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Decision Processes and Risk Taking in Traffic: Driver Response to the Onset of Yellow Light

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A field study examined the relationship between the drivers' distance from an intersection (0–100 yards [0–91.4 m]) when the light changed from green to yellow, and the probability that the drivers would proceed through the intersection. The function relating the two variables approximated a normal ogive, but there was additional evidence that drivers took both distance and speed into account in deciding whether to proceed or stop. Among the drivers who were at intermediate distances (40–60 yards [36.6–54.8 m]) when the light changed, the younger males were more likely both to proceed and to violate the red light than were other drivers. The latter finding could be attributed to the younger males' faster driving and the related tendency to ignore the consequences of the decision conflict induced by the yellow light.

The automobile occupies an important place in Americans' daily habits and general life-style. Unfortunately, it is also a prominent factor in death and injury statistics and the cause of considerable human suffering, medical expenses, and loss of wages (Haddon, Suchman, & Klein, 1965; Roberts, 1971). Nevertheless, most of the research to date has involved the post hoc analysis of accident records, in an attempt to identify accident-prone categories of drivers (Haddon et al., 1965; Roberts, 1971), and the use of mathematical models and computer simulation in the analysis of traffic flow (Gazis, 1972; Heimstra, 1970). In contrast, the knowledge about the behavior and decision making of average drivers or categories of drivers in typical traffic situations is quite limited. There is a need for field research on variables related to particular kinds of driver behavior in specific driving situations.

One possible research strategy is to select common traffic environments and conduct an in-depth analysis of the variables governing driver behavior in such settings (cf. Ebbesen & Haney, 1973). By isolating a single traffic setting and concentrating on the behavioral alternatives open to drivers in this setting, the controlling variables may be reduced to a manageable number, and an understanding of the basic components of driver behavior might be gained.

Such a strategy was used in the present research. The study focused on the behavior of drivers who approached an intersection on a green light, which then changed to yellow. In this situation, each driver's alternatives were (a) to drive through the intersection or (b) to stop. Given that both risk to life and legal repercussions may be involved in proceeding through an intersection after the onset of the yellow or red light, the course of action that a particular person took clearly reflected a nontrivial decision. Yet, all drivers have to make such decisions many times a day. The present study attempted to identify factors in the individual (e.g., sex and age) and in the situation (e.g., the distance from the intersection when the light changed to yellow, speed, lane positioning, and presence/absence of passengers), which might affect the decision to stop or proceed, and the probability of being "caught" by the red light. In addition, we were interested in the drivers' immediate reaction to the onset of the yellow light and in the manner in which the decision to stop or proceed was executed (i.e.,

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the acceleration and deceleration patterns). Finally, an issue of interest was the way in which drivers combined speed and distance information.

The interaction of organismic and situational variables examined by the present study is of considerable applied interest. Male drivers tend to be involved in a significantly greater number of fatal and nonfatal accidents than female drivers, even when the total number of miles driven is taken into account (Roberts, 1971). Young male drivers have to pay considerably higher automobile insurance premiums than older or female drivers. Two different explanations have been offered for these facts (Roberts, 1971). One emphasizes the sex and age differences in general driving style, presumably reflecting differences in psychological characteristics such as caution and competitiveness. The other invokes the hypothesis that male and younger drivers, due to various social contingencies, tend to drive a relatively greater proportion of the total miles under unfavorable driving conditions (notably in rush-hour traffic and at night) in comparison to older or female drivers. By concentrating on driver behavior under favorable driving conditions in a near-optimal setting, the present research could help elucidate whether or not there are basic differences in the driving habits of different categories of drivers.

METHOD

Setting

The setting was an intersection controlled by traffic lights on California Highway 1, designated as a "prime artery" by the San Diego Department of Transportation. The study focused on a 140-yard (127.9-m) stretch of road in the two northbound lanes, from a 100-yard (91.4-m) point before the intersection to the end of the intersection. This section of Highway 1 is adjacent to the University of California, San Diego campus, and the pedestrian traffic on the sidewalks was moderate. The speed limit was 45 miles per hour (72.4 km) and the traffic flow was about 11 vehicles per minute, taking into account both northbound lanes.

The side street with which Highway 1 forms the intersection is one of the three major campus arteries. The traffic was about 10 vehicles per minute each hour at the full hour when classes ended, but was otherwise much lighter. The lights in the intersection were fully traffic and pedestrian controlled: The green light for Highway 1 changed only if there were waiting pedestrians (about 10% of the time) or waiting cross traffic (about 90% of the time). Pedestrians could change the light by pushing a button, but the change was not instantaneous (the lag ranging from 1 sec to about 30 sec depending on traffic conditions). The yellow light lasted for an average of 2.99 sec ($SD = .08$, based on 77 observations taken on different days). This is true for all intersections in San Diego (information from the department of transportation), which means that the drivers were generally familiar with the yellow light duration. The length of the red light depended on the amount of cross traffic.

The waiting cross traffic was entirely obscured from the view of the drivers approaching the intersection by trees in the median strip and a continuous stretch of elevated ground (3-yards [2.7-m] high) east of the northbound Highway 1 lanes. However, the traffic lights were visible from at least 300 yards (274.2 m) before the experimental section and remained visible through the entire approach to the intersection, as well as through 90% of the intersection itself.

Subjects

The subjects in the experimental sample were 100 men and 44 women traveling in the northbound lanes who encountered a change of light from green to yellow while in the 100-yard stretch before the intersection. Given that the observer was ready to take an observation, the only other qualification for a driver to be a subject was that no car traveled ahead of him or her in the same lane at any point in the 100-yard stretch. With these restrictions, all approaching cars were processed. The subjects were, in essence, randomly assigned to the physical distance from the intersection at which they found themselves when the yellow light occurred.

In addition, the speed and characteristics of members of a control sample of 106 drivers (77 men and 29 women) were observed. These people traveled through the entire 140-yard stretch without encountering a yellow or red light. Otherwise, they were observed under conditions similar to those for the experimental sample.

Procedure

The data were collected during a period of over 2 months, on weekdays, during daylight hours (rush hours were avoided), in excellent weather conditions, by two carefully trained observers working one at a time. An observer was located near the pedestrian traffic light control button at the intersection, next to the southbound lanes. From this point, the observer had a clear view of the entire 140-yard stretch of road in the northbound lanes, but was completely unobtrusive. For the purpose of the study, the 140-yard stretch in the northbound lanes was divided into six parts, starting at the 100-yard point before the intersection: 100–80 yards, 80–60 yards, 60–40 yards, 40–20 yards, 20–0 yards, and 0 to −40 yards, the last 40 yards being the intersection itself. White sticks were placed unobtrusively in the median strip between the northbound and southbound lanes at the 100-, 80-, 60-, 40-, 20-, 0-, and −40-yard (91.4-m, 73.1-m, 54.8-m, 36.6-m, 18.3-m, 0-m, and −36.6-m) points, controlling for parallax. An observer could clearly see these sticks, and thus estimate when a car entered a particular stretch of road in the northbound lanes. The observer was equipped with a Datamyte portable recorder (Model DAK-8, Electro/General Corporation). The recording device consisted of an electronic "clipboard" on which entries were made by pressing appropriate keys, a built-in clock, and a cassette tape recorder (Norelco 1420) that registered entries on magnetic tape in the form of sound signals. Information from the tapes subsequently served as input to a Datamyte 608 Coupler, which was connected to a PDP-12 computer. The type, time of occurrence (with reference to an arbitrary zero point), and relative duration of observed events could thus be retrieved and analyzed, the smallest possible time unit being 1 sec.

When a car approached the 100-yard point in one of the northbound lanes facing a green light, the observer pressed the pedestrian traffic light control button. This usually caused the light to change from green to yellow when the subject's car was somewhere between the 0- and 100-yard points. As soon as the car reached the 100-yard point, the observer made an entry. Such entries were made for the same car at each of the six points if the car came to a stop at the intersection, or at seven points (including the −40-yard point) if the car went through the intersection. An entry was also made marking the time when the yellow light came on. The observer estimated each driver's sex, age (below 30 years old or over 30 years old), and whether or not the vehicle contained passengers. The lane in which the subject's car traveled, whether or not there were any other cars in the other lane at any point in the 100-yard stretch, and whether or not any of these cars passed the subjects were also noted. Finally, the observer recorded whether there was any car within 20 yards behind the subject in the same lane at the time when observation started at the 100-yard point.[1]

Results

Control Sample

A control sample of 106 drivers who proceeded through the entire 140-yard stretch on an uninterrupted green light was studied to obtain information about speed and lane positioning. The sample consisted of 34 younger men and 10 younger women and 43 men and 19 women of older appearance. In comparison to older males, the younger were far more likely to travel in the left (vs. right) lane, $\chi^2(1) = 23.66$, $p < .001$, corrected for continuity. They were also somewhat less likely to have passengers, $\chi^2(1) = 3.66$, $p < .06$, also corrected. No such patterns were evident for the women. In all, there were 24 younger men without passengers traveling in the passing lane (23% of the whole sample). These people differed significantly from the remaining 82 people in terms of average speed and the severity of speed limit (45 miles per hour) violations. They took an average of 3.29 sec to travel the 100-yard stretch before the intersection (about 62 miles per hour [99.8 km]), as opposed to 4.25 sec (48 miles per hour [77.2 km]) for the rest of the sample ($z = 6.08$, $p < .001$, two-tailed test, by the Mann-Whitney U test for large samples). Similarly, they took an average of 1.13 sec (72 miles per hour [115.8 km]) to cross the 40 yards of the intersection itself, in comparison to 1.56 sec (52 miles per hour [83.7 km]) for the remaining members of the sample ($z = 6.53$, $p < .001$). Thus, the entire sample further increased the speed in the intersection. The speed increment (from 62 to 72 miles per hour, calculated on the time data) was quite drastic for the younger passengerless males in the left lane (Wilcoxon's $T = 7$, $p < .001$), but also significant (from 48 to 52 miles per hour) for the remainder of the sample ($z = 4.89$, $p < .001$, two-tailed test, by the matched-pairs signed-ranks Wilcoxon's T test for large samples).

Experimental Sample

Speed. The first issue to be considered is the effect of the onset of the yellow light on the speed of drivers who encountered it and nevertheless proceeded through the intersection. Of the 144 people (100 men and 44 women) who encountered a change of the traffic light to yellow within 100 yards of the intersection, a total of 48 (33%, i.e., 38% of the men and 23% of the women) decided to go through

[1] Observers' task was facilitated by the features of the equipment and the practice they had had. The breadth of the median strip, and the fact that observers were stationed by the southbound lanes, combined to make the observation unobtrusive. Reliability checks were carried out at random intervals throughout the study. These checks revealed substantial interobserver agreement (.82–.95) on all measures.

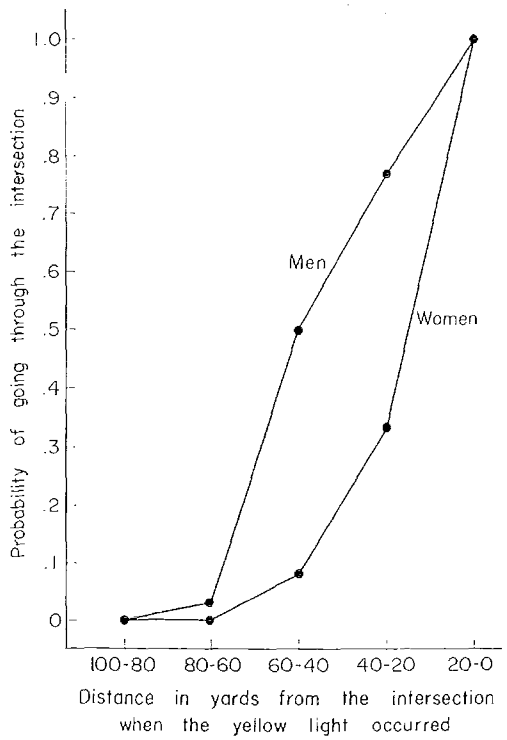

FIGURE 1. Probability of going through the intersection as a function of the sex of driver and the physical distance from the intersection when the yellow light occurred. (In the 100–80-, 80–60-, 60–40-, 40–20-, and 20–0-yard conditions, there were, respectively, 18 men, 10 women; 29 men, 7 women; 26 men, 12 women; 13 men, 9 women; and 14 men, 6 women.)

the intersection rather than stop. The 48 subjects who went through the intersection crossed the 100-yard stretch before the intersection in 5.50 sec on the average (about 37 miles per hour [59.5 km]), and the 40 yards of the intersection in 1.88 sec (about 44 miles per hour [70.8 km]). Like the controls, these subjects accelerated in the intersection ($z = 5.15$, $p < .001$, by the Wilcoxon T test), but generally traveled significantly slower than the controls ($z = 5.84$, $p < .001$, by the Mann-Whitney U test), possibly because the occurrence of the yellow light induced a conflict as to whether or not to proceed, resulting in a decrease in speed.

Probability of proceeding through the intersection. The physical distance from the intersection at which the 144 experimental subjects found themselves when the yellow light occurred had a considerable effect on the probability of their proceeding through the intersection. This relationship is shown in Figure 1 for men and women separately. It is evident that the probability of going through increased in a lawful manner as the distance from the intersection decreased. Also, there was an interaction between the distance and sex-of-driver factors, such that only in the 60–40-yard and 40–20-yard groups were men more likely than women to proceed through the intersection, $\chi^2(1) = 4.47$, $p < .05$ and $\chi^2(1) = 2.57$, $p < .15$, respectively, corrected for continuity. Of the 60 subjects in these two conditions, 27 went through; of these, 23 were male (only 4 of the 21 women did so).

The 60–40-yard and 40–20-yard distance conditions may be considered critical in the sense that the associated probability of proceeding through the intersection was close to .50. Therefore, these groups were broken down further in terms of age of driver, traveling in the right versus left lane, and presence versus absence of passengers, with stopping versus not stopping as the criterion. This choice of variables was dictated partly by the fact that they differentiated the control sample drivers in terms of speed. A significantly greater proportion of younger, as opposed to older, males in the 60–40-yard group proceeded through the intersection, $\chi^2(1) = 7.96$, $p < .01$, corrected for continuity. In contrast, age had no differential effects for women in the 60–40-yard group and for either men or women in the 40–20-yard group. In addition, younger males in the 60–40-yard group were somewhat more likely to drive in the left rather than the right lane, $\chi^2(1) = 3.43$, $p < .08$, corrected for continuity. Of the 13 men in the 60–40-yard condition who proceeded through the intersection, 9 appeared under 30 years of age, and of these, 7 drove in the left lane. Among the men in the 40–20-yard group, there was a nonsignificant predominance of the younger ones among those who drove in the left lane ($p < .20$). However, driving in the left versus right lane had no effect on the proportion of men proceeding through versus stopping ($p < .40$). Other variables, such as the presence versus absence of passengers and the presence versus absence of vehicles in the adjoining lane or behind the subject, had no effect on the probability of driving through the intersection.

Probability of being caught by the red light. In terms of risk taking, we considered the probability of drivers being in the intersection at the onset of the red light as a function of the distance from the intersection at which the yellow light occurred. Since the 20-yard stretch in which a driver had been located at the time when the yellow light occurred was known for each subject, his or her position when the red light came on could be calculated quite accurately from the individual cumulative-time data, given that the duration of the yellow light was also known.[2] For the purpose of the estimate, it was assumed that each subject was at the midpoint of a 20-yard stretch when the yellow light came on (i.e., at the 10-, 30-, 50-, 70-, or 90-yard [9.1-m, 27.4-m, 45.7-m, 63.9-m, or 82.3-m] points, depending on the experimental condition). A conservative estimate was also made assuming that each subject was at the point closest to the intersection in a 20-yard stretch when the yellow light occurred (e.g., the 40-yard point for a subject in the 60–40-yard condition).

The probability of being in the intersection when the red light occurred is shown in Figure 2 as a function of the distance from the intersection. The data for men and women are presented separately, and both the nonconservative and conservative estimates are given.

None of the subjects in the 100–80-, 80–60- and 20–0-yard blocks were in the intersection when the red light occurred (except for one man in each of the two latter conditions). Drivers in the further two blocks generally did not even attempt to enter the intersection, while those in the closest block had ample time to get through before the onset of the red light. In contrast, a considerable number of the 60–40-yard and 40–20-yard subjects were in the intersection when the red light came on, particularly male subjects in the 60–40-yard condition (among whom those appearing under 30 years of age were overrepresented). Even by the conservative estimate, 8 such people overlapped the red light (31% of all male subjects in the 60–40-yard group and 62% of those males in the group who crossed the intersection). Across all conditions in the study, 9 men and no women were in the intersection when the red light occurred, even by the conservative estimate.

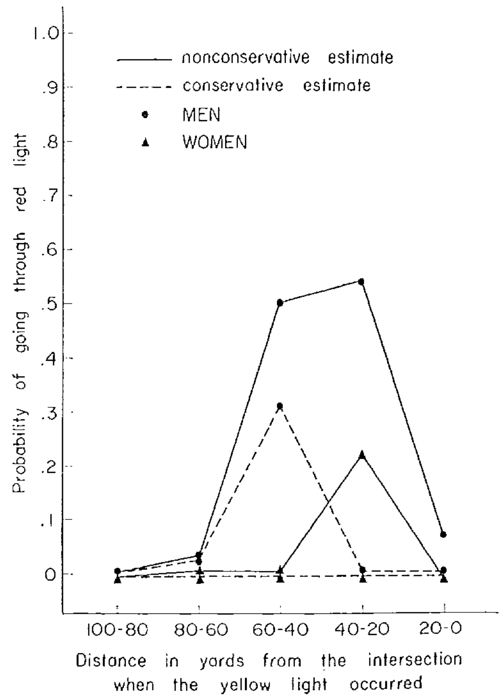

FIGURE 2. Probability of going through the red light as a function of the sex of driver and the physical distance from the intersection when the yellow light occurred.

Acceleration and deceleration patterns. In order to gain an understanding of the decision processes involved, it is important to examine the behavior of various groups of subjects over the entire stretch of road for which the data are available. The mean cumulative time taken by groups of subjects to reach various 20-yard points before and in the intersection is presented in Figure 3. The data for subgroups of people who did or did not go through the intersection within each condition are presented separately.

[2] This procedure was necessary because it had been expected that only a negligible number of people would drive through the red light. For this reason, observers did not directly record the onset of the red light.

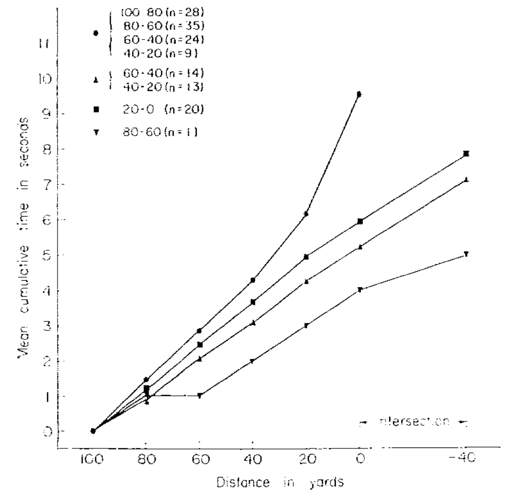

FIGURE 3. Mean cumulative time in seconds taken to reach different distances before and in the intersection as a function of the physical distance from the intersection when the yellow light occurred, and of whether or not subjects proceeded through the intersection. (In the two cases where several conditions are represented by a single line, as shown in the legend, the standard deviations of the condition means are so small that they cannot be adequately indicated by the customary vertical bars.)

Several points should be made about these data. First, people who eventually came to a stop seem to have reached the various 20-yard points at about the same time, irrespective of the distance condition they were in. A single line portrays quite accurately the decelerating behavior of subjects in the 100–80-, 80–60-, 60–40-, and 40–20-yard conditions who came to a stop.

Second, it seems that the division of subjects into those who eventually stopped and those who eventually went through was completed by the 80-yard point. Prior to this point, and again after the 40-yard point, the subjects who eventually stopped had traveled more slowly than those who eventually went through. Thus, it seems that the driving speed as far as 80 yards from the intersection had much to do with whether or not a person went through, and with the likelihood that at least a part of the crossing would overlap the red light. Data on the behavior of young male drivers from both the control and experimental samples illustrate this point.

Third, the curve for subjects who eventually came to a stop begins to deviate radically only at the 40-yard point from the curves for subjects who eventually went through (between the 80- and 40-yard points the curves are essentially parallel). However, the deviation is primarily due to the former subjects' deceleration. The 60–40-, 40–20-, and 20–0-yard subjects who eventually went through had begun to accelerate only as late as the 20-yard point. In view of this, it is not surprising that so many of the 60–40-yard subjects who crossed overlapped the red light. The curve for the 60–40-yard subjects who went through is indistinguishable from that for the 40–20-yard subjects who also went through (see Figure 3); yet, the former subjects were further from the intersection when the yellow light occurred. Apparently, a judgmental error had been committed by many of the 60–40-yard subjects.

Immediate reaction to yellow light. Information about the subjects' immediate reaction to the onset of the yellow light could be obtained by comparing the time taken by subjects in a given condition to travel the 20-yard stretch where the yellow light occurred to the time these subjects took to cover the next 20 yards. These data, presented for individual subjects, are shown in Figure 4. Panels A to D contain the results for subjects in the 100–80-, 80–60-, 60–40-, and 40–20-yard conditions who came to a stop. The data for subjects in the 80–60-, 60–40-, 40–20-, and 20–0-yard conditions who went through the intersection are shown in Panels E to H.

From Panels A to D, it is clear that subjects who eventually came to a stop reacted to the onset of the yellow light by slowing down considerably, irrespective of how far from the intersection they found themselves when the yellow light occurred. A high proportion of the 100–80-yard subjects slowed down in the 80–60-yard stretch, in comparison to the 100–80-yard stretch ($p = .064$ by the two-tailed sign test; see Panel A in Figure 4). A similar, immediate slowdown response was also exhibited by subjects in the 80–60-, 60–40-, and 40–20-yard conditions who eventually came to a stop ($p = .038$, .001, and .016, respectively, by the two-tailed sign tests; see Panels B, C, and D).

In contrast, the speed with which the 60–40-, 40–20-, and 20–0-yard subjects who

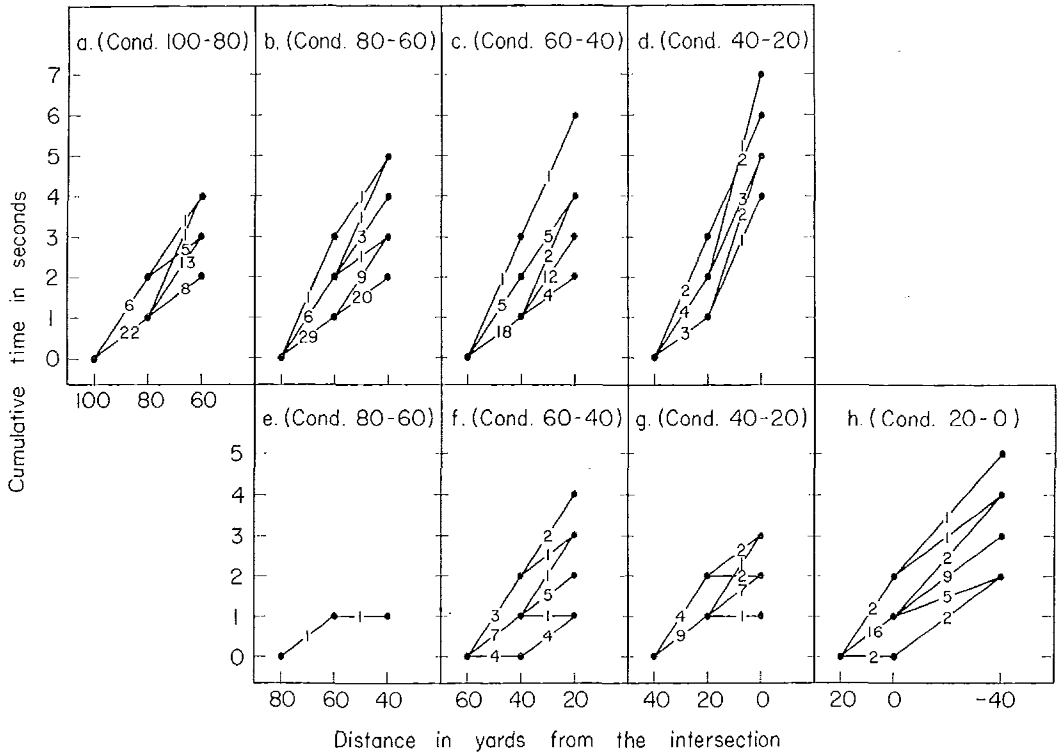

FIGURE 4. Cumulative time in seconds that it took individual subjects in the various distance conditions to reach the end of the 20-yard stretch in which the yellow light occurred, and to reach the end of the subsequent 20-yard stretch. (Panels A to D provide the data for subjects in various conditions who came to a stop; Panels E to H are for subjects who eventually went through the intersection. The moment at which a subject entered the 20-yard stretch in which he or she encountered the yellow light was treated as time zero. Numbers on the lines indicate the number of subjects who took a particular length of time to travel a 20-yard stretch.)

eventually crossed the intersection covered the 20 yards in which they, respectively, encountered the yellow light, did not differ from their speed in the next 20 yards. As is clear from Panels G and H (see Figure 4), both the 40–20- and 20–0-yard subjects sped up somewhat in the 20-yard stretch after encountering the yellow light, but this trend was not significant ($p = .22$, by the two-tailed sign test, for the 40–20-yard subjects; $p \approx .50$ for the 20–0-yard subjects). The speed with which the 60–40-yard subjects traveled the 40–20-yard stretch was also not significantly different from that in the 60–40-yard stretch ($p = .45$); in fact, these subjects tended to *slow down* (see Panel F in Figure 4), even though they were initially further from the intersection than the 40–20-yard and 20–0-yard subjects.

Speed and distance processing. The way in which the 60–40-yard male subjects combined information about the speed at which they were traveling when the yellow light came on with information about their distance from the intersection at that time should also be examined. (Such analyses could not be carried out for women, due to the small number of subjects.) For this purpose, males in the 60–40-yard and 40–20-yard groups were compared. The median cumulative time subjects took to cover the respective 40 yards preceding the 20-yard stretch where the yellow light occurred was 2 sec. Of the 10 males in the 60–40-yard group who traveled slower than the median prior to their 20-yard yellow light stretch, only 2 (20%) went through the intersection. Both of these accelerated in the 60–40-yard stretch in comparison to the average for the 100–80-yard and 80–60-yard stretches, but they still overlapped the red light even by the conservative estimate. However, 11 of the 16 60–40-yard subjects (69%) who traveled faster than the median prior to the 20-yard stretch in which the yellow light occurred proceeded through the intersection. Of these, 4 traveled the 60–40-yard stretch only as fast as the average of the 100–80-yard and 80–60-yard stretches, and 4 traveled slower than the average; all 8 went through the red light even by the conservative estimate. The remaining 3 subjects accelerated in the 60–40-yard stretch and overlapped the red light only by the nonconservative estimate. A similar breakdown of the 40–20-yard male subjects, in terms of traveling slower or faster than the median in the 80–60-yard and 60–40-yard stretches, yielded 67% and 80%, respectively, going through the intersection. The pattern of results for the 60–40-yard subjects differed significantly from that for the 40–20-yard subjects, $\chi^2(3) = 8.81$, $p < .05$. The driving speed prior to the occurrence of the yellow light had far less of an effect on subjects who were closer to the intersection (the 40–20-yard group), in comparison to those who were 20 yards further on the average (the 60–40-yard group).

Thus, the 60–40-yard males took into account both speed and distance in making the decision whether or not to proceed. The few slow-moving subjects who eventually went through accelerated immediately, but overlapped the red light despite this. However, it was predominantly the fast-moving subjects who eventually drove through the intersection. These subjects slowed down or failed to accelerate, the consequence being passage through the intersection in the presence of the red light.

Discussion

Like other complex behaviors, driving involves many related decisions that are undoubtedly affected both by situational and organismic factors. An example of such a decision is the speed at which a person drives in a given situation relative to other drivers and the speed limit. Data from the control sample showed that, in comparison with other drivers, young male drivers drove faster and increased their speed in the intersection more. Young males also chose to drive predominantly in the passing lane and were often without passengers who could potentially exert a restraining influence (cf. Ebbesen & Haney, 1973).

Such a driving-speed decision increased the risk involved in driving in general.[3] Further increasing speed in the intersection may also be hazardous, because of various kinds of interference typical of intersections (e.g., protruding automobiles waiting to make a left turn; right-hand turns on a red light, which are legal in California). Moreover, the decision to drive fast probably contributed to the young males' overrepresentation among drivers in the experimental sample who proceeded through the intersection. Namely, drivers seemed to take both speed and distance into account, that is, to "compute" *temporal* distance. It follows from this statement, and is substantiated by the data in Figure 3, that across different physical distances the fast-moving drivers (mostly young males) would be more likely to proceed through the intersection.

A passage through an intersection after the onset of the yellow light may increase the probability of accidents because it is accompanied by an increase in speed, a slowing-down pattern of other drivers who have decided to stop, and the mentioned interference within the intersection. The risk is presumably further augmented if the passage is carried out in the presence of the red light. In 1974, about 65% of automobile accidents in San Diego (excluding freeways, ramps, alleys, and parking accidents) occurred in intersections, as opposed to midblocks (data from the San Diego Department of Transportation). In our study, the Highway 1 driver's vision of the waiting and approaching cross traffic was obscured by the structural aspects of the intersection. In addition, the lights were traffic controlled. To most of the Highway 1 drivers, the yellow light should have indicated the presence of cross traffic or pedestrians (lights in the newer areas of San Diego are usually traffic controlled).[4]

[3] Roughly 7% of all automobile accidents in San Diego are directly related to speeding (unpublished data by the San Diego Department of Transportation).

[4] Of all the intersection-related accidents in San

In the experimental sample, the red light violations were committed almost exclusively by the young male drivers. While this tendency seemed to be a consequence of driving fast prior to the onset of the yellow light, and the decision to proceed through the intersection after it came on, an important qualification is in order here. Most of the drivers who overlapped the red light were at a certain critical distance (40–60 yards) from the intersection when the yellow light came on. The data for the 60–40-yard subjects who drove through—mostly young males—also indicated that these subjects tended to *slow down* after the onset of the yellow light. It can be assumed that such behavior was due to the decision conflict. The decision to drive through may have been based on the temporal distance from the intersection, one component of which was speed *prior* to the time when the decision was made (i.e., just before the onset of the yellow light). The decision may have been correct had the speed remained constant. However, the judgment to proceed seemed not to take into account the time taken by the processing of the yellow light onset, and the resulting decrease in speed. In short, drivers failed to revise the decision to proceed following the conflict-induced time (speed) loss.

It is likely that the underestimation of the time taken by the decision making is not restricted to the young male drivers. However, other drivers may not find themselves in situations where a conflict would arise. They may rarely be at critical distances from the intersection while driving at a high speed. Moreover, lower speeds and smaller distances from the intersection may be processed more quickly. A driver moving slowly, who is 30 yards away when the light changes to yellow, may need less time for decision making than a person driving fast, who is 50 yards away, although the temporal distance may be equal. To extend this reasoning, young males may be involved in a disproportionately large number of accidents because they often have to engage, as a consequence of driving fast, in time-consuming decision processes.

Apart from several near misses, no accidents were observed in the study, but it seems justifiable to conclude that the driving behavior of young males increased the probability of accidents. Had any accidents involving young male drivers occurred, the responsibility could have been assigned to these people's driving habits (rather than unfavorable driving conditions). However, the results showed that the physical aspects of the driving environment (such as the relatively short duration of the yellow light) interacted with driving habits to increase the probability of accidents.

Traffic safety efforts have included driver education, punishment of violators, development of safety standards for automobiles, and traffic engineering measures. The human factors have generally been either ignored or discussed in terms of personality traits and accident proneness (see Carlson & Klein, 1970, for a critique). Our results suggest that subtler variables, such as the decision processes and conflict, should be taken into account in planning the features of the driving environment. For example, an improved signal system could be introduced, including longer "dead" (all red) periods. Alternatively, the onset of the yellow or red light could be delayed by sensors detecting drivers traveling at relatively high speeds at critical distances from the intersection. Obviously, such changes could be efficient only as components of a plan to suit the physical features of the driving environment to the drivers' behavior and cognitive limitations.

Diego in 1974, about 55% were two-vehicle, right-angle collisions (data from the San Diego Department of Transportation). This implies frequent failures of the traffic lights to control drivers' behavior and/or drivers' reluctance to yield to cross traffic.

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