

THE MORNING RUSH HOUR

Predictability and Commuter Stress

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ABSTRACT: Although it is obvious that commuting to work is stressful, it is not at all clear why this is so. This study examined the potential role of commute unpredictability in the stressfulness of the daily journey to work among a population of rail commuters. Men and women who perceived their commute to work as more unpredictable felt greater levels of stress and evidenced higher elevations of salivary cortisol. Expected differences in motivation in task performance did not occur. Limitations of these cross-sectional findings are discussed along with future research needs. The possible roles of commute predictability and stress in transportation mode choice are also delineated.

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Although at first glance it might seem obvious that commuting to work is stressful, two facts are noteworthy. First, little scientific research has been conducted on the health and behavioral effects of commuting (Koslowsky, Kluger, & Reich, 1995). A recent article revealed only 17 such studies (Kluger, 1998). Second, assuming for the moment that commuting is stressful, we do not know how this occurs. That is, what are the underlying psychological processes that engender stress among commuters? The purpose of this study is to examine whether the degree of stress experienced on a train during the morning rush hour is influenced by the predictability of the commute.

Below, we briefly review the commuting and stress literature as well as work on stressor predictability to develop the hypothesis that greater unpredictability during the commute leads to elevated stress. We employ multimethodological (self-report, motivational behavior, psychophysiological) indicators of stress to test this hypothesis among a population of train passengers during their morning rush hour commute from suburban New Jersey to New York City.

Both driving a car (Bellet, Roman, & Kostis, 1969) and taking a train to work (Singer, Lundberg, & Frankenhaeuser, 1978) elevate psychophysiological stress. Some attention has been given to traffic congestion as a major component of the adverse impacts of automobile commuting. Studies show that greater exposure to congestion is related to elevated psychophysiological stress among automobile commuters (Schaeffer, Street, Singer, & Baum, 1988; Stokols, Novaco, Stokols, & Campbell, 1978; White & Rotton, 1998) as well as bus drivers (Evans & Carrere, 1991). As congestion increases among automobile commuters, they also report more negative affect (Novaco, Kliewer, & Broquet, 1991; Novaco, Stokols, Campbell, & Stokols, 1979; Novaco, Stokols, & Milanesi, 1990; Schaeffer et al., 1988) and motivational deficits indicative of helplessness (Novaco et al., 1979; Schaeffer et al., 1988; White & Rotton, 1998).

Thus, some evidence substantiates the widespread belief that commuting is stressful and, in the case of automobile commuting, that traffic congestion is an important ingredient that contributes to its adverse impact. But why is commuting under congested conditions stressful, and are parallel psychological processes at work for mass transit users? Congestion in and of itself is probably less relevant to train commuters because they do not operate the train, and they typically have little or no knowledge about the levels of congestion on the rail lines. Some of the traffic congestion studies point toward the role of control and predictability as salient psychological mechanisms in commuting stress. For example, locus-of-control-moderated congestion affects commuting stress among automobile drivers (Novaco et al., 1979).

Evans and Carrere (1991) showed that the adverse effects of traffic congestion on psychophysiological stress among bus drivers were mediated by perceived control over driving conditions.

As Koslowsky et al. (1995) noted, a particularly salient aspect of control for commuters may be predictability. In a situation such as commuting on a train, where opportunities for exercising behavioral control are severely constrained, predictability of the commute might function as an important process for commuters. When people cannot exercise behavioral control, predictability can function as a form of cognitive control, providing individuals with a coping strategy for alleviating stress (Averill, 1973; Evans, Shapiro, & Lewis, 1993). Consistent with this reasoning, Kluger (1998) found that a major component of commuting stress was unpredictability of the commute among automobile drivers.

The present study builds on and extends the ideas and research of Koslowsky and Kluger (Kluger, 1998; Koslowsky et al., 1995) in two respects. First, we examine whether the construct of commute predictability generalizes from automobile commuters to those who rely on mass transit. Second, whereas Kluger's data are limited to self-report measures, we augment questionnaires with a performance measure of motivation and a marker of psychophysiological stress. This multimethodological profile of outcome measures also enables us to compare our results to previous studies employing similar stress indicators.

Summarizing the argument, commuting has been shown to be a stressor with adverse affective, motivational, and physiological consequences. For automobile commuters, a potent contributor to commuting stress is traffic congestion. A psychological process that may help us better understand commuting stress among mass transit users is predictability. Although mass transit commuters have very little behavioral control, the degree of commute predictability varies. To test this idea, we examined with multimethodological indicators whether commuting stress might be, at least to some extent, a function of the predictability of the commute.

METHOD

PARTICIPANTS

Fifty-six train passengers (58% male) who regularly commuted from suburban counties in New Jersey to Manhattan in New York City were recruited by flyers in their home train stations and in the Hoboken station. Commuters

were informed that a university research project on the commuting experience was being conducted. Individuals were also told they would have a 1 in 25 chance to win a 6-month commuter pass (approximate value \$700) for their participation. To be eligible, each participant had to commute to the city during the morning rush hour at least 4 days a week and done so for at least 1 year. The sample, as expected given its suburban location, was highly educated (62% graduate work, 35% college degree), were all employed as professionals, and had an average annual gross income that exceeded \$85,000.

PROCEDURE

Prior to the appointed day of testing, the participant received written instructions. Individuals were requested not to eat, drink, or smoke on the train and were reminded that they would be met by an experimenter as they disembarked from the last leg of their journey.

Once the participant had found a seat on the train, he or she was instructed to fill out background information, to fill out rating scales about the commuting experience, and when they reached a designated train stop, to perform a proofreading task for a specified time period (10 minutes). At the end of the journey, a saliva sample was taken.

At the same time of day as the commuting data were collected, participants were met at their home on a nonworkday (Saturday or Sunday following the week in which the commuting measure was taken) and requested to provide a second saliva sample. The time of collection of the two saliva samples was closely matched because of diurnal fluctuations in cortisol. Both a resting baseline sample and a commuting sample were collected because of large individual differences in circulating corticosteroids. In all cases, baseline saliva collection was completed on a nonworkday after the commuting saliva sample collection.

MEASURES

Predictability of the commute was based on a five-item (1-5) Likert-type scale ($\alpha = .65$). Sample items included "I can usually predict when I get to work," and "my commute to work is consistent on a day to day basis." Perceived stress on the commute was based on a six-item, 5-point Likert-type scale ($\alpha = .89$) derived from items used by Kluger (1998) and Novaco et al. (1990, 1991). Sample items included "overall commuting is stressful for me," and "commuting to work takes effort."

Motivation was assessed with a proofreading index that has been used extensively in the stress literature (Cohen, 1980; Glass & Singer, 1972). This

measure has been shown both in the laboratory and in the field to be sensitive to the controllability and predictability of stressors. The measure is also affected by control-related personality characteristics such as locus of control. Performance on the task appears to be largely a function of motivation rather than skill and is related to other measures of learned helplessness. Participants were given a passage from a college urban sociology text with deliberately introduced typographical, spelling, and major grammatical errors (see Glass & Singer, 1972, for details). The percentage of accurate corrections (number of errors detected/total number of errors in the text at the stopping point) was the index of motivational performance used. Commuters worked on the text for a set 10-minute interval, finishing 5 minutes prior to leaving the train. Note, each commuter timed his or her own performance interval.

Salivary cortisol was measured with a radioimmune assay (Baxter Travenol Diagnostics, 1987). Salivary cortisol is a reliable, sensitive marker of stress for a period of 30 to 75 minutes, with peak levels lagging after a discrete event by approximately 25 minutes (Kirshbaum & Hellhammer, 1989). The commutes varied in length from 35 to 55 minutes. Saliva was collected as the participant disembarked from his or her train with a salivette collection device. Essentially, the participant took a small cylinder of cotton from a plastic tube, chewed on it for 1 to 2 minutes, and then placed it back in the tube. The samples were immediately placed in a cooler with ice and then stored at -80°C until assayed. As indicated above, the same salivary collection procedure was repeated subsequently in each participant's home at the same time of day, on a nonworkday.

RESULTS

The relation between predictability and commuting stress was examined by regressing each respective outcome variable onto predictability. All analyses statistically control for income levels. The cortisol analyses examine the difference score between the commuting cortisol levels minus the home, off-workday baseline levels. For these analyses, we included both income and the baseline level as statistical covariates. Change scores are related to resting levels so greater precision is often obtained in psychophysiological analyses by statistical controls for baseline measures.

Descriptive results for predictability are depicted in Table 1. Note that predictability is trichotomized for descriptive purposes only in Table 1. All analyses preserved the continuous nature of the predictability variable. As

TABLE 1
Descriptive Data for Commute Unpredictability and Stress

Outcome	Commute Unpredictability					
	Low		Medium		High	
	M	SD	M	SD	M	SD
Perceived stress (1-5)	2.98	0.74	3.15	0.68	3.22	0.71
Proofreading (% correct)	56	15	51	18	58	20
Cortisol elevation (ug/dl)	0.26	0.17	0.28	0.27	0.39	0.32

NOTE: Unpredictability is categorized in the table for descriptive purposes only. All analyses maintained the continuous nature of the variables.

hypothesized, predictability appears to be a salient component of commuting stress among mass transit commuters using the train during the morning rush hour. Both perceived stress and cortisol elevations are significantly higher among those who perceive their commute as more unpredictable (see Table 2). At home, baseline cortisol levels are unrelated to commute unpredictability ($r = .09$). Degrees of freedom vary slightly because of missing data.

Rail line commuters who perceive their daily commutes as more unpredictable experience greater stress as indicated by a standardized commuting stress scale and elevations in salivary cortisol. The motivational index is not significantly related to commute unpredictability.

DISCUSSION

Several strands of evidence indicate that automobile commuting is stressful, with traffic congestion playing an important role (Koslowsky et al., 1995). Research also suggests that control may be an important underlying psychological construct that helps account for the adverse effects of commuting on health and well-being (Evans & Carrere, 1991; Koslowsky et al., 1995; Novaco et al., 1979). The present study builds on this previous work in several respects. First, only one prior study (Singer et al., 1978) has examined commuting stress among mass transit users, with all the remaining studies looking at automobile commuters. Second, we use multimethodological markers of stress. The use of neuroendocrinological measures of stress is especially noteworthy given their reliability and objectivity. There are few instances of their application within environment and behavior, and more frequent application is warranted (Parson & Hartig, 2000). Third, based on prior work by Koslowsky and Kluger (Kluger, 1998; Koslowsky et al., 1995), we

TABLE 2
Regression Results for Unpredictability, Statistically Controlling for Income

<i>Outcome</i>	<i>b (SE)</i>	ΔR^2	$F(\Delta R^2)$	<i>df</i> ₁	<i>df</i> ₂
Perceived stress	.42 (.16)	.11	7.15**	1	53
Proofreading	-.02 (.04)	.01	< 1.0	1	52
Cortisol elevation	.16 (.08)	.07	3.92*	1	49

NOTE: Cortisol elevation (commuting minus baseline levels) includes an additional control for baseline cortisol levels.

* $p < .05$. ** $p < .01$.

hypothesized that a particularly salient psychological aspect of commuting by train would be the unpredictability of the commuting experience.

Our findings are generally in accord with this hypothesis. The more unpredictable the commute to work by train, the greater the levels of stress experienced by commuters. These relations were manifested on a standardized perceived stress scale and elevations (commuting - baseline) in salivary cortisol during the commute (see Table 1). The results for the measure of motivational performance were not statistically significant (see Table 2). Rail commuters, similar to automobile commuters, find the experience of commuting to work during rush hour stressful. The degree of predictability of the commute appears to be a critical contributor to this experience. We cannot be certain why the motivational results were not significant. Prior studies have found the proofreading task to be less reliable than other indices such as unsolvable puzzles (Cohen, 1980). We used proofreading because we were concerned about the participants' ability to comprehend the task on their own. Recall that the task was conducted on the train without an experimenter present. Thus, another possible problem may have been procedural errors. It is noteworthy that the standard error of the beta for proofreading exceeds the raw beta weight (see Table 2), indicating considerable random variability in this index. Another possibility is large individual differences in reading/editing ability, although the highly educated, white-collar sample argues against much difference in reading aptitude. The fact that the sample consists of highly educated, white-collar workers might offer another explanation for the insensitivity of this index—perhaps such a sample is uniformly conscientious, particularly in comparison to the oft-used undergraduate samples in prior stress and proofreading research (Cohen, 1980; Glass & Singer, 1972).

Because this is a cross-sectional study and uses a small volunteer sample, the results need to be considered preliminary. One reasonable alternative explanation is that commuters who experience more stress judge their commutes as less predictable. Although this reverse causality model is reasonable for the self-report data, it seems less plausible to argue that elevated cortisol

causes greater uncertainty about the commute. It is also possible that some third variable (e.g., personality) is creating a spurious association between commuting predictability and commuting stress. This third variable explanation is also less tenable for the cortisol results because we statistically controlled for both income levels and the at-home, baseline cortisol levels. If personality were associated both with perceived predictability and cortisol elevations, we would also expect to see some association with the baseline cortisol measure. Nonetheless, the best way to resolve these issues would be to randomly vary commuting predictability in a true experiment or to examine this issue with a longitudinal design.

Another source of potential bias in the present results is the sample. People who signed up did so in part for the 1 in 25 chance to win a free, 1-month commuter pass. Thus, there could be a tendency for risk-seeking individuals to be more heavily weighted in our sample. Perhaps people more interested in science and/or more concerned about commuting participated in this study. High-risk seekers might be likely to be more tolerant of unpredictability, whereas those worried or especially interested in commuting might be the subset of individuals more adversely affected by commuting. The multimethodological convergence of self-report and neuroendocrine data, however, provides some counterargument that such a bias led to a spurious association between perceived predictability and commuter stress. It is nonetheless important to reiterate that the design of this study is correlational. We do not claim causal evidence—what we have are patterns of data that fit with prior theoretical discussion and analyses of commuting stress.

In addition to replicating the findings with a stronger research design and a better sample, several other improvements and future extensions of the present study warrant brief comment. It would be desirable to incorporate measures of personality to help rule out spuriousness but also to examine possible moderating effects. Tolerance of ambiguity, control-related beliefs, time urgency, and anxiety are conceptually relevant personality constructs that might moderate the adverse impacts of commute predictability (Evans & Johansson, 1998). Although there is some suggestion in the commuting stress literature that women may react more negatively to automobile commuting (Novaco et al., 1991; Novaco & Sandeen, 1992), we found no gender interactions for any of the stress-outcome variables. In addition to the problem of small sample size, the high degree of homogeneity in social class of our sample may be a concern. Clearly, an important task ahead is to examine commuting stress among a larger, more representative sample of mass transit users.

Another desirable improvement would be to incorporate an objective index of unpredictability along with our standardized index of perceived