Physiological, Social, and Behavioral Consequences of Crowding on Children and Adolescents

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AIELLO, JOHN R.; NICOSIA, GREGORY; and THOMPSON, DONNA E. *Physiological, Social, and Behavioral Consequences of Crowding on Children and Adolescents.* CHILD DEVELOPMENT, 1979, **50**, 195–202. The present investigation was designed to examine systematically the effects of short-term crowding, involving close physical proximity, on children and adolescents. Fourth-, eighth-, and eleventh-grade children participated in groups of 4 under high or moderate spatial density conditions. During exposure to these conditions, physiological responses were measured, and following this experience children engaged in a cooperation-competition activity and provided self-reports related to their participation. Results demonstrated that crowding had physiological, behavioral and social consequences for the children studied. Across all grade levels, males in particular were more affected by short-term crowding, displaying the highest elevations in stress-related arousal. Following exposure to the crowding conditions, children were more competitive, despite the fact that they had all to gain from cooperating and nothing to lose. Furthermore, children reported having felt crowded, tense, annoyed, and uncomfortable as a function of the close physical proximity to others. Implications of the immediate and residual effects of crowding on the behavior and functioning of children are discussed.

During the past 50 years, increases in population growth and urbanization have enhanced the concern of social scientists with the effects of crowding and overpopulation on human behavior. Evidence from early animal research (e.g., Calhoun 1962) and subsequent human correlational research (e.g., Galle, Gove, & McPherson 1972) has demonstrated that high-density living conditions are related to various indicators of social and physical pathology.

A number of other researchers, primarily psychologists, have examined the effects of high-density conditions in other environments (e.g., classrooms, playrooms, and playgrounds). These studies have also distinguished between two types of density conditions. Of the studies reported to date, 11 have varied spatial density by observing the same number of children in different size rooms, three have varied social density by observing different numbers of children in the same size room, and two have examined both social and spatial density. With three exceptions (e.g., Smith & Connolly 1972), these investigations have found that when placed in high-density conditions children engage in less social interaction and exhibit more solitary play (e.g., Hutt & Vaizey 1966; Loo 1972; McGrew 1970).

Findings regarding the impact of density levels on children's aggressive behavior have been somewhat less straightforward. Most studies have reported that children are more aggressive in higher-density environments (e.g., McGrew 1972; Bates, Note 1; Ginsburg & Pollman, Note 2). Other studies, however, have found more equivocal results: either no differences between children under high and low densities (e.g., Price, Note 3), less aggression under high-density conditions for males and no differences for females (Loo 1972), or more aggression under high-density conditions for

This research was supported in part by a Rutgers University Research Council grant, by NICHD grant HD 8546-01, and by NIH Biomedical Research Support grant 5S07-RR07087-12. Portions of this research were presented at the meeting of the Eastern Psychological Association held in New York City, April 1976. We wish to express our appreciation to the staff and students of the Tewksbury Township schools and Voorhees High School, to Elizabeth Holland for her help in the planning and conduct of the study, and to Cathy Torre and Leslie Rosen for their help in data collection. Reprints can be obtained from John R. Aiello, presently at George Peabody College, Psychology, Box 67, Nashville, Tennessee 37203, or, after July 1, 1979, at the Department of Psychology, Douglass College, Rutgers University, New Brunswick, New Jersey 08903.

[*Child Development*, 1979, **50**, 195–202.
0009-3920/79/5001-0023$00.81]

males and no differences for females (Loo, Note 4). The results of the more recent study by Rohe and Patterson (Note 5) may help to clarify these inconsistent findings. These investigators manipulated the number of toys available to groups of children as well as spatial density and found that the most frequent occurrence of aggressive behavior was in the high-density condition containing few toys. Therefore, it is possible that objects like toys may be used by children to ameliorate uncomfortable situations involving more interpersonal interaction than they normally desire. Consequently, aggression may result as a function of the frustration and competition that occurs when a limited number of such distractor items are present in the environment (i.e., resource scarcity).

Competitive behavior has also been shown to vary as a function of density level, with children spending considerably more time in competitive play when they are in highly dense playrooms, particularly when these play areas contain very few toys (Rohe & Patterson, Note 5; Rohe, Note 6; Rohe & Nuffer, Note 7). Additional responses of children under high-density conditions include more fearful behavior and more laughing (McGrew 1972); greater frequency of interruptions (Loo 1972); increases in proximity (McGrew 1970); more passivity or vigilant onlooking, more unstable activity, greater avoidance behavior, and less self-involvement in social or toy play (Loo, Note 4); and less locomotion (McGrew 1972; Smith & Connolly 1972; Bates, Note 1). Last, two studies reported by Rodin (1976) have indicated that children living under chronic high-density conditions suffer motivational deficits and consequently are less apt to exert control over outcomes when given the opportunity to do so.

At the present time, there is a growing body of literature indicating that there can be physiological consequences for adults under conditions of short-term crowding involving close physical proximity, as well as negative behavioral and social aftereffects following exposure to these conditions (e.g., Aiello, DeRisi, Epstein, & Karlin 1977; Aiello, Headly, & Thompson 1978; Sherrod 1974). In view of these findings and the results of the density studies showing differential effects on children's behavior (e.g., aggression and withdrawal), the importance of examining the impact of crowding involving close physical proximity on the behavior and functioning of children should be apparent. Personal space preferences have been found to vary with age such that younger children interact at much closer distances than do older children and adults (Aiello & Aiello 1974; Tennis & Dabbs 1975). Might younger children, therefore, be less affected by crowding which involves the close physical proximity of others?

Consistent with our previous suggestion that multiple levels be employed in studies of human crowding (e.g., Aiello, Epstein, & Karlin 1975), the present investigation will consider the social, behavioral, and physiological responses of children and adolescents ranging in age from 9 to 17, who will be exposed to one of two levels of spatial density. Previous studies have only observed children from 2 to 8 years old and have made no attempt to evaluate whether the children actually felt crowded or whether any differential physiological responses were associated with high-density levels. Based on previous research, it was expected that under the high spatial density condition greater arousal would be manifested for all children but particularly for male children, since male adults have been shown to be more affected by crowded conditions (e.g., Nicosia, Hyman, Karlin, Epstein, & Aiello, Note 8). A second purpose of the present experiment was to examine the aftereffects of the crowding experience on cooperation. Specifically, it was expected that when compared with their noncrowded peers, children experiencing crowding would show more competition on a postcrowding cooperation-competition task.

Method

Subjects

The subjects were 184 white, middle-class children (96 males, 88 females) from several public schools in a northeastern suburban community. There were 44 fourth graders (20 males, 24 females), 52 eighth graders (28 males, 24 females), and 88 eleventh graders (48 males, 40 females) whose approximate ages were 9, 13, and 16, respectively.

Children of approximately the same chronological age and of the same sex were randomly assigned into groups of four with the exception that discussions were held with teachers to avoid grouping children who were either best friends or who did not get along with

each other. A total of 46 groups were run; two same-sexed groups of four children each participated in each session. All experimental sessions were conducted in equally unfamiliar, specially partitioned, empty classrooms within each of the participating schools. Children were removed from class to participate in the study.

Procedure

Before beginning the actual experiment, all instruments and procedures were pretested. At the start of each experimental session, eight minimally acquainted children were selected from their respective classes and were assigned a numbered badge which was either red (if the subject was in the crowded condition) or blue (if the subject was in the noncrowded condition). Following this, the subjects were taken to another room where they were prepared for the first phase of the study. One of two experimenters attached zinc electrodes coated with zinc sulfate sodium chloride in "Unibase" mixture to the palmar surface of the middle finger of each child's nonpreferred hand (see also Aiello et al. 1975).[1] While the electrodes were being attached, the other experimenter explained to the children that these "finger attachments" would not hurt and that they would be used during a series of activities in which they would be participating. The children were further instructed that if they remained seated and did not talk to one another during the first activity they would win coupons which could be traded in for prizes (e.g., Twinkies, Devil Dogs) at the end of the day. This procedure took about 5 min and, therefore, allowed for an adjustment period to the electrodes.

Upon conclusion of these instructions, the two groups of children were taken either to two small (4 × 2½-foot) or two large (10 × 12-foot) partitioned rooms where they were seated facing one another in chairs which were arranged in two rows of two seats each. In both conditions, the children sat in chairs whose numbers corresponded to the numbers of their badges. They were reminded to sit quietly and keep their hand with the "finger attachment" on their lap.

Next, skin conductance level (SCL) was recorded for each child once every 30 sec over a 30-min period, so that a total of 60 readings were obtained for each child. Room temperature and humidity were recorded both on placement and on removal of the subjects from the room. An occasional active student was asked to sit quietly and was reminded that the coupons would be awarded to those who followed the directions. Since the measurement of SCL is subject to a variety of measurement artifacts (see Montagu & Coles 1966), care was taken throughout the course of the experiment to control room temperature and humidity. The room temperature and humidity never increased more than 2° F or 3% during any experimental session, and each of these variables remained virtually identical across conditions (about 73° F and 62%). The occasional changes in temperature and humidity that were observed are too small to affect skin conductance meaningfully (see Maulsby & Edelberg 1960). In addition, experimental sessions were scheduled at similar times of the day, and the composition of the electrode paste used minimized the possibility of any hydration artifact.

After sufficient physiological data were collected, each child was led one at a time to another area, where the skin conductance unit was removed and coupons were tendered. Following this, half of the subjects were first given a postexperimental questionnaire assessing their perception of the experimental environment and attraction to their fellow group members and self-reported symptoms of stress, discomfort, annoyance, and reactions to various phases of the experiment. The other half of the subjects were first paired with a "like-badge numbered" subject from the group of which they were not a member and led to another room where they played Kagan and Madsen's (1971) "circle matrix board" game, a measure of cooperation-competition in which they could win additional coupons. In the circle matrix board game, two children attempt to reach their own personal goal or "target circle" by alternately moving a marker through a board on which there are seven rows of circles with seven circles to a row. In order to win the additional

[1] Each electrode set is composed of a finger plate with two concave zinc disks separated by 1 cm. The measurement is taken by applying a 1 volt, isolated, d.c. potential across the finger electrodes and measuring the d.c. current that flows through the skin. Montagu and Coles (1966) have noted that "the constant-voltage method would seem to possess distinct advantages over the constant-current principle" (p. 268).

coupons in the present study, the children were told that the marker had to move to a different circle for each of them on a single trial. Thus, it was impossible for both children in a pair to win a coupon on the same trial. However, if the children cooperated or helped each other within trials, they would be able to share the coupons across the four trials. When the children finished their first activity, they were escorted to another area to begin the second activity. When both tasks were completed, the children were thanked for their participation and reminded to return after classes that day to redeem their coupons for cake prizes.

Results

Postexperimental questionnaire data indicated that the crowding manipulation was effective. Subjects in the crowded condition at all grade levels considered the experimental room smaller, $F(1,171) = 135.86$, $p < .001$; having less room, $F(1,171) = 152.74$, $p < .001$; more crowded, $F(1,171) = 181.98$, $p < .001$; hotter, $F(1,171) = 17.94$, $p < .001$; and less comfortable, $F(1,171) = 10.80$, $p < .001$, compared with their noncrowded counterparts.

Electrodermal Responses

Ten trial blocks of 3 min each were formed from the data obtained during the 30-min experimental session. Consistent with the suggestions of Montagu and Coles (1966), means for each block were then subjected to log transformations. A 2 (room condition) × 2 (sex) × 3 (grade level) × 10 (trial block) repeated measures (on the last factor) analysis of variance was carried out on the transformed scores. Significant main effects of sex, grade level, and trial block were produced: $F(1,166) = 9.33$, $p < .003$; $F(2,166) = 15.30$, $p < .001$; $F(9,1494) = 120.97$, $p < .001$, respectively. The SCLs of boys and girls increased over time, with boys having higher SCLs than girls. While the youngest subjects had the highest mean SCL, the eighth graders evidenced the lowest mean SCL. Since the main effect of grade level accounted for more than 13% of the total variance, and more importantly because Jones (1949) and Obrist (1948) have reported that skin conductance changes dramatically over the 8-year age span of the subjects in this study, the data for each grade level were analyzed individually in a 2 (room condition) × 2 (sex) × 10 (trial block) factorial ANOVA.[2]

Eleventh-grade results.—The results of the eleventh-grade data evidenced a pattern of response similar to that obtained with adults. Significant main effects of sex and trial block, $F(1,180) = 7.96$, $p < .007$, and $F(9,720) = 56.63$, $p < .001$, respectively, are qualified by two significant interactions. Subanalyses of the sex × trial block, $F(9,720) = 4.85$, $p < .001$, and the sex × room condition × trial block interaction, $F(9,720) = 10.04$, $p < .001$, were conducted using Tukey's Honestly Significant Difference (HSD) statistic. Averaged across conditions, boys and girls showed approximately equal gains in SCL over the 30-min session. However, boys' SCLs increased significantly during the first half, $HSD(10,720) = 8.97$, $p < .005$, while girls' SCLs showed an initial nonsignificant decrease before a gradual increase to significantly higher levels by trial block 7. Subanalysis of the three-way interaction indicates that the observed increase in boys' SCLs is due solely to the crowded boys, who show equal and significant increases between blocks 1 and 4, 4 and 7, and 7 and 10, all $HSD(10,720) = 5.25$, $p < .04$; noncrowded boys' SCLs do not change significantly beyond initial levels. In contrast, the noncrowded girls showed large increases in their SCLs after an initial nonsignificant decrease during the first half of the session, while crowded girls exhibited a more gradual rise in SCL, $HSD(10,720) = 11.08$, $p < .001$, and $HSD(10,720) = 6.58$, $p < .001$, respectively.

Fourth-grade results.—Analyses of the fourth-grade data evidence increases in SCL by both sexes in response to both the crowded and noncrowded environments. Trial blocks was the only main effect to reach significance, $F(9,351) = 81.44$, $p < .001$. Overall, SCL increased throughout the session. The significant interaction of room condition and trial blocks, $F(9,350) = 3.60$, $p < .001$, shows that crowded subjects displayed greater and more rapid increases in SCL than did noncrowded subjects. This finding is further qualified by the significant sex × room condition × trial block interaction, $F(9,351) = 2.67$, $p < .006$. In the

[2] Given the large individual differences in SCLs that we observed in the present study, we recommend that future researchers gather base level data for subjects so that this information can be used to correct for individual differences in SCLs. Without each subject's own base level, this correction for individual differences was not feasible in the present study.

crowded condition, the SCLs of both boys and girls significantly increased during the first half of the session, $HSD(10,353) = 10.50$, $p < .001$, and $HSD(10,353) = 15.15$, $p < .001$, respectively. During the second half of the crowding session, boys' SCLs continued to increase significantly while girls' SCLs showed a slight nonsignificant increase, $HSD(10,351) = 9.09$, $p < .005$, and $HSD(10,351) = 3.53$, $p < .25$, respectively. In the noncrowded condition, boys' and girls' SCLs increased about the same amount during the 30-min session. However, noncrowded boys made rapid initial gains in SCL, $HSD(10,351) = 9.79$, $p < .005$, and did not increase SCL significantly after the third trial block. In comparison, noncrowded girls displayed a more gradual rise in SCL, increasing significantly above initial levels by trial block 7, $HSD(10,351) = 11.31$, $p < .001$.

Eighth-grade results. The data from eighth graders resembles the performance of both younger and older subjects in part. Once again, trial blocks was the only main effect in the analysis, indicating significant increases in SCL throughout the experimental session, $F(9,432) = 25.04$, $p < .001$. This effect is qualified by the significant room condition × trial blocks and sex × trial blocks interactions, $F(9,423) = 4.43$, $p < .001$, and $F(9,423) = 6.59$, $p < .001$, respectively. Noncrowded eighth graders increased SCL significantly in both halves of the session—trials 1–5: $HSD(10,423) = 8.17$, $p < .005$; trials 6–10: $HSD(10,423) = 5.73$, $p < .01$. Crowded subjects showed no increase in SCL during the first half of the session but did increase SCL significantly during the second half of the trial blocks, $HSD(10,423) = 7.17$, $p < .01$. In addition, females initially displayed a significant decrease in SCL, $HSD(10,423) = 4.85$, $p < .05$, followed by increases which reach levels significantly beyond initial ones by the end of the session, $HSD(10,423) = 5.51$, $p < .01$; conversely, males' SCLs increased during the first half of the session, $HSD(10,423) = 9.71$, $p < .005$, but remained stable thereafter. Thus, both crowded and noncrowded eighth-grade girls' SCLs first decreased, then increased, much like the performance of the eleventh-grade females. On the other hand, eighth-grade boys' SCLs increased in response to both the crowded and noncrowded environments, a pattern similar to that evidenced by younger boys.

Postexperimental Questionnaire Data

A postexperimental questionnaire assessed the extent to which persons were bothered by spatial intrusion and their general level of annoyance. It was expected that crowded subjects would report being more bothered by spatial intrusion and would express the greatest annoyance.

The proximity-discomfort index represented the mean of the following questionnaire items: felt cramped, felt squished, felt uncomfortable, felt others too close, felt others tense, and felt muscles tense. These items were significantly intercorrelated ($\bar{r} = .33$). Analysis of variance indicated a significant room condition effect, $F(1,172) = 94.76$, $p < .001$. Crowded subjects reported much greater discomfort as a function of the proximity of others than did their noncrowded counterparts. A significant sex effect was also obtained, $F(1,172) = 5.31$, $p < .025$, indicating that greater spatial discomfort was experienced by males.

An index of annoyance was also created which represented the mean of the following items: felt angry, felt annoyed, felt frustrated, felt like leaving, felt others angry, felt others annoyed. These items were also significantly intercorrelated ($\bar{r} = .32$). Analysis of variance indicated a significant room condition effect, $F(1,172) = 9.31$, $p < .001$. Crowded subjects felt more annoyed than did their noncrowded counterparts.[3]

Social Behavior: Cooperation-Competition

It was expected that, in addition to physiological indications of stress-related arousal and self-reported discomfort, there would also be behavioral aftereffects of the crowding experience manifested in the degree of cooperative and competitive behavior exhibited by children and adolescents following exposure to this condition. Specifically, it was expected that when compared with their noncrowded counterparts, crowded subjects would be less

[3] It should be noted that our procedure purposely called for some degree of restraint (absence of free movement) so that a more accurate measurement of physiological responses could be obtained and the desired levels of spatial density established. In order to evaluate the effect of these facets of the design, we analyzed the subjects' responses to several questions relevant to this aspect of the procedure. No differences were obtained between crowded and noncrowded subjects on these questions.

cooperative and more competitive after the experimental session. An analysis of variance performed upon the number of games won by the students provided support for this expectation. As anticipated, the size of the room significantly affected the children's social behavior postcrowding, $F(1,171) = 4.58$, $p < .05$. Children who had been crowded were more competitive than those who were not crowded. Further, this effect is qualified by a significant sex × room condition interaction, $F(1,172) = 3.93$, $p < .05$, indicating that males who had not been crowded were the most cooperative.

The data from the cooperation-competition games were further analyzed to determine the types of moves made in the game. Six mutually exclusive categories reflecting the distinct patterns most frequently made have been suggested by Kagan and Madsen (1971). The percentage of trials that fell into each category is given in table 1. As can be seen, submission, complete cooperation, and nonconflict rarely, if ever, occurred.

The majority of trials (75%) were characterized as partial conflict trials, representing various degrees of directly competitive moves without displaying a pattern of submission (the first subject moves toward his or her goal, the second moves toward his or her goal, the first subject then moves toward the second subject's goal) or staircasing (the first subject moves toward his or her goal, the second sideways; the first subject again moves toward his or her goal, the second moves again sideways). An analysis of these data revealed significant main effects for room condition, $F(1,172) = 10.56$, $p < .01$, and sex, $F(1,172) = 4.21$, $p < .05$. Crowded subjects evidenced a greater number of partial conflict trials than did their noncrowded counterparts. Moreover, girls had more partial conflict trials than did boys.

A distinct pattern of initial avoidance of direct conflict during the first four trials called staircasing (see above description) characterizes about one-sixth of the trials. Results indicated that this staircasing strategy of play was used more by noncrowded than by crowded children, $F(1,172) = 8.42$, $p < .005$. This pattern was also used less by older children than younger children, $F(2,172) = 3.90$, $p < .03$. Furthermore, males who had not been crowded chose to avoid initial direct conflict most often, $F(1,172) = 9.10$, $p < .005$.

In accordance with the findings of Kagan and Madsen (1971), complete competition (each subject always moving toward his or her goal) was almost never observed in the play of the youngest children. Interestingly, eighth-grade children used this competitive strategy most often. The analysis showed the highest levels of sustained competition for noncrowded females, while crowded males were significantly more competitive than crowded females, $F(1,172) = 9.62$, $p < .005$. Noncrowded males were more cooperative in game play to the extent that they chose to avoid initial direct conflict.

Discussion

Taken together, the results of the present study demonstrate that crowding which in-

TABLE 1

TYPES OF MOVES IN COOPERATION-COMPETITION GAME (%)

GRADE AND ROOM CONDITION	TYPES OF MOVES											
	Complete Cooperation		Complete Competition		Submission		Staircasing		Nonconflict		Partial Conflict	
	M	F	M	F	M	F	M	F	M	F	M	F
4:												
C....	0	0	8	0	0	0	8	16	0	0	83	84
NC..	0	0	0	0	0	0	38	25	0	0	63	75
8:												
C....	0	0	6	0	0	0	19	22	0	0	75	78
NC..	6	0	8	19	0	0	21	6	8	0	56	75
11:												
C....	4	2	6	2	0	0	4	4	4	4	81	88
NC..	0	9	0	6	0	0	27	9	6	0	67	75

volves close physical proximity has physiological, behavioral, and social consequences even for children as young as 9 years old. Children and adolescents reported feeling crowded, tense, annoyed and frustrated and experienced greater discomfort under these high spatial density conditions as a function of the excessive close proximity to others. Furthermore, with the single exception of the eighth-grade females, crowded children at each grade level evidenced more pronounced indications of stress-related arousal during crowding. This occurs despite the fact that they are smaller in stature and have smaller personal space preferences than adults (e.g., Aiello & Aiello 1974).

Studies of younger children in free-play situations have indicated that withdrawal is often used as a coping response by children in high-density situations (e.g., Loo 1972). Under the present experimental conditions, children were placed into close physical proximity with other group members. Their characteristic mechanism for dealing with this circumstance (e.g., avoiding contact with others) was unavailable, and they lacked the means for regulating any discomfort they may have been experiencing. Hence, crowded subjects generally exhibited patterns of elevating stress-related arousal levels regardless of their age. Across all grade levels, males in particular tended to be more affected by short-term crowding, displaying the highest increase in SCL. These physiological results should be interpreted with caution, however, because children may be more resistant to the cumulative effects of crowding experiences due to their possibly greater resilience. On the other hand, though, it may well be as Evans, Pezdek and Nalband (Note 9) have concluded that "young organisms are more severely affected by crowding than adult organisms" (p. 34). If the latter is the case, the importance of monitoring children's exposure to such conditions and examining the prolonged effects of crowding on children's development is clearly evident.

The present findings are quite complementary with those of the previous studies regarding the observation that children are more aggressive in higher-density environments. In the present experiment, the norms of the situation negated the opportunity for aggression during the session but, following exposure to crowding, children were more competitive, despite the fact that in terms of available prizes to win they had all to gain from cooperating and nothing to lose. In contrast to their crowded counterparts, children who did not experience crowding displayed a distinct pattern of avoidance of direct conflict. Of particular interest, however, is the observation that once again it appears that male children are most susceptible to the negative consequences of crowding. Crowded males had the highest levels of sustained (maladaptive) competitive behavior. In contrast, noncrowded male children chose to avoid direct conflict most often.

It appears, therefore, that the effects of crowding may be more potent than we had originally believed. Not only are there pronounced effects occurring during the crowding experience, but, as the findings of the present study indicate, at least some of these effects are carried over into activities following exposure to crowded conditions.

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