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**Changes in Driver Behavior Resulting from Pedestrian Countdown Signals**

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**ABSTRACT**

This paper explores the effects that pedestrian countdown signals have on driver behavior. Observations of two intersections, one with pedestrian signals and one without, were made focusing specifically on driver behavior during the amber and red phases. It was found that drivers at the pedestrian countdown intersection were less likely to enter the intersection at the end of the amber phase than those at the traditional pedestrian signal intersection. It was also found that drivers at the intersections with traditional pedestrian signals exhibited different stopping behavior near the intersection, possibly related to sudden braking. This was determined by measuring the rate of vehicles stopping at each intersection per cycle.

## INTRODUCTION

Pedestrian countdown signals are used on urban streets to make crossing busy intersections safer for pedestrians. Instead of traditional pedestrian signals, which only display a “Walk” signal, a flashing “Don’t Walk” hand, and a solid “Don’t Walk hand,” pedestrian countdown signals replaces the flashing “Don’t Walk” with a numerical sequence that “counts down” the seconds remaining until the solid “Don’t Walk.” This extra information is intended to help pedestrians within view of the countdown make better decisions about when to cross, and at what speed, in order to complete their crossing before the pedestrian phase expires.

Several studies have evaluated the behavior associated with countdown signals in a variety of different settings (1,2,4). Most studies have looked primarily at pedestrian behavior, giving only minor attention to drivers. In studies that *have* looked at driver behavior, countdown signals had a negligible effect (4), although most focused on potential negative impacts and ignored the possibility that they would have a positive (i.e. safety-enhancing) effect on drivers and vehicular traffic.

Eccles, Tao and Mangum found that only one out of seven intersections studied showed statistically significant changes in mean and 85<sup>th</sup> percentile vehicle speeds when controlling for pedestrian countdown signals. However, sample sizes were small, ranging from 35 to 50 observations (2).

Botha, Zabyszny and Day , also found no statistical association for vehicles entering intersections during amber and red phases when controlling for pedestrian countdown signals (1). However, they looked at the number of occurrences (entries on amber or red) as a percentage of traffic overall , which may have obscured actual differences. Since entries on amber or red can only occur at or near the end of the green phase, a more apt measure would be the number of entries on amber or red as a percentage of the number of opportunities to enter.

This paper seeks to explore the possibility of positive and negative safety impacts from driver behavior at pedestrian countdown intersections in Berkeley, CA. On one hand, intersection safety may be improved if approaching vehicles are able to make informed decisions about whether to slow down or speed up when approaching an intersection such that red violations will be decreased. This phenomenon has been observed in European countries where vehicle signals employ a “flashing green” phase between the green and amber phases, which in effect warns drivers that the green phase is ending (3). On the other hand, intersection safety could be adversely affected if drivers overestimate their ability to cross the intersection and use the information from pedestrian countdown signals to speed through, potentially causing an increase in red light running.

## METHODOLOGY

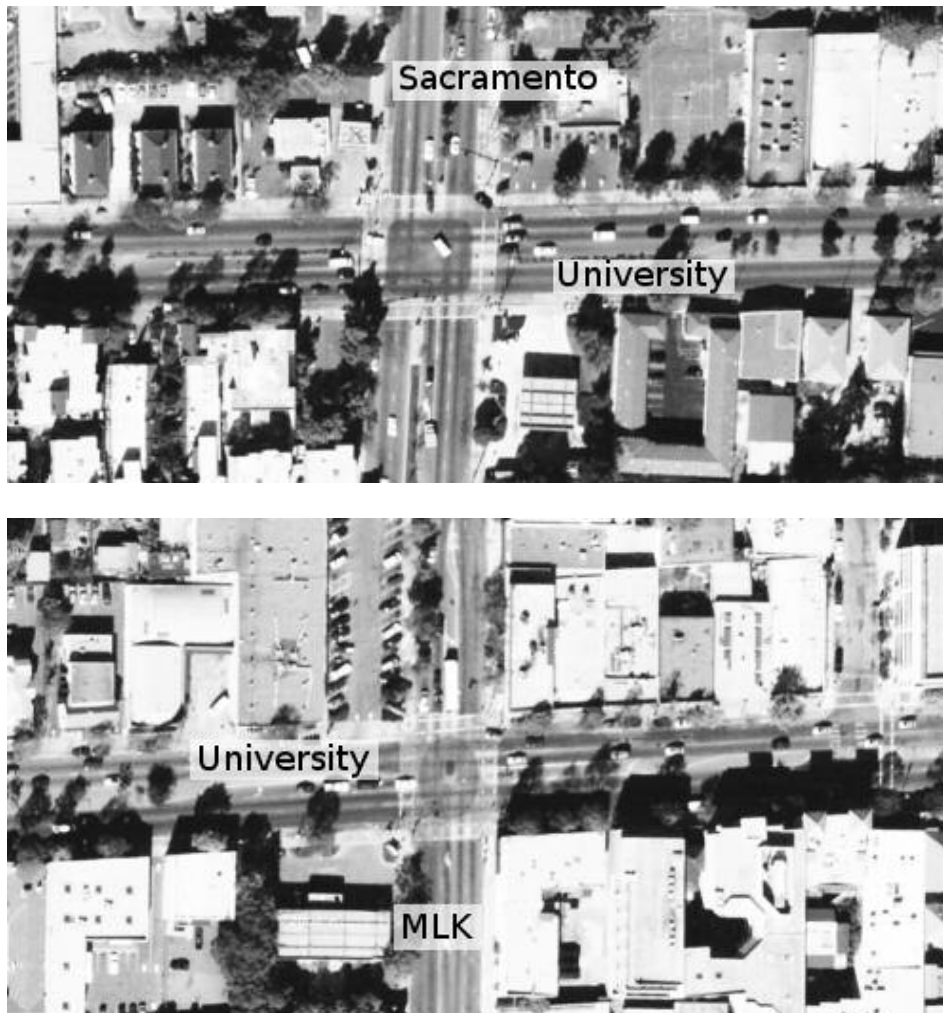
### The Study Sites

Two intersections in Berkeley, CA, with similar traffic flows and geometries, one with pedestrian countdown signals and one without, were observed for two days each in April 2006. The first was the intersection of University Avenue and Martin Luther King Jr. Way, which has pedestrian countdown signals installed at all four pedestrian crossings. The second was the intersection of University Avenue and Sacramento Street, which has traditional (flashing red hand) pedestrian signals.

University Avenue is a major east-west arterial, and both cross streets are major north-south arterials. The intersections are located four blocks apart and handle a similar level traffic and presumably similar types of drivers in terms of risk-taking behavior. There is a signal timing plan along University Avenue, with noticeable platoons, but upstream obstructions and turning traffic often cause them to arrive erratically.

Lane widths and geometries are similar at both intersections. There are two through lanes in each direction on University Avenue and two through lanes in each direction on each side of the cross streets. In addition all approaches have left and right turn pockets. The posted speed limit is 25 mph across the study corridor. There is a landscaped median throughout much of the length of University Avenue, but at each intersection, the median narrows to accommodate a left turn pocket. Several hundred feet upstream of the intersection at University Avenue and Martin Luther King Way is an uncontrolled “T” intersection, which dead ends. Figure 1 shows the two study sites.

**Figure 1: The study sites – University Avenue at Sacramento Street and University Avenue at Martin Luther King Jr. Way**



**Observation**

The two sites were observed over two days each, once on a Friday and once on a Tuesday, during the mid to late afternoon. Approximately 80 cycles were observed on each day, giving a total sample size of 323 cycles. At University Avenue and Martin Luther King Way, from 10:00 am to 4:00 pm, the cycle length is 80 seconds, and from 4:00 pm to 7:00 pm the cycle length is 85 seconds. At University Avenue and Sacramento Avenue, from 10:00 am to 2:00 pm the cycle length is 80 seconds, and from 2:00 pm to 7:30 pm the cycle length is 95 seconds. Each intersection’s pedestrian phase is a total length of 26 seconds: the signal displays “Walk” for 7 seconds and then the flashing “Don’t Walk” or the pedestrian countdown for 19 seconds. The extra ten seconds of cycle time at University and Sacramento between 2:00 pm and 7:30 pm is given to through traffic proceeding east-west on University and should not have an effect on the study since the focus is on amber and red phases, which are unchanged throughout the day. One difficulty that arose during observation was that platoons would clear the intersection before the green phase ended, since there is some level of signal coordination on University, leaving no vehicles to be observed. It was found that there was an adequate number of eastbound vehicles at the University and Sacramento intersection for observation near the end of the green, and sufficient westbound traffic at University and Martin Luther King. Observations were made roughly 80 feet upstream of the intersection so that vehicle braking could be seen.

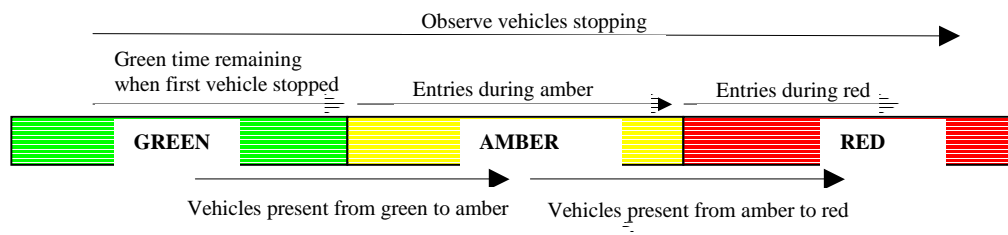
*Pedestrian Behavior*

Pedestrian flows across the study intersections were not recorded because initial field visits to both sites revealed that pedestrian activity was small enough such that pedestrians did not cause a significant impact to drivers proceeding along University. In addition, the presence of right and left turn pockets ensured that any vehicles slowing for pedestrians crossing either Sacramento or Martin Luther King before making right or left turns off of University Avenue would not impede traffic upstream.

*Driver Behavior*

Driver behavior for all through-moving vehicles from the tail end of the green phase to the end of the red phase (2 to 3 seconds before amber, amber phase, beginning of red phase) for the direction of traffic being observed was recorded. Vehicles executing turns were excluded. The majority of the green phase was not observed because it was hypothesized that through traffic would be unaffected by the pedestrian countdown signals during that part of the cycle. Similarly, only the part of the red phase when vehicles were most likely to enter, near the transition from amber to red, was observed.

**Figure 2: Depiction of driver behavior observations over the course of a single cycle**



The following observations were recorded during a given cycle: the green time remaining when the first vehicle in each lane stopped at the intersection, the number of vehicles already present in the intersection when the signal turned from green to amber, the number of vehicles entering the intersection during the amber phase, the number of vehicles present in the intersection when the signal turned from amber to red, and the number of vehicles entering the intersection during the red phase. All of these groups are mutually exclusive, that is, if a vehicle entered during the amber phase, but was in the intersection when the phase turned to red, it would be counted as a vehicle entering when the signal turned from amber to red, and would not be counted as a vehicle entering on amber. Figure 2 describes these observations' parameters over the course of a cycle.

A vehicle was considered to be already in the intersection if the vehicle was fully in the intersection at the time of the phase change. The intersection is defined by the cross walk lines, where the beginning of the intersection is anything past the first upstream crosswalk line, and the end of the intersection is the furthest downstream crosswalk line. If a vehicle was observed to be crossing a boundary when a phase change occurred, it was considered to be entering the intersection. Unusual occurrences that impeded traffic such as instances where a vehicle double parked in a lane or bus failed to fully pull in to a stop were also noted.

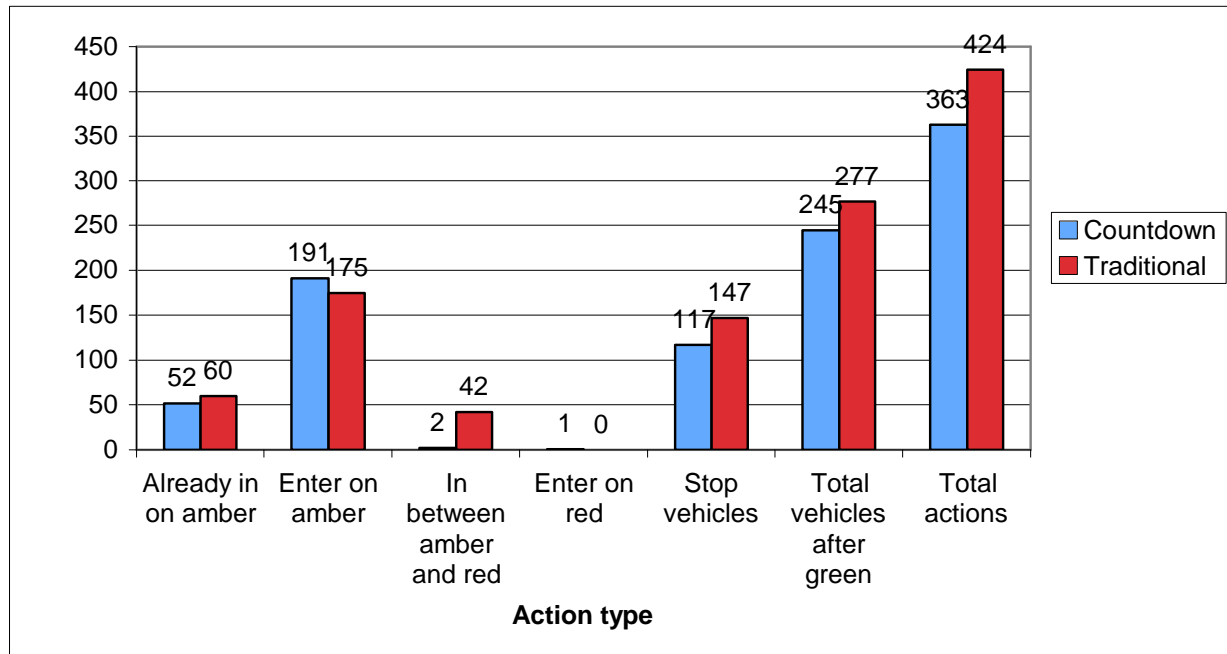
It was hypothesized that if drivers are using pedestrian countdown information to make decisions in advance of the amber phase, there would be some observable change in the number of vehicles entering the intersection at the end of the green phase, or some change in the time that vehicles begin to slow down, depending on the risk-tolerance of individual drivers.

Observations were made on four separate days over two weeks in April. Each intersection was observed once on a Friday from approximately 1:00 pm to 3:00 pm and again on a Tuesday from approximately 5:00 pm to 7:00 pm. After several hours of observing the pedestrian countdown signal intersection, it became apparent that drivers almost never slowed down before the amber. Only six occurrences over 163 cycles were observed, with one of those resulting from a downstream blockage.

## **RESULTS**

Data from the four observations were aggregated; Figure 3 plots the frequency distributions of each action by signal type.

**Figure 3: Distribution of observed vehicle actions**



The number of total vehicle actions that occurred after green (already in on amber, entering on amber, in the intersection during the period between amber and red) is higher for the traditional intersection. Likewise, the total number of actions, which include vehicle stops and entries on red, is also higher for the traditional intersection, yet both are insignificant at the 95% confidence level (although total vehicle actions after green is significant at the 90% confidence level).

The largest disparity between the traditional and countdown intersections was for vehicles that were in the intersection when the amber phase ended and the red phase began. There were only two such occurrences at the pedestrian countdown intersection versus 42 in the traditional intersection. This may result from drivers having less information to make a decision when approaching a traditional intersection, resulting in “last second” attempts to cross at the tail end of the amber. In contrast, at the pedestrian countdown intersection, drivers may be adjusting their speed upon approaching the intersection so that they have ample time to either clear the intersection or stop in anticipation of the red light. Table 1 presents the per-cycle rate of the driver behaviors observed in the study, along with tests of statistical significance. It shows that the difference between traditional and pedestrian countdown intersections is significant when looking at vehicles entering between the amber and red phase. Studies of European intersections where the traffic signal flashes green between the green and amber phases found that the number of crossings decreased once the amber phase began. In comparison, amber phase crossings at traditional signals were uniformly distributed across the length of the amber phase (3).

The number of observed vehicles that stopped at the beginning of the intersection, opting to wait for the next green phase, was significantly higher for the traditional signal intersection. Whereas the drivers of vehicles that entered the intersection when the phase changed from amber to red could be described as risk-taking, those who stopped on amber could be considered risk-avoiding. In both intersections vehicles stopped near the end of the phase; however vehicles were only counted as stopping if they were seen by the observer, who was stationed roughly 80 feet upstream of the intersection.



The extra information that the countdown signal gives may lengthen the distance before the intersection where they can make a decision about whether to maintain their speed, accelerate in order to cross the intersection, or decelerate in order to stop and wait for the next phase. This longer decision period may reduce the number of situations where risk-taking or risk-avoiding comes into play. In other words, they should be less likely to find themselves in situations where they have to either accelerate through the intersection at the end of the amber phase because they are going too fast to stop in time comfortably, or be forced to stop abruptly.

**Table 1: Observation results and statistical tests**

Average action/cycle	Countdown (N=163)	Traditional (N=160)	Diff	t-stat	p-value
Already in on amber	0.319	0.375	-0.056	-0.924	0.178
Standard Deviation	0.585	0.569	0.061		
Enter on amber	1.172	1.094	0.078	0.758	0.448
Standard Deviation	0.979	0.983	0.103		
In on amber to red	0.012	0.263	-0.250	-7.028	0.000 *
Standard Deviation	0.110	0.469	0.036		
Enter on red	0.006	0.000	0.006	1.051	0.293
Standard Deviation	0.078	0.000	0.006		
Stop vehicle(s)	0.718	0.919	-0.201	-2.579	0.010 *
Standard Deviation	0.716	0.769	0.078		
Vehicles after green	1.509	1.731	-0.222	-1.682	0.093
Standard Deviation	1.178	1.335	0.132		

\* significant at 95% confidence

## CONCLUSION

Based on the limited observations made, drivers exhibit different behavior depending on the type of pedestrian signal used. Where there is a pedestrian countdown signal, drivers may be using the information to aid them in crossing the intersection. The implications for intersection safety are unclear. The results provide evidence that in traditional intersections there is a significantly higher number of vehicles as the amber phase expires, which would have potentially adverse effects on safety. However, drivers using pedestrian countdown information may feel more comfortable entering the intersection at higher speeds, making them less able to avoid an unexpected vehicle or pedestrian. Furthermore, drivers may be so focused on the pedestrian countdown, which is normally located off to the side of the road, that they find it more difficult to respond quickly to the environment around them.

This study was intended as a coarse measurement of driver behavior. Although the sample size was large enough to draw inferences, a larger one may reveal more about less frequent driver actions such as red light running, and braking behavior before the amber phase. Another weakness of the study was the inability to use a perfect control; although measures were taken to ensure that the two intersections were as similar as possible, there is still a possibility of intersection-specific effects playing a role in driver behavior. Further studies may be warranted to combine these discrete observations of driver behavior with measures of traffic flow and vehicle speeds upstream and downstream of the intersections.

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