

Teaching intersection analysis to students with low vision

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Abstract

As municipal engineers attempt to reduce pedestrian and vehicular accidents, and promote active mobility, they have incorporated several new elements at intersections that potentially diminish the safety of pedestrians with visual impairments. Orientation and mobility (O&M) specialists must adapt to these new situations and provide instruction that take into account the complexity at these intersections. This novel method allows individuals with low vision to develop a comprehensive risk assessment and analysis that is generalizable to nearly all intersections. This teaching strategy is modified accordingly if the individual is traveling at intersections controlled by stop signs or traffic lights. This strategy has been successfully applied to promote the safety and independence of numerous travellers with visual impairments.

Keywords

Low vision, visual scanning, intersection, risk

Introduction

Street crossings are some of the most challenging yet essential things to teach as an O&M to promote independence of travelers with visual impairments outdoors. The outlined strategies in this paper are an approach to teach crossing strategies to individuals with low vision in a sequential manner to allow them to generalize the strategies across multiple intersections, whether controlled by stop signs or traffic lights. Once the student has mastered these strategies, they can be a safer, more independent, and possibly universal traveller. These strategies were designed to be independent

of the country or environment where the instruction is performed. Additionally, they are not designed for a specific type of ocular disease or functional vision loss that affect the ability of the individual to travel independently. These techniques have been applied successfully with individuals with both acquired and congenital vision loss. Elements of the strategies outlined here were inspired by the Timing Method of Detection of Vehicles (TMAD) developed by Dona Sauerburger (Sauerburger, 1999) and the Intersection Analysis and Street Crossing Mechanics for the Traveler with Low vision by Wendy Scheffers and Linda Myers (Poggrund et al., 2012).

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The strategies have been separated into 3 sections: risk analysis diagram, visual scanning plan, and visual intersection analysis checklist. The teaching of the strategies should be conducted by an O&M in that order. The risk analysis diagram and visual scanning plan may be performed with the student in a quiet, indoor setting. On the other hand, the visual intersection analysis checklist must be conducted with the student outdoors at the intersection where the instruction is conducted. The risk analysis diagram and visual scanning plan are represented in the figures by image files, but they can be performed using a dry-erase board, paper and writing material, or other means whereby the information is visually accessible to the student.

Street crossing issues for students with low vision

In order for individuals with visual impairments to cross a street independently with reduced risk, they must be able to perform the following: recognize they have arrived at an intersection, determine the configuration of the intersection, establish an optimal crossing location, align to cross, maintain alignment while crossing, and determine an appropriate time to begin the crossing (Wiener et al., 2010). For individuals with low vision, alignment issues are uncommon if they can properly use visual cues. Whether the individual has visual field, visual acuity, and/or contrast sensitivity loss, there are numerous visual alignment cues present at intersections controlled by traffic lights or stop signs, including: poles near the destination corner, road markings, crosswalk lines, or the position of parked or stopped vehicles. If the individual can visually identify visual alignment cues, it may not be necessary to teach auditory alignment strategies. However, when these visual cues are not present or unreliable, such as crossing at night for students with night blindness, the traditional alternative strategies in O&M should be taught (Robert Wall, 2017).

Often the most difficult of the above street crossing elements to perform for individuals with low vision is determining the appropriate time to begin the crossing. This is particularly challenging at intersections with traffic lights due to misinterpreted visual cues (e.g., pedestrian signals, priority turn signals) that may put the individual in direct conflict with vehicular traffic. These cues have become even more complex in recent years with the addition of specialized traffic signals for bicycles and public transportation vehicles. Also, individuals with low vision may not have visual access to the

entire complexity of the intersections. For instance, those with constricted visual fields may have difficulty recognizing the presence of certain traffic signals or vehicles in the periphery. Whereas those with reduced visual acuity may not be able to visually identify elements of the intersection, such as destination curbs or pedestrian signals, across the street. Thus, the strategies outlined here can make a positive impact on multiple street crossing elements but are particularly useful for determining the appropriate time to cross and determining the configuration of the intersection for travelers with low vision.

Risk analysis diagram

Instructions for use

The risk analysis diagram techniques should be performed first and is recommended to be used in a quiet, indoor setting with the traveler with low vision. This exercise is particularly useful for crossing at stop signs. However, it may be used at traffic lights when the individual has previously received O&M lessons in those areas. It is helpful to begin with simple, common intersections (e.g., plus intersection with 4 stop signs) before moving onto more complex intersections (e.g., offset intersections with multiple lanes of traffic in the same direction). It is not necessary that these intersections are those where the O&M lessons will be conducted, though it may help certain travelers relate to the lesson when they are mentally crossing familiar intersections, particularly at the start of the training.

Lesson

The lesson follows the following order:

1. Draw an intersection with the location of the street corners, stop signs, and road markings clearly indicated and visible to the student.
2. Draw at least one vehicle near each of these street corners.
3. Indicate the presence of the student at one of these street corners (cardinal directions could be used if mastered).
4. Draw the location of the destination.
5. Draw the direction of travel.
 - The heading direction can be drawn by the student based on the location of the student relative to the destination.

6. Separate the crossing based on the directionality of vehicles.
 - one part for a one-way street and two parts for a two-way street
7. Ask the student which vehicles pose a risk in the 1st part of the crossing and draw (with a writing instrument or indicate with their finger) the direction of travel of the vehicles.
8. Ask the student to determine the level of risk of each vehicle mentioned (low risk, moderate risk or high risk) and explain their reasoning.
 - The O&M should inform the student if their response was correct.
 - If incorrect, the O&M should explain why the level of risk is different than reported by the student.
9. Repeat steps 7 and 8 for the 2nd part of the crossing, if applicable.
10. Repeat steps 6 through 9 for a second crossing, if applicable.

An example of a risk analysis diagram for crossing at a simple intersection controlled by stop signs is demonstrated in Figure 1 and one at a complex intersection controlled by stop signs is demonstrated in Figure 2.



Figure 1. A) Schematic of a risk analysis diagram of a simple two-way plus-shaped intersection controlled by stop signs. B) Risks associated with the initial crossing from the southeast to the northeast corner of the intersection. C) Risks associated with the crossing from the northeast to the northwest corner of the intersection to reach the destination.



Figure 2. A) Schematic of a risk analysis diagram of a complex two-way offset intersection controlled by stop signs and road markings. B) Risks associated with the crossing from the southeast to the northeast corner of the intersection. C) Risks associated with the crossing from the northeast to the northwest corner of the intersection to reach the destination.

Visual scanning plan

Instructions for use

These techniques are intended to complement the risk analysis diagram and may be applied independently or in conjunction with the risk analysis diagram depending on the learning abilities of the student. Though individuals may have different visual abilities, the general scanning plan and procedure will be similar amongst students with low vision. It is also recommended that this be performed in a quiet, indoor setting and the O&M uses a visual media that is accessible to the student. Also, the complexity of the intersection should gradually increase with training based on the student's abilities.

Lesson

The drawing of the intersection, traffic, student, and destination are similar to those outlined in the risk analysis diagram (see Figures 1A and 2A). Both the separation of lanes of traffic and the directionality of traffic should be clearly indicated to properly perform the visual scanning plan.

After drawing the intersection, the following steps should be followed:

1. Identify where the vehicles that pose a risk are associated to the position of the student in the drawing.
 - If the student is incorrect, then the O&M specialist should indicate

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where these vehicles are and why they pose a risk.

2. Indicate where the student should look to identify the vehicles (e.g., to the left, right, in their blind spot)
3. Indicate the position the student should be standing when performing the visual scanning before beginning the crossing.
 - They need to see every risk (low to high) in the 1st part of the crossing before they encounter the traffic.
 - Should not look for risks in the 2nd part of the crossing before beginning the crossing due to the constant flux of rapidly moving vehicles. Otherwise, recently arriving vehicles may not be seen.
4. Develop a scanning plan with the student to ensure that vehicles are seen before the student walks in the traffic lane.
 - This scanning plan should be fluid. For instance, the student should avoid scanning from left to right and back to left before walking into the street.
 - It is often helpful to start with the vehicles over the shoulder or behind (in the “blind spot”) the student before looking in other directions because this often requires the most head turn and thus more time before crossing.
5. The order of the visual scanning plan should be indicated on the diagram by 1, 2, 3 (depending on the number of risks) to indicate where the student should look first, second, and third.
 - These risks do not have to be currently present but are potential risks.
6. If multiple lanes of traffic are in the same direction, steps 1 through 5 should be repeated before entering each traffic lane.
7. If there is two-way traffic for the crossing, steps 1 through 5 should be repeated for the 2nd part of the crossing.
8. Repeat steps 1 through 7, when applicable, for other crossings to reach the destination.
9. Gradually move to more complex intersections and have the student develop their own visual scanning plan.

Figure 3 demonstrates an example of a visual scanning plan for a simple two-way cross intersection controlled by stop signs, and Figure

4 demonstrates a complex offset intersection controlled by stop signs.

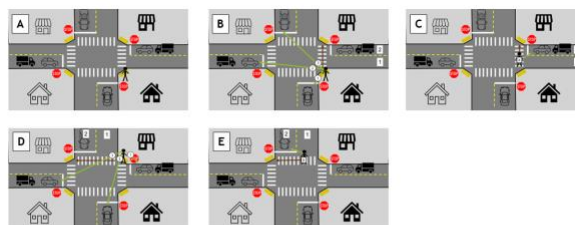


Figure 3. A) Schematic of a visual scanning plan of a simple two-way plus-shaped intersection controlled by stop signs. B) Visual scanning plan at the initial crossing on the southeast corner of the intersection; scanning plan ordered from 1 to 3. C) Visual scanning indicated after beginning the crossing (indicated by an X) before entering the second part of the crossing heading north. D) Visual scanning plan at the second crossing on the northeast corner of the intersection; scanning plan ordered from 1 to 3. E) Visual scanning indicated after beginning the crossing (indicated by an X) before entering the second part of the crossing headed west towards the destination.

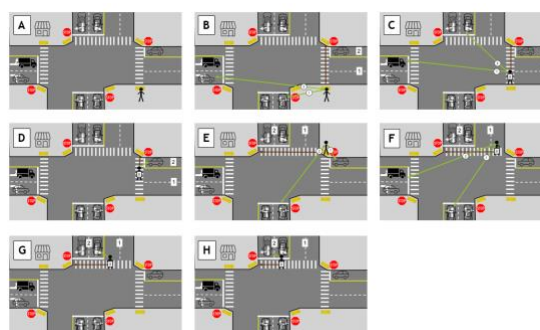


Figure 4. A) Schematic of a visual scanning plan of a complex two-way offset intersection controlled by stop signs and road markings. B) Visual scanning plan at the initial crossing on the southeast corner of the intersection; scanning plan ordered from 1 to 2. C) Visual scanning plan in the first lane of the first part of the crossing (indicated by an X) heading north; scanning plan ordered from 1 to 2. D) Visual

scanning plan in the second lane of the first part of the crossing (indicated by an X) heading north before entering the 2nd part of the crossing. E) Visual scanning plan at the second crossing on the northeast corner of the intersection; scanning plan ordered from 1 to 2. F) Visual scanning plan in the first lane of the second crossing in first part of the crossing (indicated by an X) heading west; scanning ordered from 1 to 2. G) Visual scanning plan in the second lane of the second crossing in the first part of the crossing (indicated by an X) heading west. H) Visual scanning plan in the first lane of the second crossing in the second part of the crossing (indicated by an X) heading west towards the destination.

Visual intersection analysis (VIA) checklist

Instructions for use

The following VIA checklist is represented for signalized intersections and unsignalized controlled by stop signs. These should be done at the

intersection in presence of the student and O&M after the risk analysis diagram and visual scanning plan. These strategies should not be implemented at unsignalized intersections with yield signs or no traffic control. These strategies assume that the intersection is crossable for pedestrians with low vision. Alternative strategies, should be implemented when the crossing is deemed unsafe due to traffic conditions, construction, weather conditions, or unpredictable events (Wiener et al., 2010, Jacobson, 1993). An analysis is performed only at the intended crossing. An analysis of the whole intersection is unnecessary and may confuse the student.

The O&M should check off an item for each element of the checklist. Check “yes” if an element was properly visually identified by the student. Check “no” if an element was not properly visually identified by the student. Check “unsure” if not certain if the element was visually identified (e.g., student seemed to be “guessing” or using other senses). Check “N/A” if this street crossing element is not present at a given intersection.

VIA checklist for intersections controlled by **stop signs**

Intersection _____

Date and time of day _____

Weather conditions _____

1. Finds correct approach corner position
☐ Yes ☐ No ☐ Unsure
2. Correctly identifies control on parallel street
☐ Yes ☐ No ☐ Unsure
3. Correctly identifies control on intersecting (e.g., perpendicular) street
☐ Yes ☐ No ☐ Unsure
4. Determines the direction of traffic on street to be crossed (vehicular and bicycle lanes)
☐ Yes ☐ No ☐ Unsure
5. Accurately estimates the width of the street (includes bike lanes, parked cars, and medians)
☐ Yes ☐ No ☐ Unsure
6. Identifies the destination corner (Mark N/A if accurately identifies road markings)
☐ Yes ☐ No ☐ Unsure ☐ N/A
7. Detects raised obstacles in crossing
☐ Yes ☐ No ☐ Unsure ☐ N/A
8. Correctly identifies potential risks associated with the crossing
☐ Yes ☐ No ☐ Unsure
9. Correctly describes the visual scanning plan associated with the crossing
☐ Yes ☐ No ☐ Unsure

VIA checklist for intersections controlled by **traffic lights**

Intersection _____

Date and time of day _____

Weather conditions _____

1. Finds correct approach corner position

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- ☐ Yes ☐ No ☐ Unsure
- 2. Correctly identifies vehicular traffic signals
☐ Yes ☐ No ☐ Unsure
- 3. Accurately estimates timing of vehicular traffic signals
☐ Yes ☐ No ☐ Unsure
- 4. Correctly identifies pushbutton/APS
☐ Yes ☐ No ☐ Unsure ☐ N/A
- 5. Correctly identifies pedestrian signals
☐ Yes ☐ No ☐ Unsure ☐ N/A
- 6. Accurately estimates timing of pedestrian signals
☐ Yes ☐ No ☐ Unsure ☐ N/A
- 7. Determines the direction of traffic on street to be crossed (vehicular and bicycle lanes)
☐ Yes ☐ No ☐ Unsure
- 8. Accurately estimates the width of the street (includes bike lanes, parked cars, and medians)
☐ Yes ☐ No ☐ Unsure
- 9. Identifies the destination corner (Mark N/A if accurately identifies road markings)
☐ Yes ☐ No ☐ Unsure ☐ N/A
- 10. Detects raised obstacles in crossing
☐ Yes ☐ No ☐ Unsure ☐ N/A
- 11. Correctly identifies potential risks associated with the crossing
☐ Yes ☐ No ☐ Unsure
- 12. Correctly describes the visual scanning plan associated with the crossing
☐ Yes ☐ No ☐ Unsure

The O&M specialist may direct the student to look at the vehicular and pedestrian traffic signals behind them if they are more visible and permit the student to look while standing in a safe area (e.g., on the curb or sidewalk). When the vision of the student does not allow them to correctly identify elements 2 and 5 in the VIA checklist the O&M should ask the student to monitor the flow of traffic for multiple cycles to determine if they can relate the visual information about the movement of vehicles, pedestrians, and/or bicycles to the unseen elements of the intersection. If the student is unable to, the O&M should provide precise and timely information to them. A student may be able to correctly identify unseen elements with further O&M instruction, such as when teaching visual exploration skills (e.g., eccentric viewing techniques) or the use of optical aides (e.g., telescope use).

Applying VIA checklist to generalize street crossings strategies

Once the O&M has indicated yes or N/A to all the following in the checklist, the student can begin to cross independently. If the O&M has checked unsure, more time for analysis should be given to the student or more lessons should be provided before affirming an independent crossing. Once the

O&M has completed the checklist with the student at several crossings of varying levels of complexity, they should begin to integrate the analysis by performing the VIA checklist mentally and use self-talk for the O&M to determine the potential gaps in analysis. Once the student has demonstrated mastery of the VIA checklist at multiple intersections of varying complexities, she can do the mental checklist without self-talk while the O&M monitors the safety. It is suggested to incorporate inaccessible intersections into the lesson to ensure that the student has recognized that the intersection is unsafe, cannot be crossed, and finds alternative strategies independently. Once the student has been deemed proficient (the crossing risks are reduced), he/she can perform the crossings independently of the O&M. Though this process is time-intensive, it enables the student to cross at new intersections with relative ease without the presence of an O&M. A student that has successfully integrated these approaches can not only visually analyze new intersections but can also determine when an intersection is not accessible or uncrossable.

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