is unknown but researchers have found that there are vision-related challenges for crossing streets (Geruschat, Fujiwara, & Emerson, 2011). In order to cross a street safely, pedestrians must be able to reliable detect the vehicles approaching their intended path. The human vision-cognition system, and the typical manner that people use it, can present problems for people with visual impairments when effective adaptive behaviors are not acquired and used.

The field of Orientation & Mobility (O&M) has traditionally had a set of procedures for people with visual impairments to traverse streets. By default, most techniques incorporate tasks reliant upon audition, using hearing rather than vision to analyze the environment and to manage street crossings (Fazzi & Barlow, 2017; Jacobson, 2013; LaGrow & Long, 2011). However, some students of O&M instruction rely partially or completely upon visual input to complete such tasks at crosswalks. It is essential that these students learn strategies for reliably detecting approaching vehicles.

By way of example, one of the authors in the course of instruction experienced a young deaf woman with severely restricted visual fields stepping out in front of an approaching vehicle as she initiated a crossing at a two-lane street with no signal or stop sign for traffic on the street being crossed (uncontrolled crossing). The author had already determined that the student could see well enough in each direction to know when it was clear to cross. Within minutes of this assessment, the student looked both ways and started to cross, but had not detected the presence of an approaching car, even though it was so close it would not have been able to stop in time to avoid a collision; the specialist had to physically restrain the student from stepping into its path. The outstanding questions were why the student failed to detect the vehicle, and how changes in assessment and practice might remedy the detection failure. Based on previous observations of other students with severely restricted visual fields having difficulty scanning for stationary targets, the author hypothesized that the student's scanning technique involved eye and head movements that were too rapid for her visual-cognitive system to capture and process.

A thorough review of the rehabilitation and science literature revealed that there has been little foundational research related to visual scanning, speed of head or eye movements, or duration of fixation that might apply to uncontrolled street-crossing situations. Expert opinion can be found in various references, including textbooks cited here published over the past forty years. Scanning techniques used in low vision rehabilitation emphasize that people with significantly reduced visual fields or scotomas need to employ behavioral adaptations to scan efficiently, using organized patterns and moving the focus more slowly to find things, such as dropped keys or coins (Jose, 1983; Scheiman, Scheiman, & Whittaker, 2007).

O&M specialists have also recognized that pedestrians who rely on vision to cross streets need specific training to learn how to apply these principles to the roadway environment to look for and detect approaching vehicles. An appraisal of some of the standard vision rehabilitation textbooks reveals that visual scanning is a necessary component to reduce risk and cross streets securely (Fazzi & Barlow, 2017; Jacobson, 2013; LaGrow & Long, 2011). Fazzi & Barlow (2017) noted, "Practice should include where to look and how to scan effectively [for vehicles]" (p. 151). In the most-recent edition of the textbook Foundations of Orientation and Mobility, authors state, "People with less than 5 degrees of central vision usually need to scan more slowly than they did when they had more vision because, otherwise, they will miss seeing even large objects" (Barlow, Bentzen, Sauerburger, & Franck, 2010, p. 390). Positive results for street crossing training has been reported in the literature (Wright & Wolery, 2012). Gaze, fixation, and street crossings have been studied in the past, and findings indicated that typically-sighted pedestrians "directed significantly more fixations onto cars while standing at the curb than when either walking to the curb or crossing the street at the roundabout" (Geruschat, Hassan, & Turano, 2003, p. 522). Hassan, Geruschat, and Turano (2005) also reported on head movement and crossing safety, noting the critical nature of appropriate behaviors and the need for O&M Specialists to provide training in this area.

However, little attention has been given by vision cognition sciences, and specific functional strategies for pedestrians with visual impairments to optimize visual scanning techniques at uncontrolled crossings have not been researched. In consideration of the lack of published research, the authors, in the course of more than four decades of professional vocation, developed experience-based practices that have yielded positive results for their students, which we will share here. After describing the challenges that people who have restricted visual fields or visual acuity loss may have with horizontal lateral scanning for vehicles at uncontrolled crossings, we will explain the accommodative strategies that were found to help them address those difficulties, and a procedure that can be used to train students to perform these strategies effectively.

Challenges and Accommodations for Detecting Vehicles

Severely restricted visual fields

Challenge of detection of approaching vehicles when viewing from side to side: People with severely restricted visual fields may miss detecting approaching vehicles nearby.

Individuals with restricted visual fields, as well as those who are using a telescopic device which narrows the field of view, can typically see vehicles approaching from a distance more easily than they can detect vehicles nearby. This is partly because there is an expanded field of vision when looking at objects in the distance than when looking at those that are close, whereas objects that are close may be mostly outside the narrow field of functioning vision.

More importantly, when individuals whose visual field is severely restricted look quickly from side to side, they may be unable to process and identify even stationary objects within their field of view because of the vision cognitions limitations. This may be because the constricted visual field exacerbates the effect of saccadic masking or suppression, a phenomenon that occurs when scanning with normal vision. “This robust perceptual phenomenon . . . is frequently attributed to active suppressive signals that are directly derived from eye movement commands” (Idrees, Baumann, Franke, Münch, & Hafed, 2020).

Individuals with normal vision can experience this phenomenon by looking through a tube (such as a paper towel roll), or by using a flashlight with a narrow beam in a dark room. If they move the tube or flashlight quickly to look from one side to the other and back again, they may see what is at their sides if they stop moving long enough before going back to the other side, but they cannot see anything in between. This may help understand what happens when people with severely restricted visual fields try to look quickly from left to right and back – they are likely to see what is on the street far to their left and their right, but nothing in between, including vehicles that are near to them. However, if they move the tube or flashlight more slowly, they can discern more details.

Accommodation for pedestrians with severely restricted visual fields: Scan sufficiently slow to be able to reliably detect all vehicles, even those that are close.

Reduced visual acuity

Challenge of detection of approaching vehicles when viewing from side to side: People with reduced visual acuity may miss detecting vehicles in the distance.

Individuals with reduced visual acuities usually have difficulty seeing details, such as objects that are small or at a distance away. Stationary objects in the distance, such as parked cars, are more difficult for them to see than moving objects, such as approaching cars. This is especially true for people with central scotomas such as macular degeneration who rely on eccentric viewing (seeing with their peripheral vision) because the retina’s peripheral regions are especially adept at detecting motion, rather than details and color (Ward, 2010).

In addition to reduced acuteness, students with impaired visual acuities are also subject to the effects of saccadic masking, implying that a measured gaze hold will help prevent temporary loss of perception caused by eye movement. “The faster you move your head, the shorter the fixations and the longer the saccades” (Eye Practices, 2020). According to the American Academy of Ophthalmology, “Keeping gaze still during fixations is useful to avoid blur, which degrades the image and occurs due to the long response time of photoreceptors” (Castet & Masson 2000; Ross et al 1996).

Accommodation for pedestrians with reduced visual acuity: Hold the visual gaze long enough to detect movement and/or details.

When looking from side to side for approaching vehicles, the primary accommodative strategy for people with severe reduced acuities is to direct the vision in one direction, then pause momentarily before turning to look in the other direction, and then pause when performing any further alternating views. To detect objects moving in the distance (such as approaching vehicles) students must pause long enough to allow the movement to be noticed and processed.

Procedure for Training

The authors have found the following procedure to be very effective for helping people explore and learn how slowly they need to scan or how long they need to pause in order to ensure they can reliably detect all approaching vehicles, and then learn to become skillful at doing it consistently when looking from side to side at uncontrolled crossings.

Materials

1) Ear plugs and/or headphones to block or mask sounds which may provide auditory clues to the presence of approaching vehicles. This is because the purpose of the exercise is for the instructor to assess and develop the students' ability to detect vehicles visually, so they can do it reliably even when it is too noisy to hear the vehicles.

2) A roadway location that has no stop sign or traffic signal for the street being crossed, with conditions that will present frequent opportunities for challenging situations (see, Selecting the site for training, below).

Selecting the site for training

Ideal sites for this training are crossings where there are frequent situations where the only vehicles that are visible when looking in the direction being practiced are those which are difficult for that student to see when scanning.

For students with severe acuity loss who have difficulty seeing vehicles in the distance, this means the training should be at a street with no bends or hills that block the view of distant vehicles, as well as regular occurrences when vehicles can be seen approaching from a distance while no closer vehicles are visible. This will happen more often when traffic is sporadic, or when vehicles tend to arrive in platoons with long gaps between (as often happens when they are coming from a traffic signal).

For students with restricted visual fields who have difficulty seeing vehicles close to them, training requires many instances when there is only one vehicle that is visible, and it is approaching close to the crosswalk. This happens when 1) there are frequent gaps in traffic; 2) most vehicles approach alone rather than in platoons; and 3) there is only a single lane for traffic approaching from that direction. Vehicles approaching close to the crosswalk in the far lanes are not as much of a problem for these students as those in the nearest lanes, because if students fail to see a vehicle near the crosswalk in the far lanes before starting to cross, it will probably have passed before they get to those lanes. Therefore, the primary focus of this training is usually detecting vehicles approaching in the nearest lane.

Prerequisites

This training helps students visually detect vehicles reliably when they are looking from side to side. The goal is not for the student to detect them as soon as possible, but to detect them reliably, even those which are located where they are most challenging for that student to detect. This should be done only after assessing and maximizing the student's ability to visually detect approaching vehicles as soon as possible while watching with a steady forward gaze (without turning). If students are unable to see approaching vehicles with enough warning when looking steadily in their direction, they are unlikely to see them reliably when looking from side to side.

To enable students to visually detect vehicles as soon as possible when looking steadily toward them, students with central scotomas may benefit from learning to view with the most intact part of their vision (eccentric viewing using peripheral vision). Students with severely restricted visual fields may benefit from addressing glare and lighting issues. And students with reduced visual acuity (including those with central scotomas) may need to determine how long they need to hold their gaze when looking toward approaching vehicles before they can detect them.

Once students demonstrate they are able to visually detect the approaching vehicles as soon as possible when looking steadily in one direction at a given crossing, they are ready to practice or learn to visually detect vehicles at that crossing when turning to look for them in that same direction. Training for both skills is usually done in the same session with the same lighting conditions, and is repeated in various lighting conditions and at different crossings.

Considerations

Training should be completed in one direction at a time. That is, the students practice turning to look for traffic coming from the left, for example, until they are skillful in that direction, then do the same thing for traffic coming from the right. Keep in mind that the most critical concern for students with restricted visual fields is detecting vehicles approaching close in the nearest lanes (that is, vehicles coming from the left in countries like America where drivers travel on the right side of the road, and from the right in countries like England).

Training procedure

1) To begin the training, the instructor asks the student to stand facing the street and explains that when the instructor gives the signal (such as tapping the student's shoulder), the student should turn to look toward the traffic in one direction, and then face forward again and report whether there were any vehicles approaching from that direction.
2) The student's hearing is then occluded.
3) The instructor then stands in position to watch the traffic and be ready to give the signal for the student to turn and look. The instructor gives the student the signal when either: there are no approaching vehicles visible; or the only approaching vehicles visible are where the student will be most challenged to see them. The student should have sufficient trials when there are no vehicles visible, so that the presence of approaching vehicles can not be anticipated or predicted.
4) When the instructor gives the signal, the student should turn to look for vehicles and then look forward again, and report whether there are any vehicles coming. The student should not be allowed to continue looking while reporting whether any vehicles are approaching, but should look only long enough to be confident as to whether there are any vehicles approaching, and then look forward again and report. After the student reports whether any approaching vehicles were detected, the instructor informs the student as to whether or not he or she is correct.
5) If the student fails to detect an approaching vehicle, the instructor encourages the student to improve the scanning and try again, and see if the performance improves. Students with a visual acuity loss may be encouraged to hold their gaze slightly longer, to be certain there is nothing moving before they look away. Student with a severely restricted visual field may be encouraged to scan more slowly; if they still do not improve, the problem may be that they are not scanning accurately along the street, and need to practice that.
6) Using this training procedure, students continue to practice until they can reliably and consistently determine whether or not there are any vehicles approaching every time they turn to look. Instructors can record and track vehicle detection of their students, to verify improvements and for required reporting purposes. Training and assessment should be provided in various lighting conditions.

Discussion

Detection of vehicles is a critical skill for students learning to determine when to initiate street crossings, and an organized approach to improving scanning and detection of oncoming vehicles can empower the students to make better decisions and reduce the risk of crossing streets. While there has been very little research to develop strategies for O&M specialists teaching students to reliably detect approaching vehicles, the authors, through long-term observation and trial, have developed by functional analysis a training procedure to improve students' detection rate performance.

The training procedure articulated here is specific to uncontrolled crossings. The authors have found that students who have undergone this training benefit as well from learning to apply the acquired skills to detect vehicles at signalized intersections.

It is worth noting that this article concentrated specifically on how to improve the use of impaired vision for detecting approaching vehicles, and does not address the many other components that are part of street crossing assessments and decisions.

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