Crowding and personal space invasion on the train: Please don’t make me sit in the middle

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Abstract

Mass transit users frequently experience crowding during their commutes. In this study of 139 urban passenger train commuters during rush hour, we found that the density of the train car was inconsequential for multiple indices (self-report, salivary cortisol, performance aftereffects) of stress whereas the immediate seating density proximate to the passenger significantly affected all three indices. When people had to sit close to other passengers, they experienced adverse reactions. These results are consistent with prior work indicating that individual spacing among persons that leads to personal space invasions is a more salient environmental condition than density per se. The findings also have implications for the design of mass transit vehicles.

1. Introduction

Crowding on trains is well known to commuters who use mass transit for rush hour trips. A recent report to the city of London attributed a variety of health and safety problems on trains to crowding (Turner, Corbett, O’Hara, & White, 2005). Transit authorities in the New York Metropolitan Area have noted widespread dissatisfaction about crowding among passengers using new rail cars, even though each car actually holds a smaller number of passengers, and in some cases, even provides wider seats (Mc Geeham, 2005). What the designers of these new cars may have overlooked, however, is the role of personal space invasion on trains. Mc Geeham’s article also noted the large number of vacant middle seats on trains, even when trains were filled. This observation fits well with a more systematic study of proxemic behavior on subway cars in New York city conducted three decades earlier by Fried and DeFazio (1974). Among many fascinating observations, the authors noted that as car density increased, rather than occupying available seats, many passengers opted instead to stand in places that maximized physical distance from other passengers. When extreme levels of density precluded this option, all seats were then filled and various nonverbal indices of avoidance (e.g., minimal eye contact, bodies turned towards the sides of the car and away from people, arms crossed) were markedly elevated. In this paper, we explore the role of personal space invasion and crowding among train commuters during rush hour in New York City.

Conceptual models have related crowding in situations like these to difficulties in privacy regulation. We regulate privacy by adjusting social interaction to desired levels through an intricate system of verbal, nonverbal, and physical processes (Altman, 1975). For example people use culturally accepted norms of interpersonal distance—personal space—to help regulate privacy. Crowding occurs when the regulation of social interaction is unsuccessful and our desires for social interaction are exceeded by the actual amount of social interaction experienced. Perceived crowding is related, but not identical, to the density of a situation, which is typically operationalized as the relation between numbers of people and unit of space...
(e.g., people per room) (Baum & Paulus, 1987; Evans, 2001; Stokols, 1972).

It has long been recognized, however, that density does not adequately capture the experience of individuals in a given space since the distribution of both people (Day & Day, 1973; Knowles, 1978) and of physical objects in concert with physical layout of the space (Evans, 1979) can directly influence the degree of physical proximity to others. Intrusions into personal space then may be a fundamental cause of crowding. As density grows, the probability elevates that one’s personal space will be intruded upon, creating discomfort in and of itself (Aiello, 1987; Kaya & Erkip, 1999). Higher density also increases the likelihood of physical and social contact and accompanying undesired and unpredictable interactions, which have also been identified as important facets in the experience of crowding (Baum & Valins, 1977; Saegert, 1978). We also know from laboratory (Evans & Howard, 1972; McBride, King, & James, 1965) and field studies (Middlemist, Knowles, & Matter, 1976), that involuntary physical proximity to another individual elevates physiological stress. In this paper we examine a naturalistic situation that is often experienced as crowded, commuting on public transit during rush hour. We address the question, is the adverse impact of increasing density in a naturally crowded situation, primarily a function of personal space intrusion? We believe it is the actual experience of overly close physical proximity to another individual that underlies the experience of crowded commuting.

Both Worchel and Teddile (1976) and Sundstrom, Busby, and Asmus (1975) directly tested the hypothesis that a critical component of the experience of crowding was personal space intrusion. These studies varied density and interpersonal distance in a factorial design in the laboratory, and in each case personal space invasion, not overall density, was the key factor for perceived crowding, task performance, and nonverbal indices of social withdrawal. Under more naturalistic conditions, personal space invasions but not density largely influenced nonverbal indicators of discomfort between strangers (Harris, Luginbuhl, & Fishbein, 1978) and at the office, distances between workstations had a greater influence on worker’s social withdrawal behaviors compared to the effects of office density (Oldham & Fried, 1987).

We examined the contributions of train density and seat proximity to multimethodological indices of stress among passenger train commuters. These results are not only interesting theoretically but as indicated at the onset, have direct implications for the design of mass transit systems. One of the primary reasons people give for commuting to work by automobile compared to public transit is enhanced privacy provided by cars (Dockendorf, Levinson, Fichter, Haghani, & Prestrud, 2001; Ibrahim, 2003; Joireman, Lange, Kuhlman, Vugt, & Shelley, 1998; Petkewich, 2005). If we can better understand what aspects of the commuting experience contribute to privacy, we may be able to design more appealing public transit options.

2. Method

2.1. Participants

One hundred and thirty-nine adult commuters (54% male) who had been commuting to work by passenger train from the same geographic area of New Jersey into Manhattan, New York City were recruited into the study. Each participant was provided a free monthly rail pass for their participation. Participants had been on the same commuting route for an average of 82 months with a 12-month minimum. The average duration of the commute to work was 83 min. The median income level exceeded $95,000 and 83% had a college degree.

2.2. Procedure

Salivary cortisol was collected with a Salivette in the train station at the end of the participant’s morning trip to work and at the same time of day on the following weekend at the respondent’s home. Samples were placed under −20 °C until assay. Cortisol was analysed by a time-resolved immunoassay with fluorescence detection (Dresendorfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992). The difference between resting and on-task, or at work, neuroendocrine hormones has been shown to be a reliable and valid marker of stress both in the laboratory and the field (Frankenhaeuser & Johansson, 1986; Kirschbaum & Hellhammer, 1989; Lundberg, 1984; Lundberg, 2000).

Motivation was measured near the end of the morning commute by persistence on a proofreading task (percent errors detected). This measure has been widely used to assess aftereffects from stressor exposure both in the laboratory and the field (Cohen, 1980; Glass & Singer, 1972). Mood was assessed during the commute to work by two, five point semantic differential scales (carefree–burdened; contented–frustrated), α = .74.

Public transit crowding was assessed at the distal and proximal level. Distally, we calculated the density of the passenger train car by dividing the number of people in the car at the time of the passenger’s entry by the number of seats on the car. Seat density, a more proximal index of crowding, was calculated by dividing the number of people sitting in the same immediate row the passenger was seated in by the number of total seats in the row. Fig. 1 provides a diagram of a typical seating pattern on the train.
3. Results

Car and seat density were examined as predictors of stress with multiple regression with income as a statistical control. Means, standard deviations and zero-order correlations are shown in Table 1. As can be seen in the table seat density but not car density is correlated with some of the stress measures.

All of the effects of car density remain nonsignificant with controls for income, cortisol, b = .43 (.36), ns; proofreading, b = −.09 (.06), ns; and mood, b = −.00 (.51), ns. We statistically controlled for income given the typical covariation between income and house location, commuting route, as well as overall levels of life stress. The standard error for each respective raw beta weight is in parentheses. For seat density all three stress indices are significant for crowding immediately around the participant with income as a statistical control, cortisol b = .70 (.34), p < .02, proofreading b = −.09 (.06), p < .05 and mood b = −.78 (.49), p < .05.

4. Discussion

The results of this analysis of crowding on public transit during the morning rush hour are largely in accord with prior research on crowding both in the laboratory and when observed under naturalistic conditions. We find that a more proximal index of density is correlated with multiple indices of stress wherein a more distal index of density is not. Specifically, the ratio of the number of people on a passenger car to the total number of seats (car density) during rush hour is not related to stress whereas the ratio of the number of people to seats in the immediate area of the passenger is. In some respects, these findings support Altman’s (1975) observation that indices of density that reflect the individual’s actual experience of density or the close presence of other people will be more salient in accounting for human behavior than more distal indices of density that simply represent the average amount of space available to people. More recent investigations of the measurement of crowding are in accord with this conclusion (Evans, 2001).

Both Day and Day (1973) and Knowles (1978) recognized early on that density as a measure of people per area does not fully capture the experience of crowding since people can distribute themselves in many different ways in a given space. Furthermore, floor plan layout plus the positioning of furniture and other physical barriers can alter the individuals actual experience of crowding (Evans, 1979; Stokols, 1972b). Our results suggest the immediate close presence of other passengers is probably more salient for the experience of crowding on public transit than the total number of people on the car. If anything, our results probably underestimate the impact of personal space intrusions on stress since we did not interact with the passengers and thus cannot determine whether the person they were sitting next to was a family member, friend or a stranger. Considerable research indicates that invasions of space by strangers produce more stress than those occurring among people with positive interpersonal relationships (Aiello, 1987; Evans & Howard, 1973).

As noted earlier, journalistic reports suggest that people find middle seats on passenger trains especially aversive, leading to problems for transit systems in designing cars to comfortably accommodate expected capacities (Mc Geeham, 2005). A plausible explanation for this commuter response is personal space intrusion. One of the more salient characteristics of higher density settings is the enhanced probability that one will be forced into a situation where one may find oneself standing or sitting too close to another person (Aiello, 1987; Kaya & Erkip, 1999; Worchel & Teddlie, 1976). This is particularly egregious when: (a) one has little control over the situation and (b) this happens with strangers. Both of these characteristics are commonly met during rush hour commuting on public transit. The finding that sitting close to someone as opposed to being on a train car with a larger number of people is especially stressful is also consistent with Altman’s (1975) privacy model. Personal space may act as a boundary control mechanism that enables us to optimize the degree of social interaction obtained at any one given point in time. When this mechanism becomes restricted or ineffective, such as when a stranger sits down next to you on a train, greater social interaction than desired will frequently occur. Seating in a middle as opposed to an end seat doubles the likelihood and of spatial intrusions and reduces opportunities for adjusting to the situation (e.g., turning away from the proximate seatmate).
Our interpretation of the present findings suggests a number of possible design interventions. Public transit designers could provide pairs of proximate seats on public transit vehicles, instead of three across seating, or include territorial props (e.g., arm rest, small table) in between seats to facilitate the user’s ability to regulate social interaction (Baum, Riess, & O’Hara, 1974; Dumur, Barnard, & Boy, 2004; Fisher & Byrne, 1975). Larger cars that hold more people could be incorporated to help compensate for the loss of seat space (and revenue) if our finding that overall density of the car is relatively unimportant in people’s commuting experience is robust.

The correlation between seat and car density ($r = .13$) was lower than expected. One would think that as passenger train cars filled up with people, individuals would then occupy more seats, including those nearby strangers. However as indicated in Fried and DeFazio’s (1974) ethnographic study of subway riders in New York City, many passengers instead opted to stand by themselves rather than sit next to a stranger. In hindsight, we should have counted the number of standees in addition to noting seating positioning. Anecdotally, one of the authors of the present paper is a regular train commuter to New York City, many passengers instead opted to stand by themselves rather than sit next to a stranger. In hindsight, we should have counted the number of standees in addition to noting seating positioning. Anecdotally, one of the authors of the present paper is a regular train commuter to New York City, many passengers instead opted to stand by themselves rather than sit next to a stranger.

Another limitation of the present study in addition to the cross-sectional design, is the small magnitude of the effects of seat density on stress outcomes (see Table 1). On the other hand although our effect sizes are small, the magnitude of changes in stress as a function of seat density are not trivial. For example, a one standard deviation increase in seat density after controlling for income elevates the log of cortisol by over 2000% and diminishes task performance and mood by 6% and 4%, respectively. Although seat density effects are consistently, statistically significant and car density effects are consistently not significant, a more stringent test of our hypothesis would prove more potent in predicting health and behavioral outcomes of crowding. This is true only for mood. Where another person sits relative to your position in the public transit environment appears to be salient to the commuting experience. At the same time, how many people are present relative to the total number of seats (car density), appears to be less important to commuting stress.

More fine tuned indices of density that more fully capture the actual experience of physical proximity to other people may prove more potent in predicting health and behavioral outcomes of crowding. How easily and how frequently one’s personal space is intruded upon may be one of the key underlying processes that underlie the experience of crowding.

References


