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When Context Matters: A Multilevel Analysis of Household and

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When context matters: a multilevel analysis of household and neighbourhood crowding on aggression and withdrawal

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1. Introduction

It has been speculated that environmental stressors, which emanate from less than favourable conditions in built or natural locations, generate various behavioural and psychological health problems (Lepore, Evans, & Palsane, 1991). Crowding has often been investigated as an environmental stressor since it is predicted to have a significant negative influence on social relations and psychological health (Baum & Paulus, 1991). Early sociological research on density and crowding took the perspective that crowding produces negative consequences of the type like physical and mental disease, crime, and deteriorated human functioning (Altman, 1978). Variables emphasized by this view were indicators of this pathology. An equivalent line of thinking was followed in the development of the psychological tradition, with examinations of task performance, subjective stress, aggression, and withdrawal, on the assumption that these would parallel a decline in functioning among humans as a result of exposure to crowding.

Animal studies demonstrate large negative effects of high density (e.g. Allee, Park, Emerson, Park, &

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Schmidt, 1949; Petrusewicz, 1957; Christian, Flyger, & Davis, 1960; Christian, 1961, 1963, 1970; Thiessen & Rodgers, 1961; Calhoun, 1962; Keeley, 1962; Flickinger, 1966; Willis, 1966; Davis, 1971; Myers, Hale, Mykylowycz, & Hughes, 1971; Greenberg, 1972; Gregor, Smith, Simons, & Parker, 1972). Research examining the impact of density and crowding on human populations has produced varied results. Several explanations have been offered for these inconsistencies, including whether the research involved a manipulation of spatial density (holding group size constant while varying space) versus social density (holding space constant while varying group size) (Altman, 1975; Baum & Koman, 1976; Paulus, 1980; Russell & Snodgrass, 1987; Baum & Paulus, 1991; Hitchcock, 1994), the unit of analysis (Booth & Cowell, 1976), whether the research was carried out in a laboratory versus a residential setting (Baum & Paulus, 1991), and sampling issues in survey research such as representativeness, size, and response rates (Booth, Johnson, & Edwards, 1980a, b; Gove & Hughes, 1980a, b).

This paper argues that a lack of empirical investigations which simultaneously examine the impact of residential and neighbourhood density may also be a major factor contributing to these inconsistent findings. Furthermore, that the effect of density on behaviour

may be nonlinear in nature, with both low and high levels of density having adverse consequences, needs greater consideration. Finally, there is a glaring lack of research which addresses the possibility that individuals may invoke more than one strategy in coping with high-density environments. While there is considerable evidence that both aggression and withdrawal may form responses to high density, the current study examines whether both may be used by the same person, thus bringing together what have largely been separately developing traditions in the density literature. The nonexperimental nature of the present research further helps to fill in the gaps regarding our knowledge of the impact of density on human social behaviour.

1.1. Aggression and withdrawal as responses to high density

Two major types of theoretical arguments have developed concerning the possible effects of density on human behaviour which mirror fight versus flight responses to arousal (see Cannon, 1929; McBride, 1971). One perspective views behavioural responses to density as one of withdrawal from social life (e.g. Wirth, 1938; Simmel, 1957; Milgram, 1970). Situations requiring interaction with large numbers of people may lead to social overload and threaten regulation of interaction (Altman, 1975; Baum & Koman, 1976). In response, individuals may try to withdraw and separate themselves from others as a means of diminishing the chances of coming into contact with others or to regain control of the social situation. Adaptation to crowded environments may therefore occur through withdrawal and individuals may tune themselves out to social stimulation as a means of reducing social overload (Baum & Paulus, 1991).

Environments with more people potentially amplifies the cognitive complexity of the situation through the presence of more elements, as well as the often greater uncertainty of the behaviour of these elements, reducing the amount of information that can be processed and leading to a narrower focus of attention (Mackintosh, West, & Saegert, 1975; Baron & Rodin, 1978). Thus, in its various forms, the stimulus overload model views high density as stressful through the prospect for affording individuals undue stimulation and social overload (e.g. Desor, 1972; Esser, 1972; Laird, 1973; Saegert, 1973; Valins & Baum, 1973; Baum, Calesnick, & Gatchel, 1982; Schulz-Gambard, Feierabend, & Hommel, 1988). This model theorizes the development of a syndrome involving the avoidance of interpersonal interaction and aversion to social tie formation as a systematic means of coping that diminishes social overload (Sundstrom, 1978).

Experimental research has generated some support for the stimulus overload model (e.g. Desor, 1972;

Mackintosh et al., 1975). For example, research on dormitory residents shows greater reports of crowding and unwanted social interaction occurring among students living in dormitories organized along double-loaded corridors compared to students living in suites involving two or three rooms grouped around a common lounge (Valins & Baum, 1973). Furthermore, crowded residents demonstrate poorer memory for social information (Evans et al., 2000), and exhibit a greater tendency to ignore a confederate during a waiting period of an experiment (Baum & Valins, 1979; Evans & Lepore, 1993). Thus, there is substantial evidence to suggest that individuals exposed to high-density experience excess stimulation, which may lead to withdrawal. However, it may not be the only possible reaction.

An alternative perspective on the consequences of crowding argues that frustration generated by high levels of population density will stimulate aggression in individuals. Crowding creates a more impersonal atmosphere, increases opportunities for association with deviant role models and provides greater numbers of targets for aggression (Booth, Welch, & Johnson, 1976). Behaviour may be restricted or limited in crowded environments, leading to difficulties in exercising one's freedom of choice (Lawrence, 1974; Baron & Rodin, 1978; Baum & Valins, 1979; Sinha & Nayyar, 2000). The close proximity of others may cause difficulties with the most routinized behaviours (Baum & Valins, 1979). Frustration may also arise in response to decreasing environmental resources that can result from increases in population density (Michelson & Garland, 1974; Altman, 1975; Baldassare, 1979; Verbrugge & Taylor, 1980; Loo & Ong, 1984). Aggression may encourage others to relocate elsewhere, relinquishing some of their space to the aggressive individual, in turn alleviating a number of the constraints connected with crowding (Baum & Paulus, 1991).

The literature on density provides some support for both of these coping mechanisms. Studies reveal that high density leads to withdrawal (e.g. Hutt & Vaizey, 1966; Loo, 1972; Valins & Baum, 1973; Sundstrom, 1975, 1978; Gove & Hughes, 1983; Aiello, Thompson, & Baum, 1984; Jain, 1987; Evans, Palsane, Lepore, & Martin, 1989; Baum & Paulus, 1991; Lepore et al., 1991), or aggression (e.g. Mackintosh et al., 1975; Loo, 1978, 1979; Aiello, Nicosia, & Thompson, 1979; Gove, Hughes, & Galle, 1979). However, other studies find no effect of density on human social behaviour (e.g. Loo, 1972; Stokols, Rall, Pinner, & Schopler (1973); Booth & Cowell, 1976; Booth & Edwards, 1976; Worchel & Teddlie, 1976). In some cases density is argued to have a positive impact on humans (e.g. Jacobs, 1961; Proshansky, Ittelson, & Rivlin, 1970; Hawley, 1972; Michelson & Garland, 1974; Freedman, 1975; Michelson, 1976; Verbrugge & Taylor,

1980; Owens, 1992; van Vliet, 1985; Keane, 1989; Hitchcock, 1994; Jenks, Williams, & Burton, 1996).

Several decades later, some important questions remain concerning how high-density environments are related to various behavioural outcomes. This paper argues that the varied results in the density literature are due in part to a failure to consider the possibility that individuals will invoke multiple responses in coping with high-density environments. In other words, individuals who are highly aggressive may not necessarily be withdrawn; a person can be aggressive yet avoid contact. There are a number of situations where one could conceive that both aggression and withdrawal may operate together. For example, an individual may engage in aggressive behaviour as a way of decreasing the amount of involuntary social interaction produced by crowded circumstances. This escalated aggression, however, may be accompanied by an overall deterioration of relationships with others (Booth, 1976).

There is also a significant need to examine the wider contextual environment in combination with household density in understanding the relationship between high-density environments and social behaviour. That the effect of interior density may be conditioned by levels of exterior density is an issue that remains unaddressed in the literature on density, which is limited largely to an examination of household or neighbourhood density but not both.

1.2. Household and neighbourhood density

Household and neighbourhood density likely entail different experiences (Zlutnick & Altman, 1972; Altman, 1975; Loo & Ong, 1984). Further, different types of density involve the separation of people with differing social distances (e.g. roommates, families, and strangers). High levels of density at the neighbourhood level can signify large volumes of people on sidewalks, streets, parks, shopping locations, schools, and other public or semipublic areas. High household density, in contrast, implies that there are many people living in a single residence, even to the point of several persons sharing one room. The impacts of household crowding may be felt through the intense interaction required to carry out even rudimentary activities (Booth & Cowell, 1976). Undesired contacts and the shortage of sufficient space produces significant prospects for intradwelling conflict and interpersonal frustration (Baldassare, 1979).

Although household density has been given extensive attention in the literature, there are far fewer studies which examine the effects of neighbourhood density. For example, whether high neighbourhood density is also related to withdrawal has received limited attention. The few studies which include measures of neighbourhood density do not find any association with respondents' health or family relations (Booth & Edwards, 1976; Booth & Cowell, 1976). However, research comparing residents on streets containing small markets or pharmacies at the ends with residential streets not containing any, observed that residents of the former were less likely to interact with others in these exterior neighbourhood spaces (Baum, Davis, & Aiello, 1978). Residents of streets containing stores indicated that they experienced more crowding, encountered unknown others outside of their residences more often, reported more undesired interaction with friends and strangers, had fewer friends in the neighbourhood, and expressed a greater longing to avoid others on their street than did respondents from streets without stores. Decreases in neighbourliness and the desire to meet new people and make new friends have also been shown to be related to neighbourhood crowding (Baldassare, 1975, 1979).

The majority of research on aggression and contextual density relies on official data on crime. This body of literature generally supports the idea of a positive association between population density and crime in general (Schmitt, 1957), density and juvenile crime (Schmitt, 1957; Chilton, 1964; Rosen & Turner, 1967; Galle, Gove, & McPherson, 1972; Factor & Waldron, 1973; Gillis, 1974; Levy & Herzog, 1974; Steffensmeier & Haynie, 2000), and density and violent crime (Booth & Welch, 1973, 1974; Booth et al., 1976; Harries, 1976; Shichor, Decker, & O'Brien, 1980; Roncek, 1981; Smith & Jarjoura, 1988; Williams & Flewelling, 1988; Land, McCall, & Cohen, 1990; Kennedy, Silverman, & Forde, 1991; Miethe & Meier, 1994; Kposowa, Breault, & Harrison, 1995). However, other studies fail to find a significant relationship between population density and various types of crime rates (Schmitt, 1966; Greenwood & Wadycki, 1973; Freedman, 1975; Spector, 1975; Kovandzic, Vieraitis, & Yeisley, 1998), while still another group of studies have found negative effects of density on crime (Levy & Herzog, 1974; Kvalseth, 1977; Roncek, 1981; Roncek & Faggiani, 1985; Morenoff, Sampson, & Raudenbush, 2001). Finally, there is some suggestion in the literature that the relationship between density and aggression may also be nonlinear (Loo, 1972, 1978; Beasley & Antunes, 1974).

Gaining a clear understanding of the behavioural consequences of high density necessitates taking into account that there are different types or levels of density. It also requires considering the possibility that various measures of density interact with one another. Mitchell (1971), for example, found variation in the effect of number of units in the household on emotional strain according to the floor level of the housing unit. Booth (1976) has argued that the stresses of household crowding may be exacerbated for persons who are also residents of crowded neighbourhoods. Extensive interaction continues to be necessary when outside the dwelling to shop, travel, or search out recreation. Going from a crowded neighbourhood to a crowded household

may also intensify responses to density. A person may already be pushed to their limit after dealing with the crowded subway, streets and shops on their way home, only to enter an overly dense residence—a final straw if you will. The gap in current knowledge on density regarding how different levels of density combine has been noted elsewhere (see, for example, Churchman, 1999). Whether the effects of household density are compounded in situations of high neighbourhood density is examined in the current research.

2. Methodology

2.1. Sample

This study examines data from the Toronto Mental Health and Stress Study to assess the effects of household and neighbourhood density on behavioural outcomes. The design of the study involved a multistage cluster sampling strategy. Individuals were randomly selected from households from a representative sample of dwelling addresses drawn from within 200, 1986 Census Enumeration Areas (of a total of 3088 Census Enumeration Areas that comprise the six borough target areas). The first wave, conducted in 1990–1991, yielded 1393 interviews (a response rate of 75.3%). The second wave, conducted approximately 1 year later, reinterviewed 1206 respondents (a response rate of 86.6%).

The location of the study is especially valuable in light of the subject matter. Toronto may provide a unique opportunity to disentangle the effects of density and socio-economic status. A common criticism of early correlational studies of the relationship between density and various forms of social pathology was their inability to distinguish between the effects of density per se and the effects of factors like poverty which tend to coexist with high density (e.g. Factor & Waldron, 1973). However, Toronto is unusually structured in the sense that high-rise buildings are spread across neighbourhoods of varying socio-economic levels. Therefore, the presence of a density/socio-economic status correlation is offset by the fact that some of the more high-density areas of the city are high socio-economic neighbourhoods. Further, more suburban areas, which are lower in density, are often not high in socio-economic status.

The longitudinal component of the study permits an examination of the relationship between density and various behavioural outcomes while controlling for a self-selection of individuals already experiencing these outcomes into particular housing situations. Individuals who are difficult to get along with may be more likely to move into smaller apartments where they live by themselves (Galle et al., 1972). In these situations, density can conceivably act as an outcome of aggression and/or withdrawal, and not merely just a cause. The panel nature of the current data, however, provides measures of household density, withdrawal, and aggression at both waves of the study, thus allowing for an analysis of the effects of density on social behaviour while controlling for prior levels of aggression and withdrawal.

2.2. Measures

2.2.1. Independent variables
2.2.1.1. Household density. The survey contains data on both the number of persons in the household and the number of rooms in the household, and thus persons per room can be calculated by dividing the latter by the former.[1] A squared version was also constructed in order to test for the possibility of nonlinear effects. The notion that both the lowest and highest levels of density may be detrimental has received some support in the literature (see, for example, Loo, 1972, 1978; Beasley & Antunes, 1974; Gillis, 1979; Gabe & Williams, 1986; Baum & Paulus, 1991).

2.2.1.2. Neighbourhood density. 1990 Census data were collected in conjunction with the survey. Data for each respondent were matched with the corresponding Census data. This allowed for the construction of two neighbourhood-level density measures based on this Census data.[2]

1. *Percent nondetached residences.* To construct this measure of neighbourhood density, the percentage of single detached homes was subtracted from 100. The resulting figure provides an indication of the percentage of dwelling which are not detached homes in a given Census tract—in other words, a rough approximation of the percent of multiple dwelling units in the area.
2. *Persons per residence.* This measure of neighbourhood density was constructed by dividing the total

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[1] The validity of persons per room as a measure of crowding has been the subject of some debate in the literature. Its use is based on the assumption that holding the number of persons constant while reducing the number of rooms will lead to a reduction in ability to regulate interaction, in turn decreasing privacy and generating an experience of crowding (Gove et al., 1979). Booth and Edwards (1976, p.81) caution against the operationalization of density as persons per room, asserting that, "…this estimate of crowding may not reflect the actual amount of contact between household members or the extent to which they might interfere with each other's activities". However, Gove et al. (1979, 1983) have validated its use to the extent that they have demonstrated that persons per room is strongly related to both lack of privacy and felt demands. For further evidence in support of the use of this measure, see Loo and Ong (1984).

[2] While recognizing that a given Census tract may not correspond precisely with neighbourhood boundaries, Census tract data do provide an indication of the areal characteristics in which a household is located, and are frequently used as proxies for neighbourhood-level data.

population by the number of residences in the postal code. The resulting variable provides a measure of the average number of persons per residence, or the average interior density, in the neighbourhood.

Part of the complexity of the density literature stems from the varying definitions used to measure the concept (see Alexander, 1993; Hitchcock, 1994; Churchman, 1999). Because there is no universally agreed up measure for neighbourhood density, multiple measures are employed in this study to examine the extent to which findings are contingent upon how it is measured. Choldin (1978), for example, remarks on the importance of the mixture between single-family houses and apartment buildings in a neighbourhood as an element of population density. Measures such as the proportion of multiunit structures or single-family dwellings have been included in past research (see, for example, Schmitt, 1957; Gillis, 1974; Choldin & Roncek, 1976; Roncek, 1981; Sampson, 1983). This aspect of density is captured in the measure of the percentage of nondetached residences in the neighbourhood used here. In contrast, persons per residence in the neighbourhood is essentially an aggregate-level measure of persons per room at the household level. Where the average level of household density in the area is higher, one will be faced with potentially greater numbers of required interactions with others in the neighbourhood. In some sense this represents a compromise between two other common measures of defining density: the number of people per given area and the number of dwelling units per given area (Churchman, 1999). Furthermore, prior research indicates that some urban neighbourhoods experience a decline in population density as a result of a declining number of persons per dwelling, not because the number of dwellings in the area is declining (Guest, 1972).

2.3. Dependent variables

The study includes two outcome measures, originally constructed as separate scales and then combined into a four-category nominal variable. The use of this categorical variable permitted an assessment of whether exposure to high-density environments leads individuals to cope not just by withdrawing or acting aggressively, but by invoking both responses.

2.3.1. Withdrawal

A scale measuring withdrawn behaviour was constructed on the basis of respondent self-ratings on the question "Please select the number on this scale that indicates how well each statement describes you:" I keep other people at a distance too much; it is hard for me to feel close to other people; it is hard for me to experience a feeling of love for another person; it is hard for me to show affection to other people; it is hard for me to socialize with other people; it is hard for me to introduce myself to new people; it is hard for me to join in on groups. The items were scaled such that 0 = not at all well; 2 = moderately well; 4 = extremely well. Cronbach's alpha for both the waves 1 and 2 withdrawal index is 0.87, indicating that the scales have internal reliability.

2.3.2. Aggression

A measure of aggressive behaviour was constructed on the basis of the following self-ratings: Please select the number on this scale that indicates how well each statement describes you: I am too aggressive toward other people (0 = not at all well; 4 = extremely well); I manipulate other people too much to get what I want (0 = not at all well; 4 = extremely well); submissive/forceful (1 = submissive; 7 = forceful); not at all aggressive/aggressive (1 = not at all aggressive; 7 = aggressive); I like people to be afraid of me; I try to get into positions of authority. Cronbach's alpha for both the waves 1 and 2 aggression index is 0.70, indicating that the scales have internal reliability.

The measures of both aggression and withdrawal are self-report in nature. They were designed to cover a range of possible responses to high-density environments. For example, one can conceive of aggression as consisting of a continuum, moving from aggressive attitudes and other nonverbal and nonphysical forms on one end to aggressive behaviour on the other end, with verbal aggression falling somewhere in between. Aggression may function as a response to high-density by inducing others to relinquish space and resources to the aggressive individual. Aggression need not be limited to the physical realm to accomplish this goal. Individuals exhibiting aggressive attitudes and who are verbally aggressive may also be successful in gaining control over their surroundings. The measure of aggression used in the current study may best be conceptualized as a measure of aggressive tendencies.

2.3.3. Combined categorical variable

Aggression and withdrawal in their continuous forms were combined into a four-category nominal-level variable. Each were divided at their mean values into dichotomous variables of low and high aggression, and low and high withdrawal. These dichotomous variables were then combined to make the following four categories: low aggression/low withdrawal ($N = 404$), low aggression/high withdrawal ($N = 298$), high aggression/low withdrawal ($N = 352$), and high aggression/high withdrawal ($N = 313$). The category of low aggression/low withdrawal was selected as the reference category.

If aggression and withdrawal are indeed mutually exclusive outcomes, there should be a high negative correlation between them, signifying that as the likelihood

of an individual exhibiting one response increases, the corresponding likelihood of the other decreases. Essentially, using this reasoning, aggression and withdrawal can be thought of as two extreme ends of a single continuum. Conversely, if the argument being put forth here is correct, there should be no substantial negative correlation between them, since aggression and withdrawal would instead form two separate factors. Testing the validity of this argument involved estimating the correlations between aggression and withdrawal at both waves 1 and 2. The results reveal that while aggression and withdrawal are moderately correlated, the correlation is positive, not negative. At wave 1, the correlation between aggression and withdrawal is $+0.28$. At wave 2 it is $+0.22$. Thus, the presence of one actually increases the likelihood the other will occur too. These findings support the argument that aggression and withdrawal should not be conceived of as the extreme ends of a continuum running from high withdrawal to high aggression, but rather constitute two distinct behavioural outcomes, thereby leaving the possibility open that a single person may indeed exhibit both responses.

2.4. Control variables

Keeping in mind the nature of both the independent and dependent variables of interest here, the control variables selected were gender (females = 1; males = 0;), marital status (never married, previously married, and married as the reference category), ethnicity (Black; South Asian; East Asian; Euro-Mediterranean; and white as the reference category), and household income (measured using a 15-point scale ranging from under 5000–135,000 and above). Descriptive statistics for these variables are displayed in Appendix A.

2.5. Analysis

Hierarchical multinomial modelling was used to test for interactions between household and neighbourhood density on aggression and withdrawal. The nested structure of the data required the use of a program which could incorporate the multilevel nature of the data. The analyses were carried out using hierarchical linear modelling or HLM (Raudenbush, Bryk, & Congdon, 2000a). The use of hierarchical linear modelling techniques permits a simultaneous analysis of both individual- and aggregate-level explanatory variables without the violation of assumptions that typically occurs in studying nested individuals (see Bryk & Raudenbush, 1992). The most recent version of HLM, version 5, permits the modelling of nonnormal level-1 data, such as a multicategory outcome like that under examination here. Such outcomes can be studied by means of a hierarchical multinomial model using an approach referred to as a "hierarchical generalized linear model", or HGLM.

The specific question of interest is whether the impact of household density on withdrawal and aggression is conditioned by levels of contextual density. Individuals low on aggression/high on withdrawal, high on aggression/low on withdrawal, and high on both aggression and withdrawal were compared to those low on aggression and withdrawal. At level-1 the effects of household density and density-squared are modelled, controlling for prior levels of aggression/withdrawal (thus ruling out the possibility of self-selection). Predictors in the level-2 model are the two measures of neighbourhood density constructed from Census data. All variables are grand-mean centred. Results with robust standard errors are reported (unless otherwise noted). Robust standard errors do not depend on the assumption of normality (Raudenbush, Bryk, Cheong, & Congdon, 2000b). Because the data set allowed for the construction of two different measures of neighbourhood density, two separate sets of models were tested. The first set involved interactions between household density and neighbourhood density in the form of the percentage of nondetached residences in the neighbourhood. The second set substituted the average number of persons per residence as a measure of neighbourhood density.

Due to the complexity of the models and the nature of the estimation technique, which in the case of the multinomial model is doubly iterative, it was not possible to model random effects for all of the variables in the level-2 model. As a result, each initial run of the model included random effects for the intercept, the effect of persons per room, and the effect of persons per room-squared. After assessing whether the residual variances of these parameters were significantly different from zero, further runs followed in which several parameters at a time were set free to vary. Level-1 coefficients that were found to have a significant random effect were left as random and the rest were treated as fixed effects. All of the final models included significant random effects for the intercept and some of the slopes, further emphasizing the need to use a technique like hierarchical linear modelling to appropriately model these data. After determining which effects should be fixed, each model was run twice, first without and then with controls. Control variables included gender, income, marital status, and ethnicity. Effects of the control variables were treated as fixed.

3. Results

An initial hierarchical multinomial model tested for significant main effects of persons per room on the aggression/withdrawal categories. A significant nonlinear effect of household density emerges for individuals in the low aggression/high withdrawal, high

aggression/low withdrawal, and high aggression/high withdrawal categories, compared to those low on both. In each case the linear term for persons per room is negative and the squared term is positive, indicating a U-shaped or J-shaped curve. When the percentage of nondetached residences is added to the model, a marginally significant ($p < 0.10$) nonlinear effect is found for individuals low on aggression and high on withdrawal compared to those low on aggression and withdrawal. Again, the linear term is negative and the squared term is positive, suggesting that in neighbourhoods with the fewest high-rises, withdrawal decreases up until a threshold point, after which it increases exponentially.

The results for the hierarchical multinomial model testing for interactions between persons per room and percentage of nondetached residences in the neighbourhood are presented in Table 1. The findings indicate a significant interaction between household density and the nonlinear component of the percentage of nondetached residences in the neighbourhood for the equation comparing individuals low on both aggression and withdrawal to individuals high on both. These effects remain significant once control variables are added to the model. Due to the complexity of the interaction, the relationship was plotted and is displayed

in Fig. 1. The plot represents effects on the log of the odds of the dependent variable, as would be the case in traditional logistic regression modelling. The effects of low and high neighbourhood density are calculated at one standard deviation below and above the mean. Since persons per room is grand-mean centred, the equations are plotted using values of person per room both above and below the mean of zero. All other variables in the equation are set to their mean.

What is evident from this graph is that the effects of household density are more deleterious among individuals living in neighbourhoods characterized by lower percentages of nondetached residences. That is, individuals most likely to respond with both aggression and withdrawal live in areas characterized by fewer high-rises. This may reflect a situation where aggression forms an effective response to increasing levels of household density, but withdrawal continues to be a viable option since once can retreat into a fairly low-density neighbourhood. Since behaving aggressively toward members of one's own household is likely to put a strain on interpersonal relationships within this context, retreating to an outside environment—a more attractive option in situations characterized by low neighbourhood density—may serve to diffuse any tension created and temporarily reduce the excessive

Table 1
Hierarchical multinomial model testing for interactions between persons per room and percentage of nondetached residences in the neighbourhood

Variable	Low aggression/high withdrawal versus low aggression/low withdrawal		High aggression/low withdrawal versus low aggression/low withdrawal		High aggression/high withdrawal versus low aggression/low withdrawal	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Intercept	−0.294[a]	0.187	0.193	0.167	0.515***	0.149
Persons per room	0.144	0.516	0.057	0.512	−0.128	0.509
(Persons per room)^2	1.457*	0.719	1.536*	0.709	1.641**	0.688
% Nondetached residences	−0.041	0.039	−0.006	0.049	−0.010	0.041
(% Nondetached residences)^2	0.0003	0.0003	0.0001	0.0004	−0.0001	0.0003
Low aggression/high withdrawal—time 1	2.589***	0.310	−0.616[a]	0.397	2.318***	0.340
High aggression/low withdrawal—time 1	−0.472	0.529	2.344***	0.280	2.218***	0.336
High aggression/high withdrawal—time 1	2.381***	0.480	2.329***	0.351	4.370***	0.461
(Persons per room)*(% nondetached residences)	−0.102	0.133	−0.113	0.134	−0.241*	0.145
(Persons per room)* (% nondetached residences)^2	0.001	0.001	0.001	0.001	0.002*	0.001
Household income	0.006	0.042	0.114**	0.042	0.127***	0.037
Never married	0.064	0.275	0.189	0.294	0.297	0.289
Previously married	0.034	0.396	0.504[a]	0.358	0.338	0.355
Female	−0.121	0.213	−0.151	0.189	−0.705***	0.178
Black	−0.295	0.367	−0.322	0.389	−0.325	0.408
East Asian	−1.432**	0.491	−0.648[a]	0.482	−0.696*	0.332
South Asian	−0.112	0.470	−0.378	0.400	−0.778	0.655
Euro-Mediterranean	−0.708*	0.327	0.168	0.277	−0.309	0.300

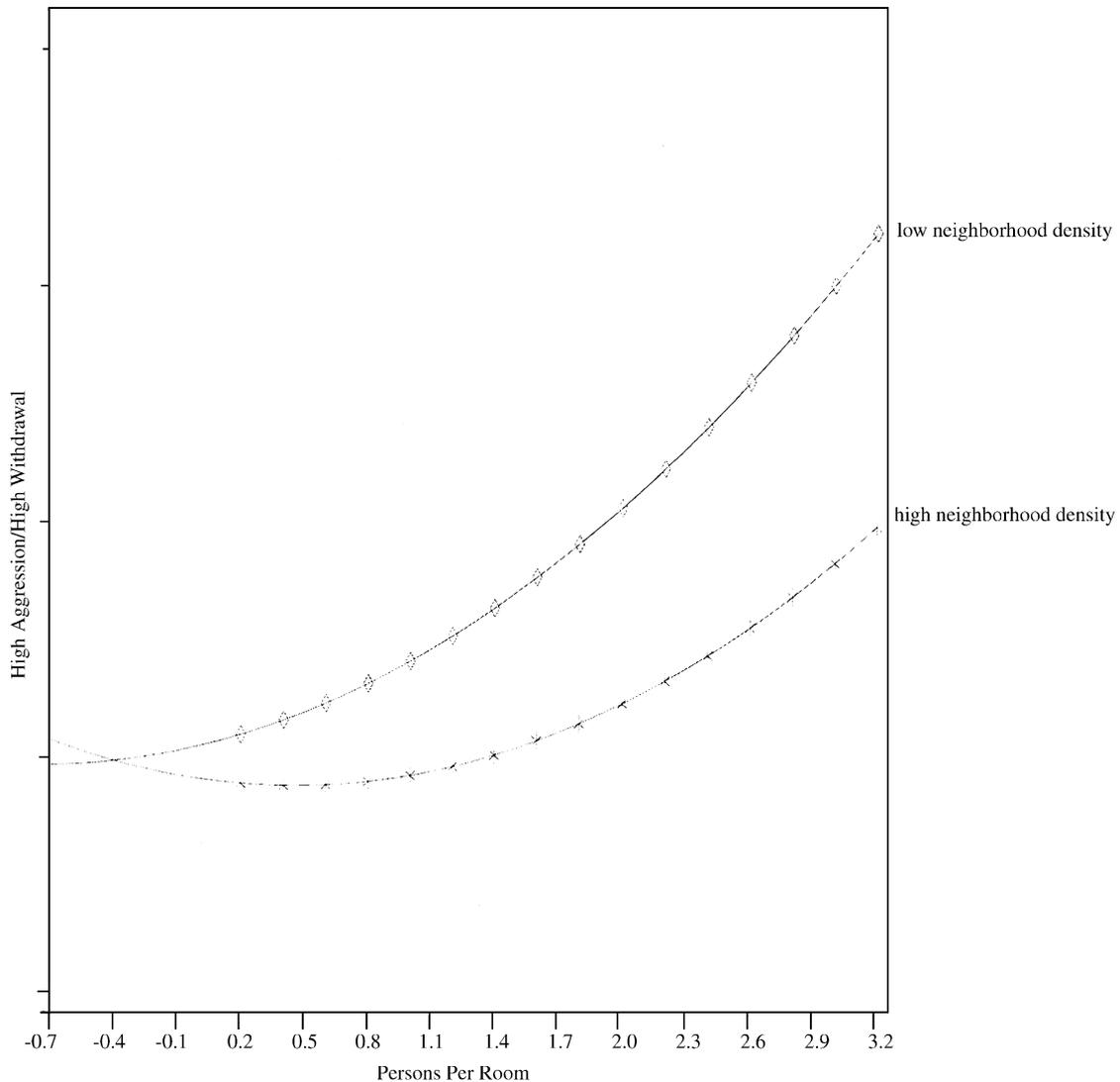*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$,
[a]$p < 0.10$.

Fig. 1. Nonlinear interaction of persons per room and percentage of nondetached residences for high aggression/high withdrawal versus low aggression/low withdrawal controlling for prior aggression/withdrawal.

demands and stimulation which lead to the initial aggressive response. In contrast, for individuals residing in neighbourhoods in which there are comparatively more high-rises, withdrawal may be of limited usefulness in terms of coping with the excessive social contacts that permeate such situations. In other words, in situations where exterior density is high, perhaps aggression alone functions as an effective coping mechanism. These findings are consistent with the notion that in situations where social control is low (as may be the case in low-density contextual environments), behavioural choices like aggression become possible.

For the other two subgroup comparisons (low aggression/high withdrawal or high aggression/low withdrawal versus low aggression/low withdrawal), a significant nonlinear effect of household density emerged. However, these relationships were not

conditional on the level of neighbourhood density (in the form of the percentage of nondetached residences in the neighbourhood).[3] A possible explanation for these findings is that once the effects of self-selection are partialled out, the conditioning effect of neighbourhood density on household density has the most significance for determining whether an individual will invoke both aggression and withdrawal as a means of coping with high density within the home. The likelihood of high aggression or high withdrawal alone may be more sensitive to other conditioning forces such as gender or

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[3] A similar pattern was found in an examination of the original dependent variables of aggression and withdrawal in their continuous forms, which revealed a significant nonlinear effect of household density on withdrawal and aggression and a significant nonlinear effect of percentage of nondetached residences in the neighbourhood on aggression, but no interactions between the two levels of density.

Table 2
Hierarchical multinomial model testing for interactions between persons per room and persons per residence in the neighbourhood

Variable	Low aggression/high withdrawal versus low aggression/low withdrawal		High aggression/low withdrawal versus low aggression/low withdrawal		High aggression/high withdrawal versus low aggression/low withdrawal	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Intercept	−0.320*	0.186	0.212	0.169	0.508***	0.147
Persons per room	0.141	0.494	−0.051	0.497	−0.358	0.508
(Persons per room)^2	1.394*	0.680	1.484**	0.571	1.594**	0.595
Persons per residence	0.002	0.009	−0.007	0.009	−0.005	0.009
Low aggression/high withdrawal—time 1	2.596***	0.301	−0.623[a]	0.395	2.293***	0.344
High aggression/low withdrawal—time 1	−0.462	0.523	2.310***	0.277	2.201***	0.335
High aggression/high withdrawal—time 1	2.384***	0.473	2.309***	0.343	4.348***	0.460
(Persons per room) *(persons per residence)	0.062*	0.036	0.040	0.035	0.014	0.042
Household income	0.006	0.042	0.116**	0.041	0.129***	0.038
Never married	0.011	0.276	0.072	0.293	0.193	0.279
Previously married	0.035	0.398	0.486[a]	0.354	0.339	0.355
Female	−0.118	0.215	−0.166	0.188	−0.707***	0.179
Black	−0.271	0.368	−0.290	0.389	−0.288	0.420
East Asian	−1.403**	0.495	−0.658[a]	0.497	−0.709*	0.345
South Asian	−0.101	0.448	−0.440	0.407	−0.869[a]	0.653
Euro-Mediterranean	−0.700*	0.322	0.134	0.265	−0.324	0.297

*$p<.05$; * *$p<0.01$; * * *$p<0.001$,
   [a]$p<0.10$.

perceived control. Alternatively, this pattern may suggest that selection effects are targeted towards responses of low aggression/high withdrawal and high aggression/low withdrawal.

The hierarchical multinomial model results of testing for interactions between persons per room and average persons per residence in the neighbourhood are presented in Table 2. There were no significant main effects for average persons per residence in the neighbourhood on the aggression/withdrawal categories. However, a significant interaction emerged between household density and persons per residence for individuals low on aggression but high on withdrawal compared to those who are low on both.[4] This interaction remained significant even with the addition of the control variables to the model.

Plotting this interaction reveals something of a J-curve (Fig. 2). For individuals high on withdrawal but low on aggression the positive effect of persons per room really takes off, especially for respondents living in higher density neighbourhoods. That is, the reliance on withdrawal as means of coping is more evident among those living in higher density neighbourhoods. Thus, the combination of high interior and exterior density

appears especially likely to produce adverse behavioural outcomes.

In some ways, Fig. 2 looks more like one would expect than was the case for the interaction involving the percentage of nondetached residences in the neighbourhood. This is perhaps to be expected, however, since persons per residence is the closest analogue to persons per room at the neighbourhood level. Thus, the two neighbourhood density measures may actually reflect different characteristics of the neighbourhood, a finding which is supported by the differing results using the two measures (see Regoeczi & Wheaton, 1998, for further evidence and support of this argument). The different pattern found when using the measure of percentage of nondetached residences may be reflecting a more complex connection between density and high-rise housing than a straightforward linear relationship (see Michelson, 1977; Alexander, 1993; Churchman, 1999, for further discussion of this issue). The use of a measure of the average interior density in the neighbourhood may more closely reflect the "typical" situation encountered by individuals living in these areas with respect to the likelihood of coming into contact with others outside of the home. Neighbourhoods which are high in density due to the presence of high-rises versus those which are high in density because they contain large numbers of high-density households may also be structured quite differently (see below), in turn affecting the utility of various coping responses.

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[4] No significant interactions were found when the continuous forms of the dependent variables were substituted as outcomes, although persons per residence in the neighbourhood has a significant main effect on withdrawal.
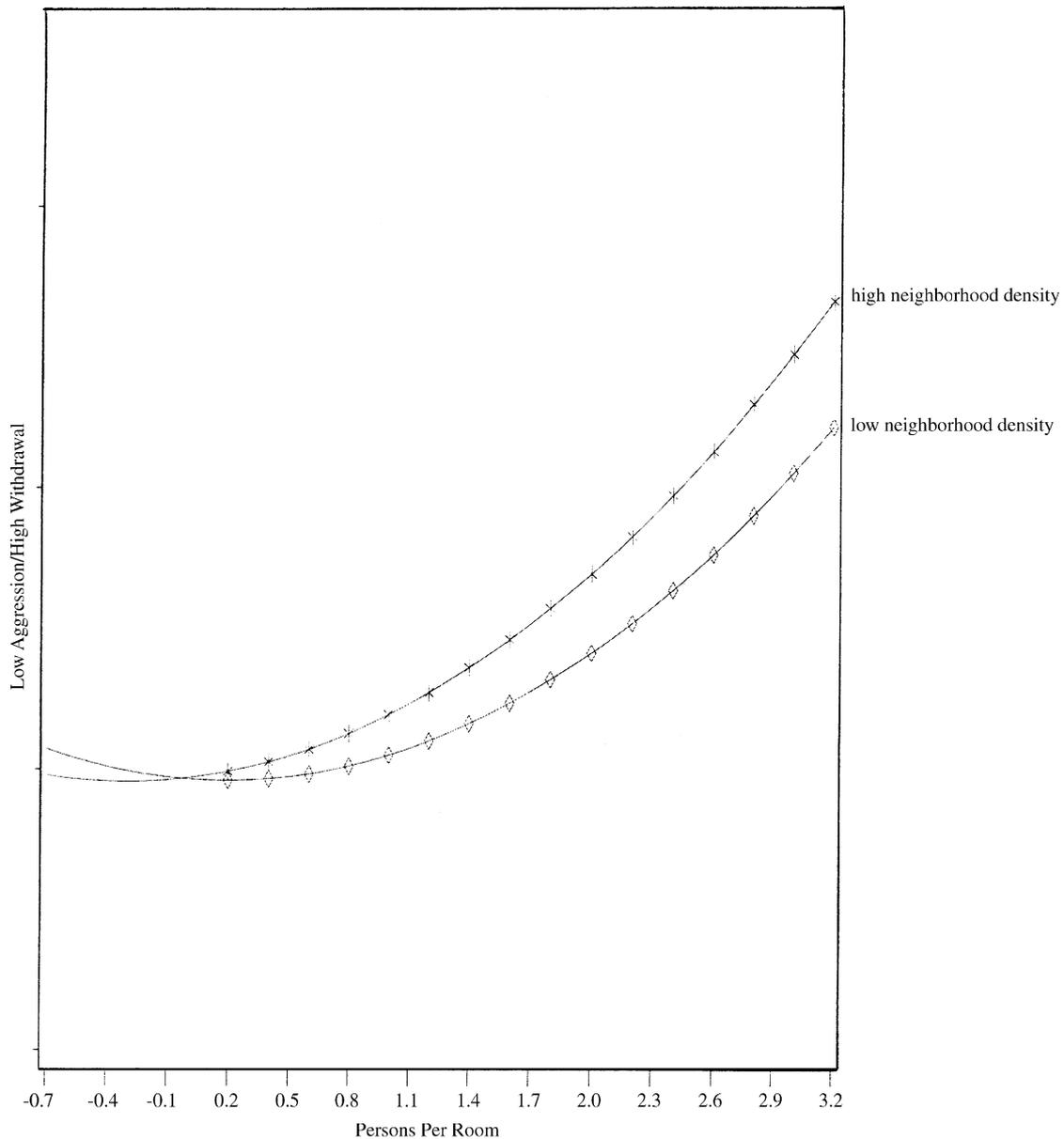
Fig. 2. Nonlinear interaction of persons per room and persons per residence in the neighbourhood for low aggression/high withdrawal versus low aggression/low withdrawal controlling for prior aggression/withdrawal.

It is possible that the slightly more delayed increase in withdrawal for individuals living in lower density neighbourhoods reflects a situation of suburban living. To put it another way, the greater reliance of individuals in higher density neighbourhoods on withdrawal as a means of coping with high density may actually be a reflection of the distractions available in one's neighbourhood. Although moving from a high-density household out into a high-density neighbourhood may mean trading one high-density situation for another, it is likely that many of the individuals one encounters in the neighbourhood will be strangers. While social interaction with members of one's own household is necessary and essentially unavoidable, one could conceivably browse local shops or find solace on an empty park bench or in the corner of a local coffee house in a manner that would minimize contact with others in such a way that would be considerably more difficult to accomplish within one's home. In other words, anonymity may be necessary for withdrawal to be effective. Thus, in spite of their high density, some of Toronto's denser neighbourhoods may actually be structured in such a way as to increase the likelihood that individuals in high-density households will exhibit high social withdrawal. This pattern also fits with the findings of other research indicating that the use of coping

strategies such as withdrawal may generalize beyond the residential setting (see, for example, Baum & Valins, 1979; Evans et al., 1989; Evans & Lepore, 1993). Note from Fig. 2 that individuals living in low-density neighbourhoods are similarly affected by high household density, it is simply that the positive effect is slightly more delayed among this group (due to the fact that the interaction is between the linear components of the two density measures, meaning it occurs on the downside of the curve).

Thus, the findings from these analyses provide substantial support for the notion that the effects of household density are conditional on levels of density in the contextual environment. Interactions emerged between household density and the percentage of nondetached residences in the neighbourhood for high aggression/high withdrawal, and between household density and average persons per residence in the neighbourhood for low aggression/high withdrawal. The findings therefore emphasize the importance of simultaneously analysing individual and contextual effects using multilevel analyses in order to more fully understand the consequences of high household density for the social behaviour of individuals. Furthermore, the effect of density was found to be nonlinear in nature, underscoring the importance of theorizing about and modelling the varied impact of crowding across the full range of levels of household density. Finally, these results support the notion that aggression and withdrawal should not be conceived of as mutually exclusive responses to density. Rather, a single individual may draw on both coping mechanisms when faced with a high-density living environment.

4. Discussion and implications

Commonsense has long suggested that as more and more people try to share a limited amount of space, undesirable consequences will result. Attempts to empirically demonstrate such a relationship, however, have produced varied support for the idea. This paper seeks to address some of the limitations in the existing literature in the hopes of shedding some additional light on the reasons for the inconsistent findings to date. In particular, although the density literature has looked at the impact of both household and neighbourhood density on individuals, rarely are these considered together. That the effects of household density may be conditioned by levels of neighbourhood density has also gone largely unaddressed. This study makes some major contributions with respect to clarifying this issue. First, it explicitly examines the possibility that household and neighbourhood density interact with one another in influencing human behaviour. Second, it uses a modelling technique to examine

these interactions which compensates for the violated statistical assumptions that come with analysing individual- and aggregate-level data simultaneously. Using hierarchical multinomial modelling allowed for an explicit incorporation of both individual and contextual effects in the analysis, as well as cross-level interactions between the two.

The results revealed several significant interactions between the different levels of density, underscoring the importance of examining the effects of household density within the context of neighbourhood density levels. Contextual analyses as an approach to studying urbanism and crowding effects have been recommended elsewhere (e.g. Fischer, 1972; Baldassare, 1979). Finally, the findings from these analyses, which in some cases revealed more elaborate interactions than a simple multiplicative effect of high interior and exterior density, should serve to remind researchers that the social world works in infinitely more complex ways than it is often portrayed. Social scientists need to continue to challenge such commonsense notions.

This study also demonstrated the importance of examining the possible deleterious effects of density at both its lowest and highest levels. The finding of a nonlinear effect of density, in this respect, supports the notion that there may be an ''ideal range'' of density in which adverse reactions are minimized. Policy recommendations depend on an accurate conception of where the problematic range of density lies.

The support generated by this research for the notion that both aggressive and withdrawn behaviour by a single individual is a viable coping mechanism in high-density situations is a key finding of this study. It emphasizes the importance of incorporating multiple outcomes when examining how people cope with high-density living environments. Future research should expand on this idea by examining additional combinations of strategies that may be invoked in dealing with high residential density. Additional analyses are also needed to explore the extent to which coping strategies vary across demographic subgroups (i.e. gender). These approaches would go a long way to broadening our understanding of the impact of high density on human social behaviour.

Appendix A. Descriptive statistics

See Table 3.

Table 3

Variable	Mean	S.D.
Persons per room (wave 1)	0.535	0.311
Persons per room (wave 2)	0.560	0.384
Aggression/withdrawal categories (wave 1)	2.580	1.137
Aggression/withdrawal categories (wave 2)	2.292	1.131
Percent nondetached residences	62.14	16.999
Persons per residence	17.697	11.248
Female	0.566	0.496
Household income	8.863	3.080
Currently married	0.483	0.450
Never married	0.391	0.488
Previously married	0.126	0.332
Black	0.080	0.271
East Asian	0.083	0.275
South Asian	0.046	0.210
Euro-Mediterranean	0.228	0.419

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