

BLINKING YELLOW AT SIGNALISED PEDESTRIAN CROSSINGS: AN EVALUATION

Wiel Janssen and Richard van der Horst

TNO Human Factors Research Institute, Soesterberg, The Netherlands

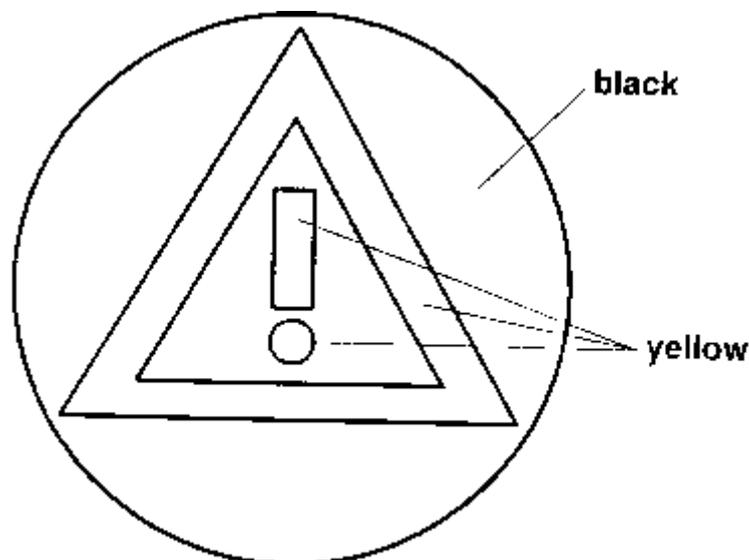
1 The problem

On standard signalised pedestrian crossings in the Netherlands an average of 45% of those arriving during red cross without waiting for the signal to turn green (Oude Egberink & Rothengatter, 1984). Since little enforcement at these sites is usually exerted it is often suggested that this form of undisciplined behaviour, apart from being inherently unsafe on its own, may generalise to other offences („halo“-effect). On the other hand, those who perform the offence say that it is rather silly to stop and be punished by long waiting times when you can see for yourself that it is perfectly safe to cross.

A proposal to find the middle ground between these different lines of reasoning is to replace the red pedestrian light by a device signalling „you may now cross at your own risk“. This would all at once reduce violations to nil, thereby removing the possibility of unwanted halo-effects, while acknowledging people’s capability of making their own judgements.

The actual device considered is shown in Fig. 1. It is the parts in this figure indicated as yellow that blink in the stage of the cycle that was formerly taken by the red light.

Fig. 1: Proposed „yellow blinking“ device.



Before giving municipal authorities the liberty of installing the yellow blinking device the Ministry of Transport thought it wise to have an a priori evaluation performed, concentrating both on the use per se that would be made of the device and on the safety effects associated with its use. This paper reports on that evaluation, which took the form of a before-and-after study on six signalised crossings (Janssen, Van der Horst & Van der Mede, 1991).

2 The Delft before-and-after study

2.1 Selection of locations

The study was performed in Delft, a medium-sized city in the West of the Netherlands which, with the Ministry's consent, acted as a volunteer test site.

Care was taken to select locations which differed in characteristics that could be considered to be of possible relevance (for example, whether the crossing was in the middle of a block or right on an intersection; whether the signal cycle was or was not conflict-free, that is, whether it contained „hard” or „soft” green for crossing pedestrians; etc.) In particular, the contrast between „hard” (exclusive) and „soft” green to pedestrians seemed of interest. A priori it seems only logical to combine an own-risk device with a setting of the green light that is conflict-free, i.e., in which you can be sure that your crossing will then indeed be riskless. It remained to be seen, however, whether this would indeed apply.

The crossings were also selected with an eye on whether they were regularly used by children and elderly people. These are the user groups that one could expect to experience difficulties when being faced with the decision whether or not to cross at their own risk.

Table 1 Characteristics of locations.

Location	Conflict on green?	Green on request?	Nr of lanes to cross	Nr of possible conflicts	
1 Minervaweg	no	yes	2	2	Mid-block
2 Papsouwsel. 1	no	yes	2	2	
3 Nassaulaan	no	yes	2	2	
4 N. Langendijk	yes	no	2	4	
5 Oosterstraat	yes	no	2	4	
6 Papsouwsel. 2	no	yes	3	1	

2.2 Design of study

The „before” and „after” measurements were taken with a one year interval between them (April 1989 - April 1990). The transition from „red” to „blinking yellow” took place at about 8 months into this interval (December 1989).

There were no control locations included at which „red” was not replaced by „blinking yellow”. This was because the change took place all over Delft at about the same time in a population of more than 50 crossings, which gave the municipality reason to think that it would be confusing to the public and bad service as well to leave crossings out from the transition. For this reason the study was a purely comparative one, assessing the differential effects of the introduction of „blinking yellow” for different locations without including a baseline.

The study comprised three elements:

- a Video analysis of actual crossing behaviour
- b Conflict observation
- c Analysis of numbers and types of accidents (for the entire population of pedestrian crossings in Delft).

3 *Video analysis of pedestrian crossing behaviour*

3.1 **Crossing at red and at blinking yellow**

Table 2 presents percentages of pedestrians, for each location, who crossed during red, respectively during blinking yellow. Table 3 does similarly, except that it contains only percentages referring to those arriving when the light was already red/blinking yellow. The latter is the most appropriate measure for indexing the inclination to cross against red per se (and also the one that was meant when it said in the beginning of this paper that there was a 45% average offence rate).

The conclusion, applying to both tables, is that the inclination to cross outside green has approximately doubled after the introduction of blinking yellow. It should also be noted that, although this increase is more or less the same for all locations, the absolute levels differ substantially.

Table 2 Percentage of pedestrians crossing at red/blinking yellow.

Location	Overall percentage crossing at:	
	Red	Bl. yellow
1 Minervaweg	19	31
2 Papsouwsel. 1	18	38
3 Nassaulaan	10	17
4 N. Langendijk	24	54
5 Oosterstraat	26	38
6 Papsouwsel. 2	14	36
Average	18	36

Table 3 Percentage of pedestrians who arrived at red/blinking yellow and crossed in that phase.

Location	Perc. Of those arriving at red/bl. yellow, crossing at:	
	Red	Bl. Yellow
1 Minervaweg	56	79
2 Papsouwsel. 1	40	64
3 Nassaulaan	11	20
4 N. Langendijk	31	64
5 Oosterstraat	46	72
6 Papsouwsel. 2	25	57
Average	34	61

3.2 Waiting times

Average waiting times before crossing are shown in Table 4. As is to be expected, because many more people crossed immediately and did not wait for green to appear, there is a considerable reduction in the average waiting time.

Table 4 Average waiting times (s).

Location	Red	Bl. yellow
1 Minervaweg	10	6
2 Papsouwsel. 1	21	13
3 Nassaulaan	13	13
4 N. Langendijk	23	20
5 Oosterstraat	12	7
6 Papsouwsel. 2	25	17
Average	17	13

3.3 Gap acceptance

The time gaps, both accepted and rejected, that crossing pedestrians showed with respect to vehicles intersecting their path were used to estimate so-called critical gaps. The critical gap is the time interval to an approaching vehicle that is accepted 50% of the time. The longer the critical gap, the safer a crossing can be said to be. Obviously, (critical) gaps only exist when there are indeed approaching vehicles, which is always the case during red/blinking yellow.

Table 5, pertaining to pedestrians crossing during red/blinking yellow, contains the results (for technical reasons the analysis could not be made for location 6).

Table 5: Critical gap (s) for pedestrians crossing during red/blinking yellow (when pedestrian rejected more than one gap before crossing longest rejected gap is used).

Location	Red	Bl. yellow
1 Minervaweg	4.2	4.2
2 Papsouwsel. 1	4.1	5.3
3 Nassaulaan	3.6	4.4
4 N. Langendijk	4.6	9.5
5 Oosterstraat	2.7	3.0
6 Papsouwsel. 2	-	-
Average	3.8	5.3

There is a clear tendency for the critical gap during a crossing outside green to have increased with the transition to blinking yellow. Location nr.4, which has only „soft” green to pedestrians, is no exception.

3.4 Gap acceptance for vulnerable groups

A separate analysis was done on gap acceptance by vulnerable groups, which were children (those judged from video to be less than 12 years old) and elderly people (those judged from video to be over 60 years old). Because the numbers of members of these groups using the selected locations turned, post facto, to be disappointingly low the data were collapsed for the five locations for which they were available. Critical gaps, estimated from the aggregated data, are shown in Table 6 for the group of vulnerable people (children and elderly people as compared to all others. It is apparent that the vulnerable group shows the same overall increase in the critical gap as the other users when red is replaced by blinking yellow. It is also interesting to note that the magnitude of the critical gap by itself is already 1 s larger for the vulnerable group.

Table 6 Critical gaps for crossing in red/blinking yellow: vulnerable group vs. others.

	Critical gap	
	Red	Bl. yellow
Vulner. group	5.4	6.4
Others	4.3	5.3

3.5 Proportions of short gaps that are accepted

It makes also sense to consider gap acceptance not only in terms of a critical gap, but in terms of accepted gaps and short gaps in particular only. These might in fact be a better index of risk actually experienced when crossing in front of an approaching vehicle.

A short accepted gap was defined as one in which the pedestrian crossed within 4 s of an approaching vehicle. Proportions of short accepted gaps, relative to total numbers of accepted gaps of any magnitude, are in Table 7. The average proportion is exactly the same in the „before” and „after” situations. It may be slightly worrying that this is not true for all locations. Specifically, location nr.4 (which is the „soft” green crossing) shows an apparent increase.

Table 7 Percentages of short <4 s accepted gaps (relative to total number of accepted gaps).

Location	Red	Bl. yellow
1 Minervaweg	39	30
2 Papsouwsel. 1	20	16
3 Nassaulaan	24	20
4 N. Langendijk	25	39
5 Oosterstraat	30	36
6 Papsouwsel. 2	-	-
Average	28	28

4 Conflict observation

Trained observers performed conflict observations on the spot, at the same time the video recordings for the behavioural analysis were made at that location, according to the so-called DOCTOR-method. The core of this method is that the occurrence and the severity of a conflict are judged on the basis of objective criteria, notably the relative speeds of those involved and the time-to-collision when a collision configuration exists (Van der Horst & Kraay, 1986). On the basis of these criteria conflicts are, furthermore, differentiated into non-serious and serious conflicts. In the present study conflicts were always between a pedestrian and a motor vehicle crossing his path.

Because it was known from the video recordings how many pedestrians actually used a crossing during the conflict observation period rates of conflicts per crossing pedestrian could be derived. These are shown in Tables 8 (for serious conflicts) and 9 (for non-serious conflicts), and they apply to pedestrians crossing during red/blinking yellow.

Given the limited numbers of conflicts that were actually observed one must be cautious in drawing „before” and „after” conclusions. What appears clear, however, is that there is little reason to worry about the possibility that the use of blinking yellow may generate an extra risk compared to the risk experienced when formerly crossing during red.

Table 8 Rate of serious conflicts for pedestrians crossing during red/blinking yellow.

Location	Rate per 100 pedestrians crossing during:	
	Red	Bl. yellow
1 Minervaweg	0.62	0.91
2 Papsouwsel. 1	1.07	0.00
3 Nassaulaan	4.00	1.69
4 N. Langendijk	1.32	1.21
5 Oosterstraat	0.81	0.00
6 Papsouwsel. 2	0.00	0.34
Average	1.18	0.90

Table 9 Rate of non-serious conflicts for pedestrians crossing during red/blinking yellow.

Location	Rate per 100 pedestrians crossing during:	
	Red	Bl. yellow
1 Minervaweg	1.86	0.46
2 Papsouwsel. 1	3.21	1.32
3 Nassaulaan	2.00	1.69
4 N. Langendijk	0.00	0.00
5 Oosterstraat	0.00	0.89
6 Papsouwsel. 2	0.00	1.02
Average	1.18	0.90

Conflicts were also scored for the green phase, in an effort to assess whether the replacement of red by blinking yellow would affect behaviour in that phase. Also, it should be reminded that two of the locations (nrs. 4 and 6) had a „soft” green cycle, so that conflicts could in particular occur on these two. What could be expected, in fact, is that the somewhat illogical combination of blinking yellow (cross at your own risk) with „soft” green (basically also: cross at your own risk, where people might now, however, expect „hard” green) could generate more conflicts during green.

Tables 10 and 11 show the relevant results. It seems that there is little reason for worry. In particular, locations 4 and 6 do not at all yield evidence that more risk may result from the combination of blinking yellow with „soft” green.

Table 10 Rate of serious conflicts for pedestrians crossing during green.

Location	Rate per 100 pedestrians	
	Red	Bl. yellow
1 Minervaweg	0.00	0.00
2 Papsouwsel. 1	0.00	0.00
3 Nassaulaan	1.29	1.25
4 N. Langendijk	0.58	0.00
5 Oosterstraat	0.35	0.56
6 Papsouwsel. 2	0.00	0.00
Average	0.37	0.30

Table 11 Rate of non-serious conflicts for pedestrians crossing during green.

Location	Rate per 100 pedestrians	
	Red	Bl. yellow
1 Minervaweg	0.00	0.00
2 Papsouwsel. 1	0.00	0.00
3 Nassaulaan	0.52	1.67
4 N. Langendijk	0.58	0.00
5 Oosterstraat	1.74	2.25
6 Papsouwsel. 2	0.00	0.00
Average	0.47	0.65

5 Accidents in the population of pedestrian crossings in Delft

Accident counts for the Delft population of signalised pedestrian crossings were obtained from files kept by the police. The „before” period was the last 3 years before the transition to blinking yellow, the „after” period the first 1.5 years after the transition.

It appeared that there were 2.7 accidents per year in the population (n = 59) in the „before” period and 2.6 in the „after” period. There was no apparent shift in the seriousness of the accidents.

When looking at only those locations that formed part of the present study it was found that there was 1 accident in the „before” period (at the Nassaulaan crossing) and none in the „after” period.

6 Conclusions

Replacement of the red pedestrian light by a device („blinking yellow”) signalling that crossing may be attempted at one’s own risk appears to lead to the following:

- The percentage of those crossing outside the green phase doubles.
- Correspondingly, average waiting times are reduced.
- Crossing outside green considered on itself has not become more unsafe, as indexed by gap acceptance data.
- The latter is also true for potentially vulnerable groups, i.e., children and elderly people.
- Conflict observation does not show a negative effect of the transition to blinking yellow, not even in combination with „soft” green.
- Similarly, accident figures do not show so.

7 Recommendations

On the basis of the above findings there should be nothing that prevents the liberal use of the yellow blinking device on signalised pedestrian crossings. A few points, though they did not result in negative effects in this study, may be important enough to merit further and more extensive investigation. These are:

- (1) The issue of „hard” versus „soft” green, particularly in connection with:
- (2) The issue of vulnerable (groups of) users.

References

Horst, A.R.A. van der, & Kraay, J.H. (1986). The Dutch conflict observation technique „DOCTOR”. In: Proceedings of the Workshop on „Traffic conflicts and other intermediate measures in safety evaluation”, Budapest: Institute for Transport Sciences.

Janssen, W.H., Van der Horst, A.J. & Van der Mede, P.H.J. (1991). An evaluation of „blinking yellow” on pedestrian crossings. Report IZF 1991 C-14 (in Dutch), TNO Human Factors Research Institute, Soesterberg, NL:

Oude Egberink, H.J.H. & Rothengatter, J.A. (1984). Red-light negation of pedestrians at signalised crossings: summary report. Report VK 84-05 (in Dutch), Groningen University, Traffic Research Centre, Haren, NL