The Animated “Eyes” Symbol as Part of the WALK Signal: An Examination of the Generality of its Effectiveness Across a Variety of Intersection Geometries and Timing Parameters

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Abstract

This series of studies examined the use of animated eyes as part of the WALK signal. In the first experiment the conflicts were examined before and after the animated eyes were introduced at two intersections with one way traffic on both streets, four intersections with two way traffic on both streets, and two intersections with one way traffic on one street and two way traffic on the other. Conflicts were reduced at crosswalks on all eight streets with significant reductions on 7 of the 8 streets. The second experiment examined whether it was better to have the eyes look in both directions, eyes scanning back and forth with equal dwell times in each direction, or only in the direction of the threat, unequal dwell times with the eyes looking longer in the direction of the threat, at crosswalks on one-way streets. The results of this study showed that looking one way was no more effective than looking both ways. The effect of varying the percentage of the time that the eyes message was repeated during the WALK interval on looking behavior and conflicts was examined in the second experiment, and third experiment. The results of this study show that having the eyes on during the entire WALK interval was no more effective than having the eyes alternately on for 3.5 seconds and off for 3.5 seconds, but having the eyes alternately on for 3.5 seconds and off for 7 seconds was somewhat less effective.

Previous work by Van Houten, Retting, Van Houten, Farmer and Malenfant (1999) has shown that an experimental animated light-emitting diode (LED) pedestrian signal head that included two eyes with eyeballs that scanned left and right significantly increased pedestrians' observing behavior and markedly reduced pedestrian-motor vehicle conflicts at two signalized intersections. Benefits were sustained over six months, suggesting they were not merely novelty effects. Both intersections examined in this research consisted of roads carrying two-way traffic. These finding are in agreement with earlier data reported by Zegeer, Cynecki and Opiela (1984) which showed that adding the words "WITH CARE" below the text message "WALK" signal reduced pedestrian/motor vehicles conflicts.

The research reported in this report examines the generality of the Van Houten et. al. finding by examining the efficacy of the animated eyes symbol with a variety of typical intersection geometries, and timing parameters.

Experiment 1: Multi Site Conflict Study

Method

Setting. This study was conducted at five signalized intersections in downtown St. Petersburg, Florida, two signalized intersections in Clearwater Florida, and one signalized intersection in Halifax, Nova Scotia, Canada. Two crosswalks were at intersection of one-way streets, four crosswalks were at the intersection of two-way streets, and two were at the intersection of a one-way street and a two-way street.

Data Collection. Three observers scored pedestrian/motor vehicle conflicts on weekdays between the hours of 9:00 a.m. and 4:30 p.m. Each session included the collection of data from 50 pedestrians starting to cross the street during the WALK interval at all eight intersections. A pedestrian/motor vehicle conflict was scored if the driver of a turning vehicle had to engage in abrupt braking, had to swerve to avoid striking the pedestrian being observed, or if the pedestrian had to take sudden evasive action to avoid being struck.

Inter-observer Agreement. Two observers independently scored pedestrian/motor vehicle conflicts during two sessions during the baseline condition and two sessions during the treatment condition at each of the eight sites. A measure of inter-observer agreement was computed by dividing the number of agreements on the occurrence conflicts by the number of agreements on the occurrence of conflicts plus disagreements. Inter-observer agreement was 100% for pedestrian-motor vehicle conflicts.

Apparatus. The equipment used in this research was an LED signal head. The ‘eyes’ display was populated with blue (460 nm) LEDs and consisted of two blue eyes with blue eyeballs that scanned left and right. The eyes were each 5 inches wide, 2.7 inches high and 2.25 inches apart. The WALK indication was an 11.2 inch-high outline of a walking person constructed from blue LEDs. The DON’T WALK indication was an 11.2 inch-high upraised hand constructed from orange (615 nm) LEDs. The DON’T START indication consisted of the flashing DON’T WALK, as specified in the Manual on Uniform Traffic Control Devices (U.S. Department of Transportation, 1988). A photograph of the device is shown below in Figure 1.

Figure 1 A Photograph of the experimental pedestrian signal.

Experimental Design. A before/after research design was employed in this research. Data were collected for 14 days at each site for a total of 700 pedestrian crossings during the baseline and treatment conditions.

Results

The number of conflicts per session observed at each of eight locations, before and after the treatment (baseline vs. animated ‘eyes’) is presented in Figure 2. It was hypothesized that there would be a decrease in conflicts as a result of the treatment. This was tested for each location, and for the total number of conflicts across all locations, using Wilcoxon-Mann-Whitney tests. This non parametric test was selected because the number of conflicts were non-normal but rather Poisson in nature. There is a significant (P=<05) decrease in median conflicts at 7 of the 8 locations, but the strongest and most interpretable result occurs across the total of all locations. In this case, the median number of conflicts drops from 8.5 (per 400 pedestrians) to just 1.0. As is seen, although actual numbers of conflicts are small in absolute term, this decrease is not just statistically significant, but can surely be considered to have practical value. The median number of conflicts decreased in the range of 59% to 94% (95%confidence interval). The results of the Wilcoxon-Mann-Whitney procedure across all 8 sites was significant at the .001 confidence level.

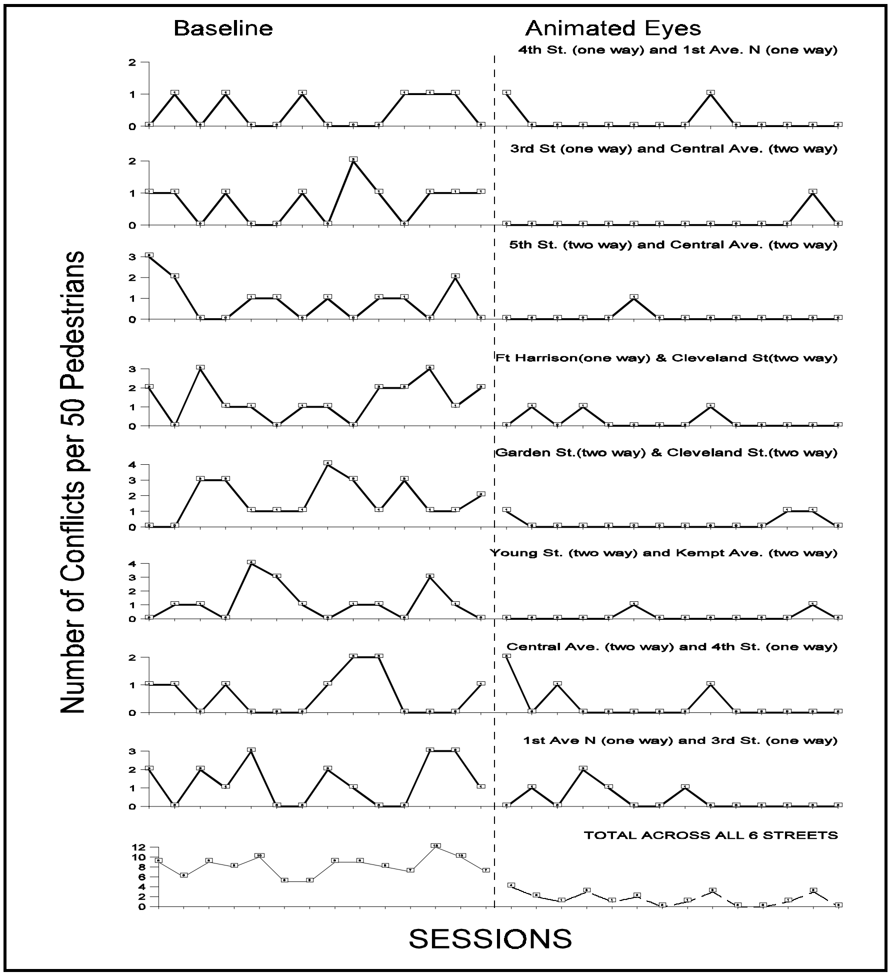

Figure 2 *The number of conflicts per session at each site and the total across all sites before and after the animated 'eyes' were installed.*

Table 1 shows the results of the Wilcoxon -Mann-Whitney procedure, adjusted for discrete distributions for each site. The null hypothesis is equality of the location parameter (i.e., medians), before and after the treatment, against the alternative that the location is shifted downward by the treatment.

Location	P-Value (2 decimals)	Location	P-Value (2 decimals)
4th St. & 1st Ave. N.	.05	3rd St. and Central Ave.	.01
5th St. & Central Ave.	.00	4th St. and Central Ave.	.07
1st Ave. N. and 3rd St.	.01	Ft. Harrison & Cleveland St.	.00
Garden St. and Cleveland St.	.00	Young Ave. & Kempt Rd.	.03

Discussion

These results confirm that the use of the animated 'eyes' can produce a significant reduction in motor vehicle/pedestrian conflicts that could be expected to translate into a meaningful reductions in crashes at signalized intersections. These data provide a systematic replication of the findings of Zegeer, Cynecki and Opiela (1984) who evaluated a "WALK WITH CARE" indication during the crossing interval at four test sites in three cities. They obtained significant reductions in total conflicts at all four sites. These data taken together with the results of the present studies demonstrate that modifying the WALK indication to remind pedestrians to be more cautious leads to significantly fewer conflicts between pedestrians and turning vehicles.

Experiment 2: Analysis of Directional Prompting and Repeated Prompting

One way to prompt a person to look in a particular direction is to repeatedly look in the direction you wish the other person to look. In many situations people will follow another persons gaze to see what they are looking at. One way to emulate directed looking with an animated 'eyes' display would be to increase the dwell time in the desired direction while decreasing the dwell time in the opposite direction. One purpose of the the second study was to examine whether increasing the dwell time in the direction of traffic at crosswalks on one-way streets would be more effective than having the eyes look both ways with equal dwell times.

In previous research Van Houten, Retting, Van Houten, Farmer and Malenfant (1999) compared having the eyes on only during the first 2.5 seconds of the WALK interval with repeating the 2.5 second presentation of the eyes every 7 seconds during the entire WALK interval. They found that repeating the eyes were more effective than just presenting it once at the start of the WALK interval. Another purpose of this experiment was to determine if repeating the animated eyes more often would be still more effective.

Method

Setting. This study was conducted at three signalized intersections in downtown St. Petersburg, Florida, 1st Ave North and 4 th Street, Central Avenue and 3rd Street, and Central Avenue and 5 th Street. First Avenue North and Fourth Street are one-way, four lane streets with 1 st Ave North carrying west bound traffic and 4 th Street carrying south bound traffic. Data were collected at the crosswalks on the west side of 1st Avenue North and the north side of 4 th Street because these crosswalks had conflict points with right and left turning traffic respectively. Central Avenue has one lane in each direction at the intersection with 3 rd Street and one lane in each direction with right turning lanes at the intersection of 5 th Street. Third Street is a one-way with four lanes carrying southbound traffic. Data were collected at the south crosswalk on Third Street because it had both right and left turning conflicts with vehicles turning from Central Avenue. Fifth Street is a four lane road with two lanes in each direction. Data were collected at each crosswalks on this street. All crosswalks were 10 feet wide and marked with two parallel white lines. The duration of the WALK indications were: 12 seconds for crosswalks on 1st Avenue North and 20 seconds for crosswalks on 4th Street; 6 seconds for the crosswalk at Central Ave and 4th Street; and 15 seconds all crosswalks at Central Avenue and 5th Street.

Data Collection. Three observers scored pedestrian's observing behavior and pedestrian/motor vehicle conflicts on weekdays between the hours of 9:00 a.m. and 4:30 p.m. Each session included the collection of data from 50 pedestrians crossing at the start of the WALK interval and as many pedestrians that could be scored crossing during the remainder of the WALK interval. To be scored as crossing during the start of the WALK interval the pedestrian had to begin to cross within 4 seconds of the start of the WALK indication. Pedestrians that started to cross during the remainder of the WALK indication were scored as crossing during the WALK interval. Because the WALK indication was only 4 seconds long at 3rd Street and Central Avenue, no pedestrians could be scored as beginning to cross during the WALK interval at this site.

Pedestrian observing behavior was scored whenever a pedestrian looked in the direction of a potential conflict before crossing the conflict path. Because turning vehicles can turn into more than one lane at the junction of two one-way streets the pedestrian had to check for turning vehicles before crossing several lanes. At 5th Street and Central Avenue the pedestrian had to look for vehicles turning right on red, left on green and right on green before entering the turning vehicle's lane of travel. To be scored as checking for a particular threat, a pedestrian had to orient his or her head in the direction from which the vehicle would be coming prior to and within three seconds of entering that vehicle path. From each group of waiting pedestrians, a lead pedestrian was selected. Pedestrians/motor vehicle conflicts were scored as described in the preceding study.

Inter-observer Agreement. Two observers independently scored pedestrian behavior and pedestrian/motor vehicle conflicts during two sessions for each research condition. A measure of inter-observer agreement was computed by dividing the number of agreements on the occurrence of each behavior by the number of agreements on occurrence plus disagreements. Inter-observer agreement averaged 85% for not looking for any threats, 90% for looking twice, 85% for looking for all threats, and 100% for pedestrian/motor vehicle conflicts.

Apparatus. The LED signal head with the 'eyes' display described above was employed during the treatment condition at each site. The signal head used in previous research (Van Houten, Retting, Van Houten, Farmer, & Malenfant, 1999) was redesigned so that scanning rate, dwell times, and presentation duration could each be programmed on site.

Experimental Design. A reversal design was employed at each site in this research. At 3rd St. and Central the eyes looking back and forth with equal dwell times was compared with the eyes looking one way (unequal dwell times). At 5th St. and Central alternating presenting the eyes on for 3.5s and off for 3.5s during the WALK interval was compared with alternating presenting the eyes on for 3.5s and off for 7s. Both interventions were examined at 4th St. and 1st Ave. North. The diagram presented below in Figure 3 shows the order that treatments were introduced at each site.

Figure 3

Treatment Diagram

4th St. and 1st Ave. North

Baseline	15 days								
Look both ways		9 days		17 days					
Look one way			12 days		17 days				
Eyes on 3.5s off 7sec	15day	9 days	12 days	17 days	17 days	7 days		11 days	
Eyes on 3.5s off 3.5s							11 days		19 days

3rd. St. and Central Ave.

Baseline	23 days						
Look both ways		10 days		9 days		14 days	
Look one way			9 days				
Look one way longer time					9 days		14 days

5th St. and Central Ave

Baseline	13 days			
Eyes on 3.5s off 3.5s		9 days		9 days
Eyes on 3.5s off 7s			8 days	

Following the baseline condition at the At 4th St. and 1 st Avenue North site the ‘eyes’ looking both ways (equal dwell times of 0.5 seconds in each direction) was first introduced. Next the eyes were programmed to look one way with a dwell time of 0.7 seconds in one direction and 0.3 seconds in the other direction (a value that equated cycle duration). This value was selected because the data from a human factors study showed that 30 out of 30 subjects stated that they perceived this display as looking in the direction of the longer dwell time. Next the device was programmed to look both ways again followed by a condition where the eyes looked only one way. Next the interval that the eyes were off was varied from 3.5 to 7 seconds.

At 3 rd Street and Central Avenue the ‘eyes’ looking both ways (equal dwell times of 0.5 seconds in each direction) was introduced following the baseline assessment. Next the ‘eyes’ were programmed to look one way (in the direction of the one way traffic) with a dwell time of 0.7 seconds in one direction and 0.3 seconds in the other direction. Next the device was programmed to look both ways again. After 9 sessions in this condition the ‘eyes’ display was programmed to look in the direction of the threat with a dwell time of 1 second and in the other direction with a dwell time of 0.25 seconds (the value which gave the best perception of directed looking in human factors testing). This condition was followed with a return to the ‘eyes’ looking both ways for 14 sessions and a return to the ‘eyes’ looking one direction with the 1 second and 0.25 second dwell times for the final condition. At 5th Street North and Central Avenue the ‘eyes’ looking both ways was introduced following the baseline condition with the ‘eyes’ on for the first 3.5 seconds of the WALK interval and repeated after being off for 3.5 seconds. Next the ‘eyes’ were alternately on for 3.5 seconds and off for 7 seconds. During the final condition the ‘eyes’ were alternately on for 3.5 seconds and off for 3.5 seconds.

Results

Data Analysis. An arcsin transformation was applied to stabilize the variances in each of the three statistical analysis. In addition, suspected outliers were detected and removed. This correction had no effect on the significance of any of the analyses. After the arcsin transformation there was no evidence of heteroscedasticity or non-normality ($P > .05$ in all cases). The data collected at 4th Street and 1st Avenue North were analysed with a one way anova with treatment groups broken down into baseline, eyes looking one way, eyes looking both ways, eyes repeated every 3.5 seconds and eyes repeated every 7 seconds. A significant difference among treatments was found in each case ($P= <.0001$). A Tukey’s analysis revealed that overall there were highly significant differences in the percentage looking for no threats and the percentage looking twice at the start of the WALK and during the remainder of the WALK between the baseline vs the animated ‘eyes’ condition (p= <.05) and that in each case repeating the eyes after 3.5 seconds was superior to repeating them every 7 seconds (p= < .05).

The data collected at 5th Street and Central Avenue were analysed with a one way anova with treatment groups broken down into baseline, eyes repeated every 3.5 seconds and eyes repeated every 7.5 seconds. Overall there were highly significant differences between the treatment groups (p= <.0001). The Tukey’s analysis revealed that this resulted from the baseline vs. animated ‘eyes’ contrast rather than the 3.5 second repeat interval vs. 7 second repeat interval contrast. The data collected at 3rd Street and Central Avenue were analysed with a one way anova with treatment groups broken down into baseline, eyes looking one way and eyes looking both ways. Overall there were highly significant differences between the treatment groups for the percentage not looking (F=54.14, P<.0001) and the percentage looking twice (F=8.63, P<.0001).   The Turkey’s contrast analysis indicated that the percentage not looking during treatment differed from baseline (p<.05). However, the percentage not looking did not differ between the two way and one way prompting conditions.

Discussion

The results of this research demonstrated that the use of the animated ‘eyes’ display was effective in increasing pedestrian observing behavior at all major urban intersection geometries. The results also showed that prompting pedestrians to look in the direction of the threat was no more effective than prompting them to look both ways.

There are several possible reasons why prompting pedestrians to only check for threats in one direction did not produce a marked improvement in the percentage of pedestrians looking for threats with turning vehicles: First, pedestrians who look both ways are as likely to see threats as people who only look in the correct direction. Second, most pedestrians who cross in downtown St. Petersburg are regular users, who are familiar with the streets and therefor already know which way to look for turning vehicles.

Although the use of directional prompts does not seem to present a major advantage at crosswalk applications it may be more useful in ITS applications where the threat can be detected as coming from a particular direction. For example, at garage exits pedestrians are usually not present, but when they are they could come from either direction and it is important that drivers know which direction to look first because they are only visible for a relatively short time before crossing the vehicle path. In this type of application directionality may offer significant advantages. Furthermore, it is possible to increase the directional effect by having a pictograph of the threat on each side of the 'eyes' display. The detection of a threat in one direction could then be associated with both eyes repeatedly looking in the direction of an illuminating the target symbol oriented in the direction that the pedestrian is crossing.

Although repeating the 'eyes' display was more effective in prompting pedestrians at 4 th St. and 1 st Ave N. it did not produce a significant improvement at 5 th St. and Central Ave. One possible reason for the small effect at 5 th St. and Central Avenue are differences in the site characteristics. At 4 th St. and 1 st Ave N. the approach to the intersection was less clearly visible because physical features such as outdoor eating establishments, awnings etc. could block the view of the signal head, while at the 5 th St. and Central Ave. site the intersection was relatively open and the signals could be seen by pedestrians approaching the intersection from a block away. Thus it is more likely that pedestrians would see the animated ‘eyes’ display as they approached this intersection. Another possible reason why little difference was detected at the 5th and Central Ave. site was that high levels of looking behavior at this site may have imposed a ceiling effect on further improvement.

Experiment 3: Presenting the ‘Eyes’ During the Entire WALK Interval

Because no sign of cognitive capture was noted in the previous studies the purpose of this study was to evaluate the effect of presenting the ‘eyes’ display throughout the entire WALK interval.

Method

Subjects and Setting. This study was conducted at 1st Ave North and 4 th Street in St. Petersburg, Florida between December/98 and January/99.

Data Collection. Observers scored pedestrian’s observing behavior and pedestrian-motor vehicle conflicts on weekdays between the hours of 9:00 a.m. and 4:30 p.m. Each session included the collection of data from 50 pedestrians crossing at the start of the WALK interval. To be scored as crossing during the start of the WALK interval the pedestrian had to begin to cross within 4 seconds of the start of the WALK indication. Pedestrians that started to cross during the remainder of the WALK indication were scored as crossing during the WALK interval. Pedestrian observing behavior and motorist/pedestrian conflicts were recorded in same way as described in the previous studies.

Apparatus. The equipment used in this research was the LED signal head described in the first field study.

Experimental Design. An ABA reversal design was employed in this research. The ‘eyes’ were programmed to look both ways (equal dwell times of 0.5 seconds in each direction) throughout the experiment. During the intermittent presentation condition the ‘eyes’ display onset was simultaneous with the onset of the WALK indication and terminated after 3.5 seconds. The ‘eyes’ display was then repeated after being switched off for 3.5 seconds. During the continuous presentation condition the ‘eyes’ were programmed to remain on during the entire WALK interval.

Results

The results of this study showed that fewer pedestrians starting to cross later during the WALK interval looked for no threats when the ‘eyes’ were presented continuously and that more pedestrians looked twice for threats when the ‘eyes’ were presented continuously. However, none of these differences were significant. Only one conflict was detected during this study.

Discussion

The results of this study show that presenting the animated ‘eyes’ throughout the entire WALK indication is not less safe than presenting the animated ‘eyes’ intermittently. Because it is technically easier to present the animated ‘eyes’ throughout the entire WALK interval it is recommended that crosswalk signals should be designed to perform in this manner.

General Discussion

The results of all this research and of previously reported studies (Van Houten, Retting, Van Houten, Farmer and Malenfant, 1999; Van Houten, Van Houten, Malenfant, & Andrus, 2000) document that the animated 'eyes' display can improve safety in a number of sites where it is important for drivers and pedestrians to look for potential threats. These results support these findings and show that the animated eyes display is effective at all common intersection geometries.

Because the animated eyes display prompt pedestrians to look for threats from turning vehicles they should be on during the entire WALK interval if it is an unprotected pedestrian phase. The eyes could be omitted when the pedestrian phase is exclusive.

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