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# Traffic Congestion, Driver Stress, and Driver Aggression

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**Drivers were interviewed over cellular telephones in high- and low-congestion conditions during a single commute. During each interview, state measures of driver stress and driver behaviors were obtained. Behavior responses were subdivided into six categories: aggressive, information seeking, planning, minor self-destructive, distraction, and relaxation techniques. Both state driver stress and aggression were greater in high- than in low-congestion conditions. No other behavior category differed between low and high congestion. Multiple regressions were calculated to determine the predictors of state driver stress. In low congestion, time urgency predicted state driver stress, while aggression predicted driver stress in high congestion. In both conditions, a trait susceptibility toward viewing driving as generally stressful was predictive of state driver stress levels, which further strengthens the use of the Driving Behaviour Inventory—General as a predictor of "trait" driver stress. Females and males did not differentiate on state stress or any behavior category. Aggr. Behav. 25:409–423, 1999.** 

**Key words: automobile driving; aggression; stress; traffic congestion**

## INTRODUCTION

### Driving as a Source of Everyday Stress

According to Lazarus [1966], an event that is interpreted as undesirable or taxing on personal resources may result in psychological stress. Much of the stress encountered by an individual is a product of the continuous bombardment of common daily hassles, such as time pressure, job concerns, and financial considerations [Kanner et al., 1981]. Hassles have been defined as the seemingly minor, chronic, or everyday pressures that are experienced and perceived as "somewhat severe" difficulties [Kohn and Macdonald, 1992a]. Repeated exposure to daily hassles, even under perceptibly low levels, has been linked with minor physical illness [Kohn and Macdonald, 1992b]. Research has

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recently turned to automobile driving as a salient source of everyday stress [see Gulian et al., 1990; Hennessy and Wiesenthal, 1997; Novaco et al., 1990]. The number of private automobiles used on a daily basis has been steadily multiplying, with little increase in the number of public roads and highways [Taylor, 1997]. As a result, competition for space; congestion levels; and potential sources of frustration, irritation, and stress have escalated.

Drivers interviewed in high-congestion conditions have been found to exhibit elevated levels of driver stress, including frustration, irritation, and negative mood [Hennessy and Wiesenthal, 1997]. Psychological and physiological health are adversely affected by congested traffic conditions, including negative affect, as well as increased arousal, heart rate, and blood pressure [Novaco et al., 1979; Stokols et al., 1978]. Frequent stressful driving encounters may ultimately lead to a dispositional tendency to experience all driving encounters in a more negative manner [Gulian et al., 1989b]. Other potentially dangerous effects of driver stress that have been identified are increased aggressive driving [Gulian et al., 1989b; Hartley and El Hassani, 1994], poor concentration levels [Matthews et al., 1991], and increased accident occurrences [Selzer and Vinokur, 1974]. Driver stress has been found to subsequently influence mood, thoughts, feelings, and behaviors in nondriving situations, such as work and home [Gulian et al., 1989a].

## ”Road Rage” and Driver Aggression

Prolonged or repeated exposure to stressful situations has been linked with heightened aggression [Cohen, 1980; Gibson and Wiesenthal, 1996]. Gulian et al. [1989b] have identified driver aggression as one potentially hazardous consequence of driver stress. The danger of driver aggression is evidenced through its relationship with increased accident involvement, a danger not only to the aggressor but to surrounding motorists [Furnham and Saipe, 1993; Hansen, 1988; Roy and Choudhary, 1985]. Public concern has recently been aroused over escalating incidents of “road rage” worldwide [Sleek, 1996]. Concern over road rage has extended to the Internet, where several Web sites have addressed highway aggression (see http://www.aloha.net/~dyc/testimony.html, http://www.state.ia.us/government/dot/roadrage.htm., and http://www.stop-roadrage.com.main.html). The America Automobile Association (AAA) Foundation for Traffic Safety commissioned three studies of aggressive driving (1997). The studies analyzed 10,037 police reports and newspaper stories concerning traffic incidents that were followed by violent behaviors. Congressional testimony indicated that aggressive behaviors were involved in nearly 28,000 American highway accidents according to Dr. Ricardo Martinez, head of the U. S. National Highway Traffic Safety Administration [Wald, 1997]. In Washington, there has been an increasing tendency for motorists to blame aggressive behavior for accidents on the Capital’s roadways [Reid, 1998]. The problem is also of concern in Canada, where the Ontario Provincial Police report receiving 500 telephone calls per week complaining about the aggressive practices of other highway users [Mitchell, 1997; see also Gottleib, 1997; Taylor, 1997].

Vest et al. [1997] describe some of the perpetrators of road rage who do not fit the expected profile of young, risk-taking males with histories of aggressive/antisocial behavior. They report that in Salt Lake City, Utah, a 75-year-old driver, angered over a honked horn sounded by a 47-year-old driver for blocking traffic, followed the other driver off the road, where he hurled a bottle of prescription drugs and then "in a display of geriatric resolve smashed Remm's [the other driver's] knees with his '92 Mercury. In tony Potomac, Md., Robin Flicker—an attorney and ex–state legislator—knocked the glasses off a pregnant woman after she had the temerity to ask him why he bumped her Jeep with his" (p. 24).

Media reports have provided numerous illustrations of the dangers of extreme roadway aggression. In Washington, a driver frustrated by a slow-moving car approached the vehicle at a red light and shot and killed a passenger [Fraser, 1997]. Similarly, after reciprocally flashing high beams and cutting one another off, a pair of motorists pulled off the road to settle their dispute; one driver retrieved a crossbow and killed the other ["Crossbow used to end dispute," 1994].

Examples of road rage are overwhelming and are growing at an alarming rate [Mizell et al., 1997]. However, the focus of media attention toward road range has been placed generally on the most extreme forms of driver aggression. As justifiable as this attention may be, there are other, more common, forms of aggression that may impact on a greater number of drivers [Hennessy, 1998]. Extreme aggressive actions are rare occurrences, considering the number of people who travel by automobile on a daily basis [Novaco, 1991]. Milder forms of driver aggression, such as horn honking, yelling at other drivers, purposeful tailgating, and flashing high beams at other motorists, have been found to occur frequently in frustrating conditions that elicit anger in drivers [Ellison et al., 1995; Hennessy, 1998; Hennessy and Wiesenthal, 1997; Kenrick and MacFarlane, 1986]. Their use as indices of aggression has been based on the intent of the perpetrator to inflict some form of harm, either physical or psychological, on other drivers [Hauber, 1980].

According to Novaco [1991], mild forms of driver aggression may be of little consequence to most drivers because they do not relate to more serious forms of aggression, such as roadside confrontations, drive-by shootings, chasing, and vehicular homicide. Their danger value lies only in their potential to escalate into more serious forms of aggression. Although Novaco [1991] has noted that evidence of such a relationship does not exist, he has provided preliminary evidence that drivers who engage in mild aggression more frequently report chasing other drivers and having been involved in verbal confrontation with threats of physical violence. Escalation in the use of multiple forms of mild driver aggression has also been demonstrated in that drivers who engage in one form of mild aggression have been shown to frequently engage in others [Hennessy, 1995; Novaco, 1991]. The target of such aggression is typically other drivers who are perceived as the source of frustration [Gulian et al., 1989a]. Driving "vengeance," in the form of reciprocal driver aggression, may present a special form of "escalation potential" [Gibson and Wiesenthal, 1996]. Aggression toward another driver may elicit return, or revenge-oriented, aggression. Considering the speed involved in driving, and the size and destructive power of the automobile, the expression of even mild aggression cannot be ignored as a potential source of physical and psychological danger within the driving situation.

## Predictions

A major foundation for life stress is the continuous bombardment of minor hassles in various situational contexts [Kanner et al., 1981]. Daily driving, particularly in high-congestion conditions, can be viewed as a frequent source of irritation, negative affect, and stress [Gulian et al., 1989a; Novaco et al., 1990; Stokols et al., 1978]. It is predicted that state driver stress, measured in situ, will be greater in high- than in low-congestion conditions. One manifestation of driver stress that has been of growing concern is aggressive driving. High-congestion conditions typically elicit greater feelings of frustration and irritation; thus, it is predicted that aggressive driving will be greater in high congestion. Also, because aggression has been linked with driver stress [Gulian et al., 1989b], and high congestion is more likely to elicit frustration, it is hypothesized that driver aggression will predict state driver stress in high congestion. No predictions regarding the prevalence of other categories of driving behavior are offered. Rather, the intent is simply to examine any possible relationships that exist within low and high congestion.

## METHOD

### Participants

Participants consisted of 60 members of the North York business sector and York University students and staff, who commuted to or from school/work along Highway 401 in Metropolitan Toronto, Ontario. Participation was on a voluntary basis. Half were males and half were females. Their ages ranged from 21 to 60 years, with an average age of 28.8 years.

### Apparatus

Cellular telephones were equipped with a visor mounted microphone to provide hands-free capabilities, and a stationary antenna. A cigarette lighter power adapter afforded continuous in-automobile power access.

### Measures

**Driving Behaviour Inventory—General (DBI-Gen).** "Trait" driver stress was measured using a variation of the Driving Behaviour Inventory—General Driver Stress questionnaire [Gulian et al., 1989b]. The Driving Behaviour Inventory—General (DBI-Gen) scale has been designed to assess a general disposition, or trait susceptibility, to driver stress. The DBI-Gen consists of 16 items, such as "I feel tense when overtaking other vehicles," "I get annoyed by driving behind other vehicles," and "I mind being overtaken." It has been found to be a robust and reliable self-report measure of driver stress [Glendon et al., 1993]. Matthews et al. [1991] have also found the DBI-Gen to have high validity in predicting participant predispositions to driver stress. The present study eliminated three items that did not pertain to highway driving ("Annoyed when traffic lights change to red when I approach them," "I am more tense on new than familiar roads," and "I feel bothered when overtaking at a junction"). Two additional items were eliminated because pilot study participants indicated some uncertainty as to the specific meaning of key concepts ("Driving gives me a sense of power" and "I do not feel indifferent when overtaking other vehicles"). Responses to the remaining 11 questions on the revised questionnaire were transformed from a Likert scale ranging from 0 to 4, indicating agreement with each statement, to a scale ranging from 0 = "strongly disagree" to 100 = "strongly agree." Scoring consisted of the mean response to individual items. Previous research has found the above revisions to maintain high reliability (alpha = 0.92–0.93) [Hennessy, 1998; Hennessy and Wiesenthal, 1997].

**State Driver Stress Inventory.** The State Driver Stress Inventory was developed to assess the situational experience of driver stress using the 11-item revision of the DBI-Gen and 10 items from the Stress Arousal Checklist [Mackay et al., 1978]. Half of the Stress Arousal Checklist items were positive mood items (relaxed, contented, peaceful, comfortable, and calm) and the other half were negative mood items (tense, bothered, nervous, uneasy, and distressed). To represent state rather than trait measures of stress, items were reworded in present tense, for example. "Trying but failing to overtake is frustrating me" rather than "Trying but failing to overtake frustrates me" and "I am feeling tense" rather than simply "Tense." Responses were placed on a Likert-type scale ranging from 0 = "strongly disagree" to 100 = "strongly agree," indicating the extent participants agreed that each item pertained to their experience in the present driving situation. Scoring was represented by the mean response to individual items, with the positive mood items reverse keyed. A manipulation check was also added to determine if low– and high–traffic congestion conditions were, in fact, perceived as distinct ("Traffic conditions are congested"). Finally, one item was used to tap perceived control ("I have control of this driving situation") and three items were used to tap time urgency ("I am in a hurry," "I am concerned about getting to my destination on time," and the reverse keyed item "I have a flexible time schedule") because they have been found to covary with driver stress [Hennessy, 1995]. Previous research has found the above state stress measure to demonstrate high reliability in both low- (alpha = 0.92–0.97) and high- (alpha = 0.90–0.95) congestion conditions [Hennessy, 1998; Hennessy and Wiesenthal, 1997; Wiesenthal et al., 1998].

**State Driving Behavior Checklist.** The State Driving Behavior Checklist consisted of 26 items developed from similar previous studies [Hennessy, 1995; Hennessy and Wiesenthal, 1997]. Several items were selected from those identified by Gulian et al. [1989a] as behaviors used to cope with driver stress (e.g., aggressive thoughts or behaviors, seeking alternative actions, planning, and taking precautionary measures). In addition, other items were developed through interviews with regular highway commuters (see the Appendix). Items were intended to tap situation-specific driving behaviors used in distinct driving conditions. Participants were required to indicate whether they engaged in each individual behavior during the preceding 5 min of their present commute. Items were subdivided into six categories of similar behaviors: driver aggression (items 1, 2, 6, 8, and 15), information seeking (items 19, 20, 22, and 25), minor self-destruction (items 4, 7, 11, and 26), relaxation techniques (items 12, 13, and 16), planning (items 3, 18, 21, and 23), and distraction (items 5, 9, 10, 14, 17, and 24). Category scoring consisted of summing the number of behaviors used per category.

## Procedure

The present study was designed to measure driver stress and driving behaviors in actual low- and high-congestion conditions through the use of cellular telephones. Research participants were enlisted through course recruitment and personal contact. During an initial appointment, informed consent was obtained and instructions regarding the experimental procedure and cellular telephone operation were given. Following the instruction period, participants completed the DBI-Gen to assess their trait disposition toward driver stress. Participants then provided information regarding their regular travel route along Highway 401 because all measures were administered during their usual daily commute. Highway 401 was chosen because it is the major traffic artery for Metropolitan Toronto, with as many as 14 lanes divided into a series of express (core) and collector lanes. The average annual daily traffic on this highway for the Metropolitan Toronto area is more than 255,000 vehicles [Ontario Ministry of Transportation, 1992]. For each participant, two areas along their regular commuting route were chosen: one that is typically lowest and one that is typically highest in traffic congestion. A landmark unique to each chosen location was then selected that would be subsequently used during their actual journey as a cue to initiate a cellular telephone call to the experimenter. Both the low- and high-congestion telephone interviews were scheduled during a single journey.

Two groups of drivers were formed: those who typically encountered high prior to low traffic volumes and those who encountered low prior to high volumes. This process allowed for the assessment of cumulative state driver stress through the comparison of the high-congestion first and the low-congestion first groups and helped rule out state driver stress simply as a function of fatigue. Prior to initiating their commute, participants were allowed to make a practice cellular telephone call to the experimenter to ensure that the telephone was functioning properly and to avoid any confusion regarding its use while actually driving. No measurement took place during the pretest telephone call. Participants were reminded of the response scale and instructed to commence their journey as usual. On approaching their first designated landmark, participants telephoned the researcher, through a single-button speed dial operation. When a successful telephone contact was made, the State Driver Stress Inventory and the State Behavior Checklist were administered verbally, while the driver was engaged in the actual driving process. On completion of the first telephone interview, the cellular telephone call was terminated and the participants continued driving until their second landmark was reached, which prompted the second telephone call. The State Driver Stress Inventory and State Behavior Checklist were, again, administered verbally.

All measures were obtained between October and March in Toronto, Ontario. Participants were tested only on Tuesdays, Wednesdays, and Thursdays because most participants were not available on weekends and Mondays and Fridays have been found to provide elevated driver stress levels [Gulian et al., 1989a]. To eliminate the possibility of poor weather increasing stress, participants were tested only on partly cloudy to sunny days.

## RESULTS

### State Driver Stress

Separate state driver stress scores were calculated for low and high congestion based on the mean response to the State Driver Stress Inventory items in each respective congestion condition. Higher scores indicated greater state driver stress. The Cronbach alpha for the state stress scores in low and high congestion were 0.94 and 0.97, respectively. To determine the effect of congestion level and driver sex on state driver stress, a split plot factorial analysis was performed, with the state driver stress scores as the dependent measures and time urgency and perceived control as covariates. Congestion level represented the two levels of the within-subject condition, while driver sex represented the two levels of the between-group condition.

As predicted, state driver stress was greater in high- than in low-congestion conditions (X = 52.48, n = 60, SD = 23.66 and X = 32.08, n = 60, SD = 17.05, respectively, F(1,56) = 15.59, $P < .01$). However, males and females reported similar state driver stress levels in both congestion conditions (X = 42.65, n = 30, SD = 18.84 and X = 41.88, n = 30, SD = 13.58, respectively, F(1,56) = 0.22, $P > .05$).

## Driving Behaviors

The State Driving Behavior Checklist was intended to identify behaviors reported by drivers in actual driving situations. Individual items were grouped into categories of similar behaviors, including driver aggression, information seeking, planning, minor self-destruction, relaxation techniques, and distraction. Scoring consisted of the sum of individual behaviors reported in each category. Higher scores indicated more frequent use of that behavior category. To determine the influence of congestion level and driver sex on specific categories, separate split plot factorial analyses were performed on each category, with congestion level as the within-group factor and driver sex as the between-group factor. Aggressive behaviors were the only category that differed in frequency between low and high congestion (see Table I). As predicted, aggressive behaviors were reported more often in high congestion. No sex differences were found in the frequency of use for any behavior category (see Table I).

## Predictors of State Driver Stress

To determine potential predictors of state driver stress in low and high congestion, a stepwise multiple regression was performed. State stress levels from low and high congestion were used as criterion variables, while the mean behavior scores from each category in low and high congestion, driver sex, trait driver stress levels, time urgency, and perceived control represented the predictor variables. Table II represents the significant predictors in the final models for both low- and high-congestion driver stress. State driver stress in low congestion was predicted by time urgency in low congestion, and a disposition toward (trait) driver stress ($R^2 = 0.31$, $P < .01$). As can be seen in Figure 1, state driver stress in low congestion increased as time urgency increased. Similarly, according to Figure 2, state driver stress also increased in low congestion with a greater predisposition toward perceiving the driving situation as generally stressful. Alternatively, within the high-congestion condition, state

**TABLE I. Mean Behaviour Frequencies and ANOVA Results Between Congestion Conditions and Driver Sex†**

| | Congestion condition | | | Sex | | |
|---|---|---|---|---|---|---|
| Behavior | Low | High | F | Female | Male | F |
| AGG | 0.80 (1.42) | 1.73 (1.60) | 47.87* | 1.35 (1.70) | 1.15 (1.31) | 0.29 |
| DIST | 2.08 (1.41) | 1.93 (1.37) | 1.67 | 2.31 (1.48) | 1.78 (1.24) | 3.39 |
| INFO | 0.95 (0.81) | 0.98 (0.87) | 0.19 | 1.04 (0.88) | 0.89 (0.81) | 0.66 |
| REL | 0.31 (0.81) | 0.28 (0.76) | 0.34 | 0.30 (0.79) | 0.29 (0.83) | 0.00 |
| PLAN | 1.43 (0.67) | 1.48 (0.62) | 0.42 | 1.50 (0.78) | 1.41 (0.62) | 0.31 |
| SD | 0.25 (0.57) | 0.35 (0.60) | 2.01 | 0.40 (0.69) | 0.20 (0.43) | 2.25 |

†AGG = Aggression; DIST = Distraction; INFO = Information Seeking; REL = Relaxation; PLAN = Planning; SD = Self-Destructive. Values are means (standard deviations) df = (1,58).
*$P < .01$.

**TABLE II. Significant Predictors of State Stress Within Low and High Congestion†**

| Criterion | Predictor | b | t |
|---|---|---|---|
| State stress: LC | Time urgency | 0.427 | 3.874* |
| | "Trait" stress | 0.417 | 3.783* |
| | $R^2 = 0.314$, $F(2,57) = 13.10$, $P < .01$ | | |
| State stress: HC | Aggression | 0.294 | 3.412* |
| | Time urgency | 0.304 | 3.630* |
| | "Trait" stress | 0.536 | 6.789* |
| | $R^2 = 0.677$, $F(3,36) = 39.27$, $P < .01$ | | |

†LC = Low Congestion; HC = High Congestion.
*$P < .01$.

driver stress was predicted by driver aggression and time urgency in high congestion, as well as a disposition toward (trait) driver stress ($R^2 = 0.67$, $P < .01$). Figure 3 demonstrates that, as predicted, state driver stress increased with incidents of driver aggression in high congestion. According to Figure 4, elevated state driver stress was also found for those high in time urgency. Finally, as in low congestion, Figure 5 illustrates that a greater disposition toward driver stress led to greater state driver stress in high congestion.

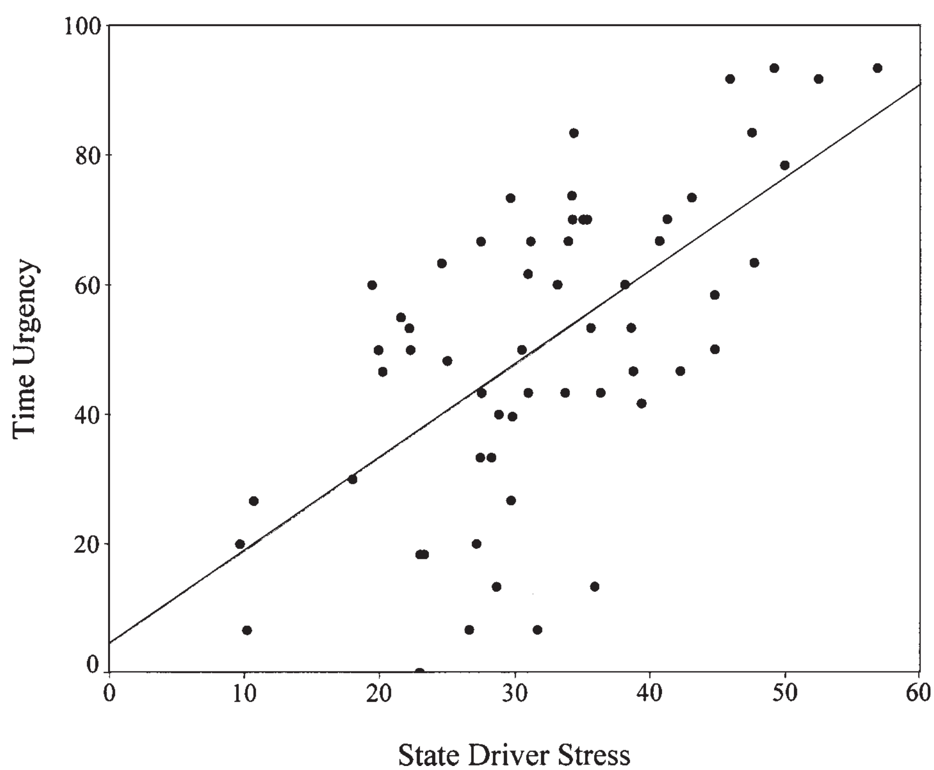


Fig. 1. State driver stress level within low congestion as a function of time urgency scores.

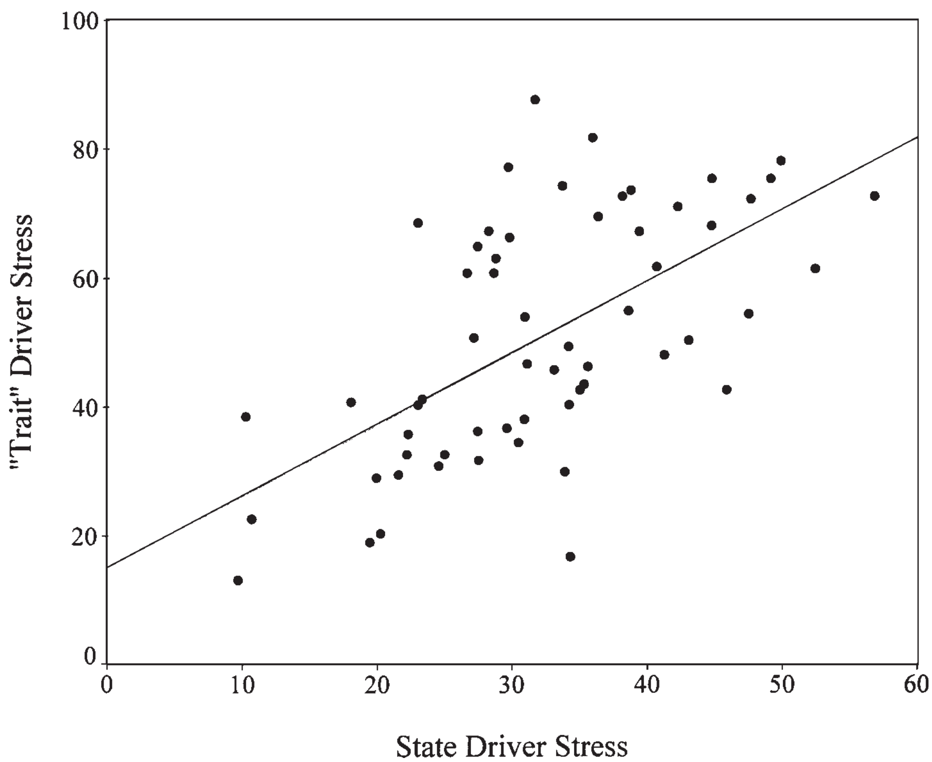


Fig. 2. State driver stress level within low congestion as a function of “trait” driver stress scores.

## DISCUSSION

### Driver Stress

The present findings are supportive of an interactional interpretation of driver stress, where elements of the person and elements of the situation determine stress levels. As with previous research [Hennessy and Wiesenthal, 1997; Stokols et al., 1978], state driver stress was greater in high- than in low-congestion conditions. However, the degree of reaction was dependent on a “trait” disposition toward viewing driving as generally stressful. In both low- and high-congestion conditions, state driver stress levels were predicted by the level of “trait” driver stress susceptibility, although greatest in high-congestion conditions. This serves to heighten the reliability and validity of the DBI-Gen as a predictor of “trait” driver stress. According to Matthews et al. [1991], those with “trait” driver stress susceptibility are more likely to interpret unique driving situations as stressful. The peril lies in the fact that each stressful driving encounter likely supports and strengthens the driver stress “trait,” which then increases the tendency to view subsequent driving encounters as stressful [Gulian et al., 1989a]. To ultimately reduce driver stress, the destructive, circular, and self-fulfilling nature of the state-trait relationship must be interrupted. Perhaps repeated “nonstressful” encounters can reduce the trait tendency to view successive encounters as stressful.

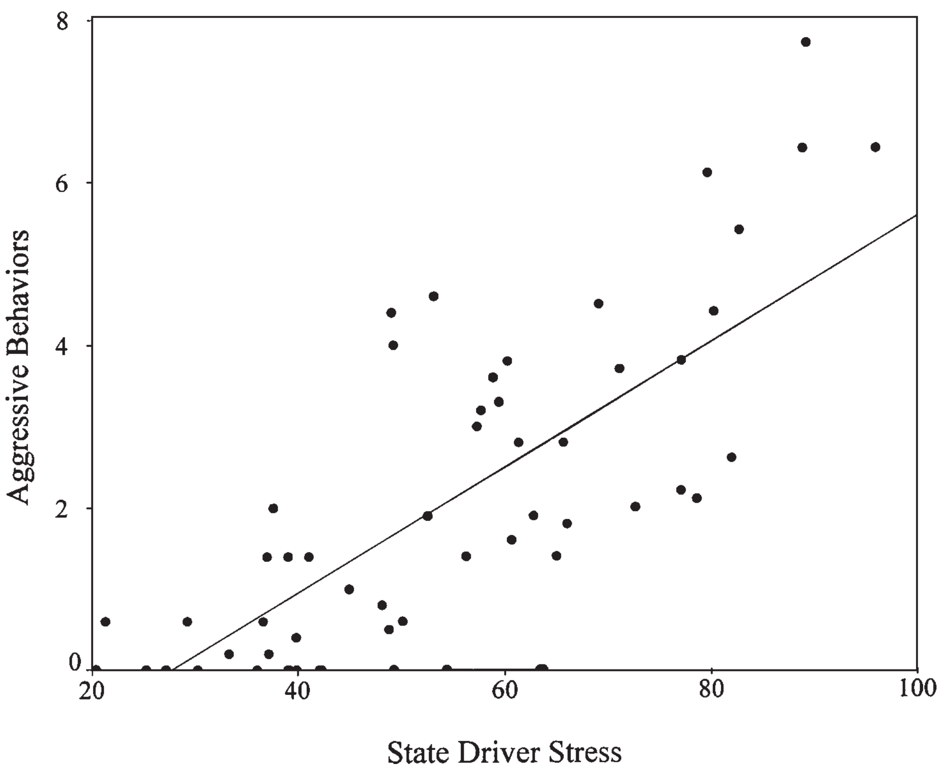


Fig. 3. State driver stress level within high congestion as a function of the number of aggressive behaviors.

## Driving Behaviors and Predictors of Driver Stress

Time urgency predicted state driver stress levels in both low and high congestion, which is consistent with previous research identifying time urgency as a significant contributor to driver stress [Gulian et al., 1989a; Koslowsky, 1997]. Lazarus [1981] found that everyday hassles, such as time pressure and adverse driving conditions, typically have an additive effect, where the influence of one event can add to the severity of another. Personal concerns, such as getting to work/school on time or not having a flexible schedule, may simply serve to heighten frustration, irritation, and negative affect associated with the situational demands of the driving situation.

Driver aggression was the only category of behaviors that differed between low- and high-congestion conditions, with greater aggression found in high congestion. Surprisingly, no sex difference was found in the expression of driver aggression. Previous research has generally identified males as more prone to exhibitions of direct aggression and to hold favorable attitudes toward aggression [Harris, 1995; Lindeman et al., 1997]. One possible explanation for the discrepancy could be that the female participants in the present study represented a young sample. Hauber [1980] identified age as a greater predictor of driver aggression than sex, where young females were found to report greater driver aggression than older males. Alternatively, the automobile provides drivers, both female and male, with a degree of anonymity and deindividuation [Novaco, 1991]. Drivers deindividuated through the use of tinted windows have been

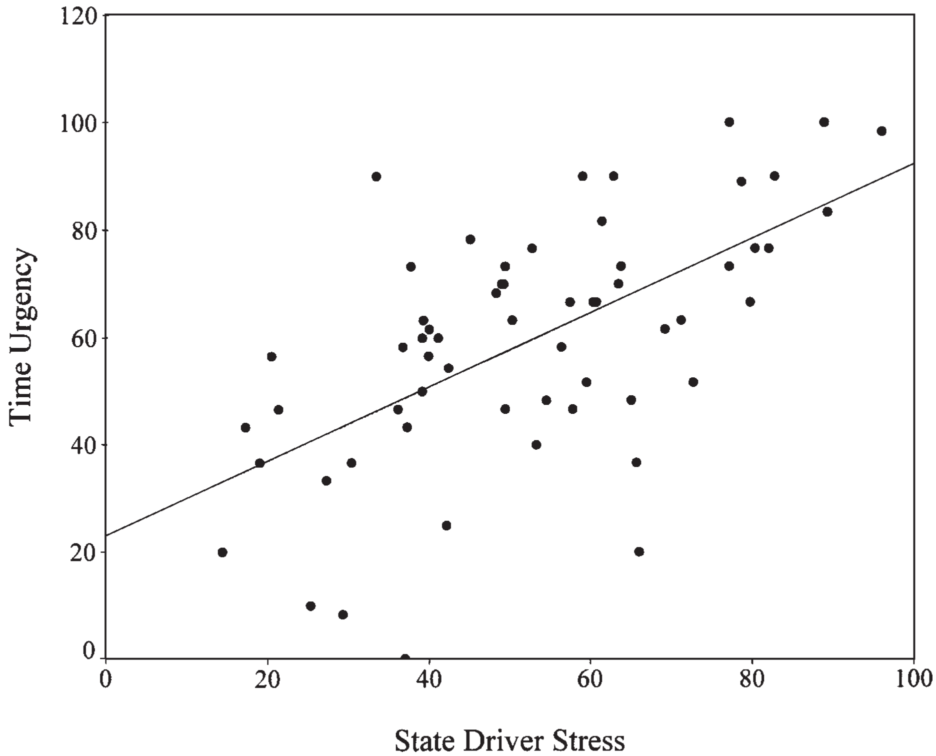


Fig. 4. State driver stress level within high congestion as a function of time urgency scores.

found to display elevated levels of dangerous driving behaviors, such as increased acceleration following light changes and failing to signal [Wiesenthal and Janovjak, 1992]. According to Lightdale and Prentice [1994], sex differences in aggressive tendencies disappear under conditions of deindividuation.

Within the high-congestion condition, only aggressive behaviors were predictive of state driver stress levels. Those who were more aggressive were more likely to exhibit elevated state driver stress. High congestion typically involves a greater number of vehicles that travel at a slower pace. According to Broome [1985], such impediments represent the greatest source of driving irritation, frustration, and goal blocking, which are precursors to driver stress. However, irritation and frustration also represent precursors to aggressive behavior [Blanchard and Blanchard, 1984]. Within the confines of a highly irritable, highly stressful congested situation, anger and its expression through aggression are becoming more common. Reported incidents of road rage have been escalating worldwide, particularly under conditions of heightened demands on drivers [Taylor, 1997]. Gulian et al. [1989a] found that the expression of aggressive thoughts and behaviors while driving are directed mainly toward other drivers. Likewise, greater accident involvement has been found under conditions of both stress and aggression [Furnham and Saipe, 1993; Hansen, 1988; Hauber, 1980; Matthews et al., 1991]. Considering the relative closeness of vehicles in high congestion, deindividuation and anonymity of drivers, easy escape, and the fact that the vehicle can be used as a weapon

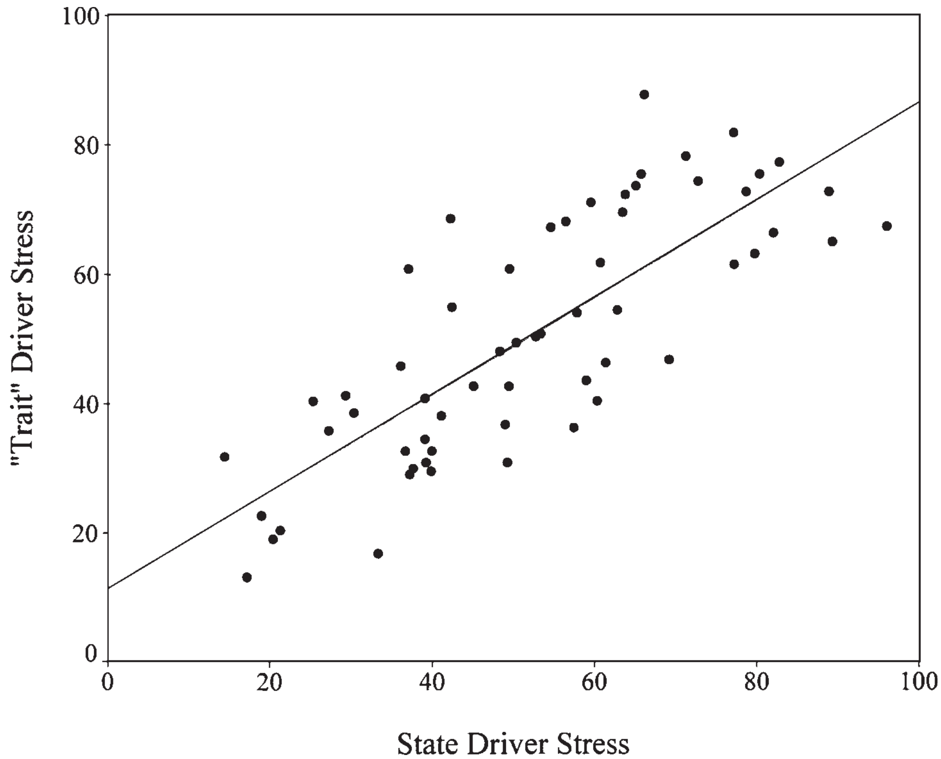


Fig. 5. State driver stress level within high congestion as a function of “trait” driver stress scores.

[Marsh and Collett, 1987; Novaco, 1991], the potential for physical danger within the aggression-stress link are immense.

## Shortcomings of the Present Study

One major problem with the present study was the fact that behaviors and stress were measured during a single trip. The complexity and interaction of feelings, thoughts, and behavior patterns may have been more complex than a single measure would allow. For example, some drivers who typically exhibit driver aggression may not have had reason to aggress during the measurement period, while others who may seldom exhibit aggression may have had an unusually frustrating day at work, accompanied by several irritating driving incidents. A more detailed analysis of daily routines, hassles, and general behavior patterns may be required to more clearly understand the interaction of driver stress and behavior. Another problem was that the sample consisted largely of younger drivers. Previous research has found that younger participants typically exhibit greater levels of driver stress and aggression [Hauber, 1980; Gibson and Wiesenthal, 1996]. Future research could employ a more diverse age sample to present a clearer analysis of driver stress. Finally, the behavior measure utilized a forced choice response method. Behaviors that were not included among the choices may have more accurately reflected the behavior patterns of certain participants. The use of open-ended behavior responses in future research could provide a wider variety of possible behavior outcomes.

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## APPENDIX

### State Driving Behavior Checklist

Please indicate whether you have employed the following behaviors during the past 5 min of this particular commute.

1. Horn honking at other drivers out of frustration.
2. Purposely tailgating other drivers.
3. Talking on a CB radio to make alternate travel plans.
4. Nail biting.
5. Eating or drinking to pass time.
6. Flashing your high beams at another driver out of frustration.
7. Smoking.
8. Hand gestures at other drivers.
9. Daydreaming to pass time.
10. Fixing your hair and/or makeup.
11. Scratching.
12. Muscle relaxation techniques.
13. Meditating.
14. Listening to talk radio programs to pass the time.
15. Swearing at other drivers.
16. Purposeful breathing techniques.
17. Talking to passengers to pass time.
18. Planning "ON THE SPOT" alternate routes to travel.
19. Seeking the information provided by the changeable message signs.
20. Using a CB radio to gain access to traffic information.
21. Sticking to a prearranged plan of action (MADE PRIOR TO DRIVING) for dealing with traffic.
22. Talking to passengers to gain information about the traffic situation.
23. Talking to passengers to plan alternate travel routes.
24. Listening to music to pass the time.
25. Consulting radio traffic reports.
26. Grinding your teeth.