*PEDESTRIAN JAYWALKING UNDER
FACILITATING AND NONFACILITATING CONDITIONS*

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Each year, thousands of pedestrians are killed or injured while crossing streets in the United States. Pedestrians who jaywalk across busy intersections increase their risk of being injured by an automobile. The present series of studies investigated pedestrian jaywalking behaviors under temporal conditions which appeared to control noncompliance and compliance with pedestrian walk signs. An intersection involving three major streets was the target site of the studies. The timing of walk and no-walk light sequences was different in the clockwise and counterclockwise direction and produced differential delays. In three separate studies, significantly more pedestrians jaywalked when walking in the long-delay as opposed to short-delay direction. Traffic planners might use these findings to establish safer pedestrian signal systems.

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In recent years, behavioral psychologists have had considerable impact on transportation systems by prompting energy conservation (Foxy & Hake, 1977), promoting safety programs (Geller, Casali, & Johnson, 1980), reducing speeding (Houten, Nau, & Marini, 1980) preventing accidents (Jason, 1977; Larson, Schnelle, Kirchner, Carr, Domash, & Risley, 1980), and encouraging use of mass transit (Everett, 1980; Lavelli & Jason, Note 1). One of the most serious transportation-related problems concerns deaths and injuries due to traffic accidents. In 1975, 44,820 people were killed in traffic accidents in the United States. Of this number, 8,155 were pedestrians (Vital Statistics of the United States, 1979). This latter statistic strongly indicates a need for mounting controlled investigations to identify strategies for reducing the alarming number of pedestrian traffic accidents.

Several studies have been aimed at investigating safety programs to reduce the incidence of pedestrian traffic accidents. For example, Wilson and Raab (Note 2) observed few pedestrians

using a crossway which traversed a street with heavy vehicle traffic. When a sign ("Enjoy the view. Please use crossover.") was placed at the entrance, usage of the crossway increased from 18% to 28%. In a study involving elementary school children, Yeaton and Bailey (1978) found that normally only 40-50% of youngsters displayed correct street crossing behaviors (e.g., wait at curb, look all ways) during a baseline phase. When safety skills were taught (e.g., waiting at the curb, looking in all directions), 95% of the children used correct pedestrian street crossing behaviors.

Traffic planners have often taken responsibility for establishing large-scale traffic lighting systems, which are designed to engineer an optimal flow of both vehicular and pedestrian movement (Hobbs, 1979). Computerized traffic signal systems have been installed in many metropolitan areas (Chicago's computerized traffic control system, 1979). Evaluations of these traffic flow systems have usually focused on molar-type variables such as the number of stops, amount of delay, and number of accidents. More fine-grained analyses of specific contingencies, operating on both vehicles as well as pedestrians,

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have not been conducted. For example, some schedules of light-timing sequences might encourage individuals to violate traffic regulations. Studies focusing on signalized intersections might be prime target areas for these types of analysis, since these are the locations for numerous pedestrian accidents (Jennings, Burki, & Onstine, 1977).

The present study assessed jaywalking behaviors when the timing of pedestrian signals either facilitated or impeded compliance. Under facilitating conditions, the pedestrian walk lights were set up such that after pedestrians had crossed one street, they only had to wait a few seconds before being allowed to cross the second street. In contrast, under nonfacilitating conditions, each time one street was crossed, pedestrians had to wait about 30 sec before being allowed to traverse a second street. It was predicted that overall rates of jaywalking would be higher under a nonfacilitating pedestrian light system than a facilitating system.

EXPERIMENT 1

The site of the study was a busy intersection on the north side of Chicago. From 1977 to 1980, there were 152 traffic accidents at the target intersection; 39 individuals were injured, 10 of whom were pedestrians. Three major streets crossed at this intersection. Because of heavy pedestrian traffic, there were pedestrian signals on each street ("Don't Walk" flashing signal; "Don't Walk" steady signal; and "Walk").

Two observers collected data on the timing of the pedestrian lighting system between 4:00 and 4:15 p.m. for 11 days. After a "Walk" sign appeared, the observers would traverse a street, using the average amount of time to cross a specific street. (Two observers used separate stop watches to record the number of seconds it took for each of ten pedestrians to walk across each of the six streets. The Pearson correlation coefficient between the observers' independent recordings was .92 ($p < .01$). The average amount

of time to traverse each of the streets ranged from 11 to 14 sec.) They would then time the number of seconds it took for the next pedestrian sign to signal "Walk." This delay averaged 33 sec (range 31-34 sec) on each street walking clockwise and 10 sec (range 8-12 sec) walking counterclockwise. The correlation coefficient for two independent observers was .99 ($p < .01$). Overall, the pedestrian walk and no-walk signs were on an equal amount of time in the clockwise and counter-clockwise directions. The timing of the light sequences was, however, different in both directions. If a pedestrian walked clockwise, the second street that was crossed would involve an average wait of about 33 sec. If a pedestrian walked counterclockwise, the second street they crossed would involve a wait of only about 10 sec.

For 11 days, between 4:15 and 5:15 p.m., the number of pedestrians who complied with and violated the pedestrian signals were counted. Each street was observed for 10 min (the order of observing streets was randomized each day). Complying with the pedestrian signal was defined as a pedestrian walking across the street either when the "Walk" sign was on or when the flashing "Don't Walk" sign was on as long as the person was at least 3 feet from the curb when this flashing sign appeared. Crossing the street under any other conditions was counted as a violation. Two independent observers collected data for one session using the above system, and they obtained 100% reliability (agreement/agreements plus disagreements).

Across the 11 days, walking counterclockwise, an average of 7% of the pedestrian (92 out of 1,347; range of 4% to 14% for different streets) violated the signs. In the other direction (clockwise), an average of 26% of the pedestrians (338 out of 1,305; range 17% to 35%) were in violation of the pedestrian signs. Using the Mann-Whitney U test, there were significantly more violaters for the clockwise as opposed to the counterclockwise direction ($U = 0$, $p < .01$). As expected, the amount of time waiting for pedestrian lights to turn was significantly

longer for the clockwise as opposed to the counterclockwise direction ($U = 0$, $p < .01$).

EXPERIMENT 2

Experiment 1 evaluated overall rates of jaywalking for pedestrians walking clockwise or counterclockwise. Many pedestrians within this study, however, only walked across one street. Therefore, the facilitating or nonfacilitating contingency of walking across the second street was not operating for these single street crossers. Experiment 2 focused on only those pedestrians who crossed a second street. The number of seconds for pedestrian lights to change was timed each day. Each street was observed for 10 min, between 4:15 and 5:15 p.m. over a 10-day period. (The order of observing streets was randomized daily.) Interrater reliability on one session was 89%.

Based on an independent assessment, when complying with pedestrian signals, pedestrians had to wait an average of 10 sec (range 9 to 12) traveling counterclockwise, and an average of 34 sec (range 33 to 35) going clockwise to cross the second street. This difference was significant ($U = 0$, $p < .01$). In addition, significantly fewer ($U = 0$, $p < .01$) pedestrians (2%; 11 out of 547 pedestrians; range 0% to 7% for different streets) violated the signs in the counterclockwise as opposed to the clockwise direction (38%; 192 out of 509; range 24% to 49%).

EXPERIMENT 3

Experiment 3 lasted 5 days, and included a similar observational system as described in Experiment 2. The only difference was that only pedestrians who crossed the first street just when the light changed from "Don't Walk" to "Walk" were included in the study. This controls for problems in the previous studies (e.g., pedestrians who only crossed one street were included in Experiment 1. In Experiment 2, pedestrians could have reached the second street at times

when jaywalking would not have been possible). When individuals in Experiment 3 reached their second street to cross, pedestrians traveling in both directions had an opportunity to jaywalk. Pedestrians walking clockwise were confronted with a flashing "Don't Walk" sign on the second street to be crossed. Since these individuals saw the light change just before being able to cross the second street, it was predicted that many would jaywalk. Pedestrians who crossed counterclockwise were confronted with a "Don't Walk" sign on the second street but for a shorter time (10-12 sec). For one hour, jaywalking behaviors were recorded at the second traversed street. For the clockwise direction, jaywalking occurred after an average of waiting 1 sec, and for the counterclockwise, 2 sec.

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Fig. 1. Average percentage of violations for pedestrians traveling in a clockwise (long-delay) or counterclockwise (short-delay) direction.

36 sec, range 35-37) than the counterclockwise direction (mean = 11 sec, range 10-12) ($U = 0$, $p < .01$). Significantly more pedestrians ($U = 0$, $p < .01$) jaywalked in the clockwise (70%; 100 out of 142) as opposed to the counterclockwise direction (2%; 4 out of 161). Jaywalking data for the counterclockwise streets were 5%, 0%, 0%, 0%, 20%, 5%, and for the clockwise streets, 53%, 82%, 100%, 70%, 66%, and 65%.

Social Validity

At the end of the study, a verbal questionnaire was administered to 18 pedestrians waiting at a corner of the intersection. Only pedestrians who indicated that they regularly crossed more than one street in both directions at the target intersection were given the questionnaire. On the average, the participants crossed the intersection 10 times per week (range 2-20), for an average of 6 years (range 1-45). On a scale from 1 to 5, with 1 signifying very safe and 5 very dangerous, the average pedestrian rating for this intersection was 4.1 (range 3-5). The pedestrians were also asked: "In crossing the streets you mentioned above, if you obey the "Walk" and "Don't Walk" signs, does it take less time for you to walk one way (point) or the other way (point)?" Seventeen of the pedestrians indicated there was no difference in times. One pedestrian indicated that it was quicker walking clockwise (counterclockwise is actually the quicker way).

DISCUSSION

Under facilitating conditions, significantly fewer jaywalking episodes were observed, in part due to the fact that when pedestrians traversed one street they only had to wait a few seconds at the next street before observing the onset of a green "Walk" signal at the second street. In the nonfacilitating direction, pedestrians always had to wait at the corner of the second street, after crossing the first target street. If a pedestrian, walking clockwise, began crossing a street following the onset of the green "Walk" light, the

flashing "Don't Walk" sign began flashing on the next street which the pedestrian might cross just as the pedestrian crossed the first street. Many pedestrians jaywalked at this point rather than wait at the street for about 30 sec. Arriving safely at the other side presumably negatively reinforced the entire behavioral episode.

Given the robust effect of these contingencies on the pedestrian jaywalking behaviors, it was unexpected to find that none of the interviewed pedestrians were aware of the longer delays in crossing streets under nonfacilitating versus facilitating conditions. In part, this might be because many pedestrians jaywalked under nonfacilitating conditions and their actual time traversing streets might have been equivalent for both directions. Many pedestrians complied with the light signals, however, even under nonfacilitating conditions, and still the verbal reports indicated a total lack of recognition of the differential contingencies.

Ubiquitous salutary and deleterious contingencies directly influence and shape the behavior of millions of people. The public is often unaware of these contingencies. This supposition, as well as the findings from the present study, suggests an alternative conceptual role for the applied behavioral psychologist. Contingencies operating within community and societal settings can be explicitly documented and the findings used in developing more planned, facilitating contingencies. The findings from the present study have been given to the Commissioner of Traffic for the City of Chicago. The authors hope to develop a collaborative relationship with this public official in an effort to acquaint the Commissioner with functional relationships in real-life settings, and the possibilities inherent in planning light-timing sequences that facilitate compliance with stipulated rules.

Laboratory studies have assessed the aversive properties of delays in reinforcement schedules and their effects on patterns of preferential responding in infrahumans (Honig & Staddon, 1977). Schedules of reinforcement are also of importance in naturalistic settings. The present

study documented different schedules of light-timing patterns in a heavily traversed inner-city intersection. Future research in this area might profitably incorporate either a factorial design (comparing direction with numbers of street crossings) or reverse the delay length midway through the study (e.g., clockwise could be made the quicker route). Even without these two methodological refinements, the present studies did clearly document nonoverlapping levels of jaywalking under facilitating and nonfacilitating conditions. These findings suggest that behavior analysts might profit from exploring naturalistic contingencies affecting the public, disseminating such information to policy formulators, and ultimately working toward reforming institutions and designing systems that possess systematically verified benevolent contingencies.

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