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Modelling the causes and consequences of perceptions of personal safety on public transport ridership

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Abstract

Fears about personal safety on public transport can have an important impact on ridership. A range of studies have examined different factors that influence perceptions of crime risk. This study uses structural equation modelling to explore the influences on perceptions of safety on public transport and the impact these perceptions have on ridership using a survey sample from Melbourne, Australia. The largest direct influences on feelings of safety on public transport were trust in others and feeling safe in one's home or on the street at night. Gender and age are commonly-cited influences in the literature but in this model their influence on feelings of safety was indirect. The total indirect effect of age was larger than the indirect effect of gender. Feelings of safety had a small but significant positive influence on how frequently people used public transport. This was slightly smaller than the negative effect of cars in the household but larger than the negative effect of distance from the city centre.

Personal safety; public transport; structural equation modelling

1 Introduction

Perceptions of personal safety are believed to have a significant influence on public transport ridership. Studies in the UK suggest 10% of the population would reconsider using public transport if their fears were addressed (Crime Concern, 2004) and an analysis of influences on satisfaction with bus journeys in Edinburgh found that safety was the most commonly-cited concern (Stradling et al., 2007).

However fear of crime is not necessarily a reflection of actual risk. The criminology literature identifies a range of factors that can influence whether someone believes they are at risk of being a victim of crime including gender, age, socio-economic status, ethnic background and neighbourhood conditions. Furthermore there is some disagreement in the literature over the degree of negative influences which personal safety concerns can have on transit ridership (Booz Allen Hamilton, 2007).

Within the transport literature the influence of age, ethnic background and gender on perceptions of safety have all been examined. However the additional effects of neighbourhood and psychological characteristics have not been explored in any great depth. This leaves much scope to explore these influences and their downstream effects on public transport ridership.

This paper uses structural equation modelling to explore the interrelated influences of demographics, psychological factors and neighbourhood characteristics on perceptions of safety and frequency of use of public transport. Structural equation modelling provides the ability to compare the interrelated relationships between multiple variables, including both directly measured variables (such as age) and indirectly measured variables (such as fear of crime). The sample data is drawn from a household survey in Melbourne, Australia.

The paper starts with a review of the research literature in this field. This is followed by a review of the methodology adopted to collate and analyse survey evidence. The results of the theoretical and revised models are then described. The paper concludes by summarising key findings and a discussion of their implications for research and policy.

2 Research context

The study of the fear of crime has been recognised as distinct from the actual rate of crime since the 1960s (Crime Concern, 2002). The fear of crime can be very pervasive in society; in the UK 50% of respondents were worried about burglary and 40% were worried about muggings or physical attacks (Crime Concern, 2002).

Within the criminology literature, a range of studies have examined the factors that make people more or less likely to feel safe in various situations such as their own home or a dark street at night. These factors fall into three broad categories:

- situational factors,
- demographic factors, and
- socioeconomic/neighbourhood factors.

Different <u>situations</u> can elicit very different responses, for example people feel much less safe on a dark street alone than with a group during the day (Lynch and Atkins, 1988, Crime Concern, 2002). In transport, these factors are taken into account when designing the transit environment to make passengers feel safer, for example by increasing lighting or the presence of staff (Cozens et al., 2003). Although these are the factors under the direct control of transport planners, it is important to understand demographic and socioeconomic factors also underpin feelings of safety. As Wallace et al. point out, "even when noticed, safety enhancements are limited (but by no means powerless) in their ability to affect transit passengers' feelings" because of the characteristics of passengers and not characteristics of the service (Wallace et al., 1999, pg. 138).

The influence of demographics on fear of crime has been studied quite extensively in the criminology literature. Studies have identified that people in ill health, people with disabilities, women, older people and ethnic minorities are all more likely to be concerned about their personal safety (Crime Concern, 2002, Pantazis, 2000, Ross and Jang, 2000, Lynch and Atkins, 1988). Many of these demographic influences have been corroborated in the transport literature (Currie et al., 2010, Crime Concern, 2004). However not all studies find a significant relationship between feelings of personal safety and age (Morse and Benjamin, 1997, Ferraro and LaGrange, 1992, Ross and Jang, 2000, Tulloch, 2000).

Socio-economic factors and neighbourhood characteristics are also thought to influence fear of crime. People who think their area has high levels of disorder, litter and graffiti tend to be more anxious about crime, fearful and mistrustful of their neighbours (Crime Concern, 2002, Pantazis, 2000, Ross and Jang, 2000). People living in poverty are more likely to feel unsafe in their street and in their own home after dark (Pantazis, 2000).

In most transport surveys people are more likely to feel unsafe *travelling to* bus or train stops than riding the bus or train (Mahmoud and Currie, 2010, Crime Concern, 2004, Booz Allen Hamilton, 2007, Cozens et al., 2003, Reed et al., 2000); it is therefore likely that neighbourhood characteristics are an important factor for journeys that begin or terminate at home. Indeed a study in North Carolina found that crime rates in the census home tract significantly increased feelings of insecurity on public transport (Morse and Benjamin, 1997).

The methods used to measure the antecedents of fear of crime vary considerably. Much research, especially on the effects of demographics on fear, use simple categorical comparisons between groups for all or part of their analyses (e.g. Pantazis, 2000, Cozens et al., 2003, Lynch and Atkins, 1988). Sometimes research is supplemented with the results of focus group discussions (e.g. Cozens et al., 2003, Tulloch, 2000).

Other work uses more sophisticated modelling techniques to weigh the influence of multiple variables together. Studies that use dichotomous measures of safety (e.g., "do you feel safe in your home at night?") tend to use types of discriminant analyses (e.g. Toseland, 1982, Pantazis, 2000). Other studies use continuous measures of safety, either through individual measurement scales (e.g. ratings between 1 "very unsafe" to 5 "very safe") or mathematical combinations of different scale items. The most common analysis used to predict continuous variables were multiple regression analyses (e.g. Morse and Benjamin, 1997, Ross and Jang, 2000, Wallace et al., 1999).

One shortcoming of these methods is that they struggle to model the relationships between independent variables and possible indirect effects on dependent variables. Some studies have expanded these analyses using more complex methods. A path analysis of the influence of age on perceptions of safety was able to examine the interrelationships between age, neighbourhood safety, gender and victimisation rates and the direct and indirect relationships between these influences and perceived risk (Tulloch, 2000).

However path analyses only illustrate the structural relationships between variables measured using a single indicator. Subjective concepts such as "perceptions of safety" cannot be measured directly but must be operationalised based on survey responses. These indirectly-measured latent variables can be estimated using single survey questions or by taking averages across multiple survey responses. Measurement error can be reduced by using more sophisticated methods such as confirmatory factor analysis to triangulate on underlying latent constructs. Unlike path analysis, structural equation modelling allows the estimation of latent variables based on multiple observed indicators as well as providing the structural relationships between these variables (Byrne, 2001).

2.1 Safety in Public Transport Research

The effect that feelings of personal safety have on transit ridership are widely quoted but not widely researched. They are based on self-reported statements such as “I might use public transport if I was happy about personal security” (Crime Concern, 2004) or car owners saying they would use the bus more if they were “reliable, clean and safe” (Loukaitou-Sideris, 1997). Some studies find that the more unsafe people feel on public transport the less likely they are to use it, although it is hard to know if fear reduces use or frequent use reduces fear (Lynch and Atkins, 1988). Other studies find the frequency, reliability and cost of public transport are more important to users than safety (Mahmoud and Currie, 2010, Booz Allen Hamilton, 2007), at least during daylight hours.

Furthermore, sophisticated empirical techniques are noticeably lacking from transport literature’s analysis of perceptions of safety. Conclusions are drawn almost exclusively from focus groups or comparative analyses (Reed et al., 2000, Cozens et al., 2003, Crime Concern, 2004). A few exceptions exist, such as simple regression analyses used in Wallace et al. (1999) and Morse and Benjamin (1997).

This paper aims to contribute to this field of research by considering the combined influence of age, gender, income, neighbourhood characteristics and user feelings of trust on passenger perceptions of personal safety. The use of structural equation modelling (SEM) will expand the methodological rigour applied to this issue in the transport domain. It will also explore the impact that perceptions of safety have on the use of public transport compared to other known influences (e.g. car ownership, income and public transport service levels).

3 Methodology

3.1 Survey Sample

Data for this study was provided by a household interview survey. The survey was administered by a market research company, usually in people’s homes, and took 60 to 90 minutes to complete (see Currie and Delbosc, 2010 for further details on the survey method).

The survey data was collected in two stages. In the first stage, households that had completed a household travel survey called VISTA (the Victorian Integrated Survey of Travel and Activity, The Urban Transport Institute, 2008) were invited to participate in a follow-on survey. The sample frame covered both socially advantaged and disadvantaged households (based on income) as well as groups who had good and bad access to transport and walk accessibility. Some 535 responses were from the greater Melbourne area (406 in outer suburban areas).

In the second stage, a further 249 interviews were conducted on people facing acute social and economic disadvantage. This sample was recruited from government and non-government social support providers. This sample contained a high proportion of low income persons, lone parents, the disabled and carers of the disabled[1]. Overall the study had a sample of 784.

3.2 Structural equation modelling

Structural equation modelling (SEM) is a statistical methodology that examines the underlying structural relationship between variables and displays these relationships pictorially. Variables in these models are conceptualised in one of two ways:

- *Latent variables* are theoretical constructs that cannot be directly observed. Feelings of trust in others or neighbourhood quality are examples of latent variables. They must be operationally defined using observable behaviours or indicators that are believed to represent the underlying variable (Byrne, 2001).
- *Observed variables* are the observed indicators of underlying latent constructs. Self-reported feelings of trust or ratings of neighbourhood characteristics are examples of observed variables that can be used to define latent variables. Directly observable measures, such as gender and age, are also considered observed variables.

Within the structural equation model, confirmatory factor analysis methods are used to form latent variables using observed variables as indicators. Observed variables must be selected with careful deliberation based on knowledge within the field. .

A range of variables were selected as potential explanatory variables for feelings of safety on public transport. These included gender, age, feelings of safety in the home/street, feelings of trust and neighbourhood characteristics. Two further variables were selected as potential influences on the frequency of use of public transport: distance from the city centre and household car ownership.

Perceptions of safety were measured on a five-point scale from "very unsafe" to "very safe." Respondents rated how safe they felt on public transport, on their own street at night and in their own home at night. Based on the literature, feelings of safety on one's own street and home were hypothesised to increase feelings of safety on public transport (Morse and Benjamin, 1997).

Trust was measured using two different variables: a) trust in "people in your local community" and b) trust in "people in general." It was measured on a three-point scale, asking whether respondents felt they could trust "not at all," "sometimes" or "yes definitely." It was hypothesised that trust in others would increase feelings of personal safety. Neighbourhood characteristics were hypothesised to influence trust in people/community.

Neighbourhood quality was measured using three variables. The SEIFA (Socio-Economic Indexes for Areas) index of relative socio-economic disadvantage measures the level of advantage in a geographic area. It is made up of variables related to disadvantage such as low income, low educational attainment, unemployment and dwellings without motor vehicles (Australian Bureau of Statistics, 2006). The SEIFA rating provided by the Australian Bureau of Statistics was applied to the census collection district of each survey participant.

The other two aspects of neighbourhood quality were based on participant's self-reported ratings on two different scales. The first was a measure of disorder in their

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[1] *This sampling method did not appear to have a significant impact on the model findings as preliminary modelling found income did not significantly contribute to the model.*

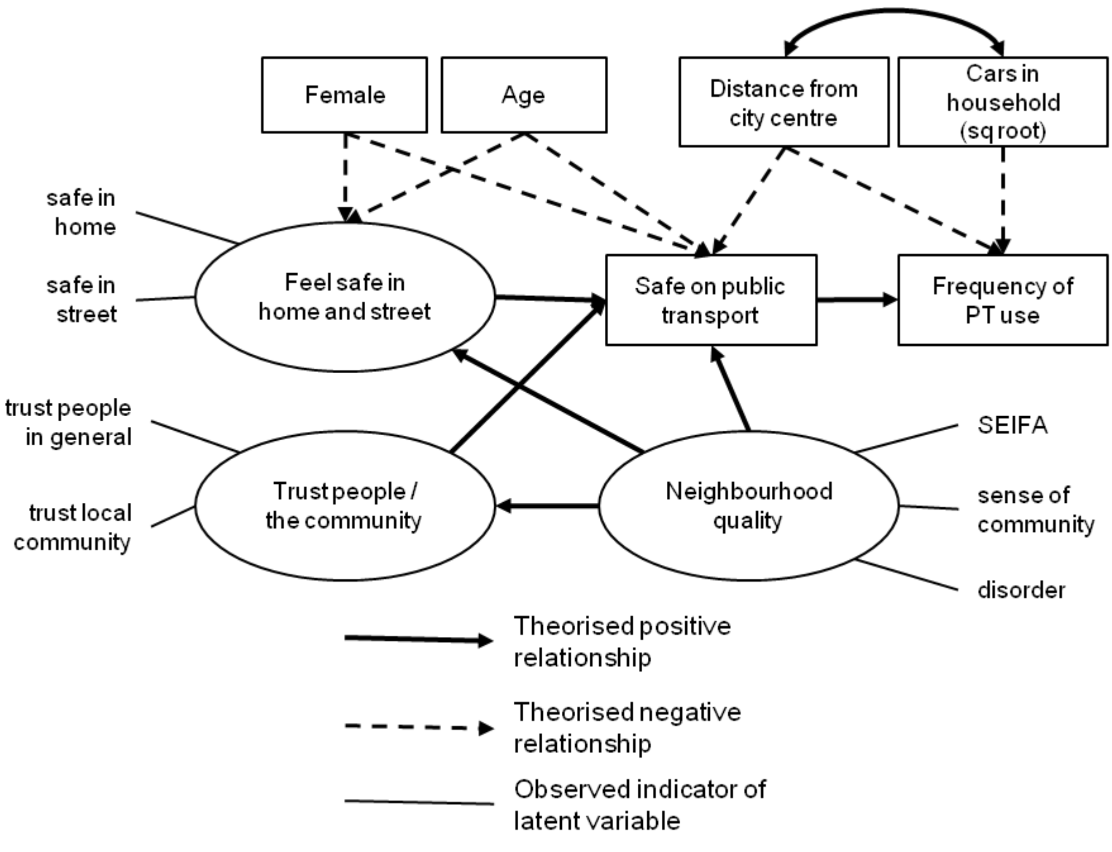
neighbourhood. They rated the extent to which graffiti and vandalism, rubbish lying around and houses and fences “not looked after” were present in their neighbourhood (not present, present a little or present a lot). The second measured the sense of community in their neighbourhood. Participants were read statements such as “I feel at home in my neighbourhood,” “Very few of my neighbours know me” and “I care about what my neighbours think of me” and rated the statements on a five-point scale from “strongly disagree” to “strongly agree”. Neighbourhood quality was hypothesised to increase trust in people/community and feelings of personal safety.

Public transport use was measured on an eight point scale from “never” and “once a year or less” to “at least one or two days a week” and “at least three days a week.” Perceptions of safety on public transport were hypothesised to increase the frequency of using public transport.

In addition, two other variables were suggested to be important impacts on public transport use: the **number of cars** in the household and the **distance of the household from the city centre** (straight-line). The influence of household car ownership on public transport use was not believed to be linear so the number was transformed to the square root. Distance to the CBD was measured as the straight-line distance from the household’s census district. Both of these influences should reduce the frequency of public transport use and they should be somewhat correlated with each other. In addition, living far from the city centre was hypothesised to decrease feelings of safety on public transport due to longer travel distance/time and fewer riders.

Gender and **age** were also considered as important influences on the model. Based on the literature, women and older people were hypothesised to feel less safe at home and on public transport.

Figure 1: Hypothesised model predicting feelings of personal safety on public transport



The hypothesised model is presented in Figure 1. Latent variables are represented in ovals and connected to their observed variables using straight lines. Directly-measured observed variables such as age and cars in household are represented using rectangles. Dashed arrows are hypothesised negative relationships and bold arrows are hypothesised positive relationships.

4 Analysis and results

Table 1 provides some characteristics of the survey sample. There were slightly more males than females in the sample (57%) and the majority of respondents were between 25 and 64. Low-income groups were over-represented in the sample with 63% of respondents in a household with below-median income, a reflection of the sampling method that targeted disadvantaged households. The use of public transport was relatively high with 31% reporting they used it at least three days a week.

Table 1: Survey sample characteristics

		Percent (%)
Gender	Female	57
	Male	43
Age	15-24	24
	25-44	27
	45-64	30
	65+	19
Household income	Below median ($1,100 per week)	63
	Above median ($1,100 per week)	37
Frequency of public transport use	Never	4
	Once a year or less	8
	At least once within the last 6 months	9
	At least once every 2 to 3 months	13
	At least once per month	13
	At least once per fortnight	9
	At least one or two days per week	15
	At least 3 days a week	31

Table 2 shows the percent of the survey sample that feels safe or unsafe on public transport, in their own street at night, and in their own home at night. Some 20% of participants felt unsafe or very unsafe on public transport compared to 10% in their own street and only 3% in their own home.

Table 2: Percent of sample feeling safe or unsafe

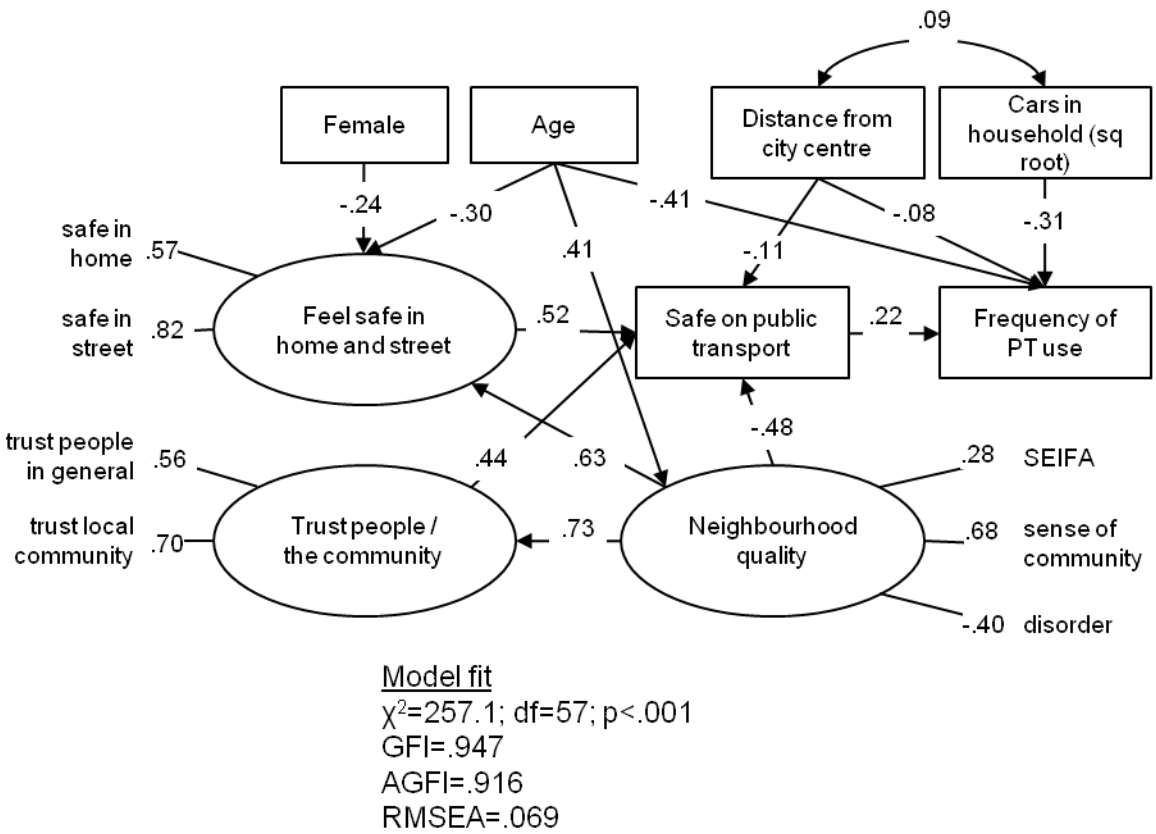
	Percent (%) who feel		
	Public transport	Own street at night	Own home at night
Very Unsafe	3	2	1
Unsafe	17	8	2
Neither safe/unsafe	30	13	2
Safe	45	49	35
Very safe	5	28	61

Analysis of the hypothesised SEM model shown in Figure 1 showed a poor fit to the data. The evaluation of the overall hypothesised model resulted in a significant chi-square (χ^2 = 499.2; df = 57; p < .001), suggesting that the fit of the model to the data is not adequate. However χ^2 has been proved to be an unrealistic measure of statistical significance due to its extreme sensitivity to large sample sizes (MacCallum et al., 1996). For this reason, additional indicators of model fit are consulted. Three additional measurements of model fit were used. The Goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) indicate a good “fit” if their values are above .90 (Byrne, 2001); GFI for the model was .908 but AGFI was .853 indicating an insufficient fit. The root mean square of the error of approximation (RMSEA) was .102, considered a poor fit (MacCallum et al., 1996).

Further investigation uncovered two reasons for this lack of fit. The first was that the hypothesised relationships between age, gender and feelings of safety on public transport were not statistically significant. The second was that modification indexes suggested that two significant relationships were not being represented in the hypothesised model. The modification index is an estimate of how much the χ^2 value of the model would change if these relationships were added to the mode (Byrne, 2001)l. The modification index between age and use of public transport was 137.5 and between age and neighbourhood quality was 65.3; both of these values are quite large considering the χ^2 of the initial model is 499.2.

A modified model was analysed removing the two non-significant relationships and adding connections from age to both neighbourhood quality and public transport use (see Figure 2). The resulting model had a much lower (but still significant) chi-square (χ^2 = 257.1; df = 57; p < .001). The GFI value was higher at .947 and AGFI rose to .916; both values are considered a good fit. RMSEA decreased to .069, considered a reasonable fit.

Figure 2: Modified model predicting feelings of personal safety on public transport



The values shown in the arrows of Figure 2 represent regression coefficients between variables. As with all regression models these values can range between -1.0 (perfect negative relationship) to 0.0 (no relationship) to 1.0 (perfect positive relationship) and represent the standardised relationship between variables. That is, if variable X has a .50 effect on variable Y, that means that for every standard deviation that X increases Y will increase by .50 standard deviations. Indirect effects are interpreted by multiplying coefficients along a path.

All of the regressions in this form of the model were significant at p<.05. The strongest direct predictor of feeling safe on public transport was feeling safe in one's own home and street at night (.52), a medium-large effect. The next-highest direct influence was neighbourhood quality which was unexpectedly negative; the better the neighbourhood the more likely people were to feel unsafe on public transport (-.48). However this effect was slightly ameliorated by the indirect influence neighbourhood quality had on feeling safe in the home and street (.63*.52 = .33) which, when combined with the direct effect, reduced the overall negative influence of neighbourhood quality to -.15. Finally, the farther from the city centre someone lived the more likely they were to feel unsafe, although this effect was small (-.11).

Gender and age did not have a direct influence on feelings of safety on public transport in this model. However several indirect effects contributed to the likelihood that women and older people would feel less safe. The indirect effect of gender through feeling safe in the home and street was small but significant (-.24*.52 = -.12). The indirect effect of age went through two channels, feeling safe in the home (-.30*.52 = -.16) and neighbourhood quality (.41*-.48 = -.20) resulting in a slightly larger combined indirect effect of -.36.

Feeling safe on public transport had a small but significant influence on the frequency of transit ridership (.22). This effect was greater than the influence of distance from the city centre (-.08) but smaller than the influence of cars in the household (-.33).

5 Discussion and Conclusions

This analysis has supported and expanded previous findings from the research literature but also uncovered some unexpected relationships. Some of the strongest influences on feelings of safety were trust in people and feeling safe in one's home and street. These findings suggest that it is worth considering community perceptions of safety in a broader context than solely concentrating on public transport. Feeling safe on one's street and trust in the local community had the largest influences on their underlying latent variables, which in turn had moderate influences on feelings of safety on public transport.

Furthermore, although the perception of safety has a relatively small influence on ridership, this effect is larger than the influence of distance from the city centre and not much smaller than the influence of household car ownership. It should be noted that SEM does not prove the direction of causality; it is likely that less familiarity with public transport contributes to greater fears for safety. For example Cozens et al. (2003) describes the "cycle of fear" where fear reduces the number of people travelling on public transport, which reduces the perceived effects of safety in numbers, which increases levels of fear. Isolating the degree of influence is an important area of future research.

The most unexpected finding was that gender and age did not have a direct influence on feelings of safety on public transport. However there were indirect gender effects through feelings of safety in the home (-.12) and indirect age effects through both safety in the home and neighbourhood quality (-.36). It should also be noted that not all studies find a significant relationship between feelings of personal safety and age (Morse and Benjamin, 1997, Ferraro and LaGrange, 1992, Ross and Jang, 2000). These findings highlight the complexity of understanding these relationships and illustrate the benefits of the structural equation modelling technique.

This model found that although people living in better-quality neighbourhoods felt safer in their home and trusted people more (which supports past research (Pantazis, 2000, Ross and Jang, 2000)), in this study they were *less* likely to feel safe on public transport than people in neighbourhoods with high socioeconomic disadvantage and high neighbourhood disorder. An initial hypothesis was that people living in better neighbourhoods were less likely to use public transport and that this unfamiliarity resulted in feeling less safe; however there was no significant relationship between the neighbourhood variable and public transport use. Another possible theory may be that people in high socioeconomic neighbourhoods feel “buffered” by their safe area and see public transport as a conduit to dangerous situations.

These findings suggest the need for further research in this area. The most obvious contribution would be to model how likely people are to feel unsafe on public transport *at night* to see if the influence of age, gender and neighbourhood characteristics would align with past research. It would also be valuable to weigh these influences against a number of additional variables such as personal experience with threats or attacks on public transport and psychological characteristics (such as fear of strangers).

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