ORIGINAL ARTICLE

Eating in larger groups increases food consumption

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Objective: To determine whether children's food consumption is increased by the size of the group of children in which they are eating.
Design: Crossover study.
Setting: University based preschool.
Participants: 54 children, aged 2.5–6.5 years.
Interventions: Each child ate a standardised snack in a group of three children, and in a group of nine children.
Main outcome measures: Amount each individual child consumed, in grams.
Results: Amount eaten and snack duration were correlated (r = 0.71). The association between group size and amount eaten differed in the short (<11.4 min) versus the long (≥11.4 min) snacks (p = 0.02 for the interaction between group size and snack duration). During short snacks, there was no effect of group size on amount eaten (16.7 (SD 11) g eaten in small groups vs 15.1 (6.6) g eaten in large groups, p = 0.42). During long snacks, large group size increased the amount eaten (34.5 (16) vs 26.5 (13.8), p = 0.02). The group size effect was partially explained by a shorter latency to begin eating, a faster eating rate and reduced social interaction in larger groups.
Conclusions: Children consumed 30% more food when eating in a group of nine children than when eating in a group of three children during longer snacks. Social facilitation of food consumption operates in preschool-aged children. The group size effect merits consideration in creating eating behaviour interventions.

Adults and animals consume more food when eating in the presence of others than when eating alone.[1] This phenomenon, termed social facilitation, is defined as an increase in a behaviour merely from the sight or sound of others engaged in the same behaviour.[2–5] Eating behaviour is one of the clearest demonstrations of the social facilitation effect, and has been documented in animals[6–10] and adult humans [11–22]; adults eat 30–50% more in groups than when alone.[23] Prior human research has been limited by the fact that most studies measured amount consumed only by self-report,[11–19 21] and the group-eating situations were not always comparable to the non-group situations with regard to environment or meal content.[16 24] To our knowledge, social facilitation of eating behaviour has not been investigated in children, nor has it been examined through direct observation or measurement of consumption in a natural setting.

There are two primary hypotheses in the literature for the mechanism of the effect. The arousal hypothesis states that in larger groups activation or arousal is greater, which results in a faster eating rate and greater consumption.[12 25] The time extension hypothesis states that larger group size increases social interaction, which extends meal duration, increases the length of time that the individual is in the presence of food, and thereby increases the intake.[1 12 26] Under this hypothesis, children eating in large groups would be more likely to remain seated at the table socialising at the end of a meal, and thereby continue to eat. The arousal hypothesis has primarily been used to explain the phenomenon in animals, whereas the time extension hypothesis has been invoked to explain the effect in adult humans.

Understanding whether and how social facilitation operates in young children has potential clinical application and relevance. Childhood is theorised to be a critical period for the development of lifelong eating habits which presumably are associated with obesity risk. Along with the increase in overweight prevalence among children,[27] there has also been an increase in the number of young children potentially eating in group situations with peers, in that the proportion of preschool-aged children attending childcare outside the home has increased in the past 50 years from 11% in 1949 to 62% today.[28 29]

The primary aim of this study was to determine whether social facilitation by group size of amount consumed occurs in children as it occurs in animals and adults. We hypothesised that children would consume more when eating in a larger group than when eating in a smaller group. The secondary aim of this study was to identify mediators of the effect, if present. We hypothesised that in children the effect would be mediated by arousal and not by extension of meal duration because we predicted that preschool-aged children would be unlikely to remain seated at a table socialising at the end of a meal.

METHODS

Participants

Fifty-four 2.5–6.5-year-old children attending a university-based preschool participated in this study. Parents were told that the study would evaluate the amount of food children consumed while eating in smaller or larger groups of children, and agreement to participate was nearly universal. The study was approved by the University of Michigan Medical School Institutional Review Board and written informed consent was obtained.

We aimed to study each child's eating behaviour in two conditions: eating in a small group (three children) and eating in a large group (nine children). These group sizes were chosen a priori based on the literature,[23] as well as on the practical consideration that nine was the maximum number of children who could reasonably be seated at the table simultaneously. Children within each classroom, which were grouped by age, were randomised into groups of three (small group condition). These groups of three were randomly combined to form groups of nine (large group condition). The identities of the other

children with whom a child ate were therefore held constant. The order of participation in the small group condition versus the large group condition was randomised. Of the 54 children, 17 participated in only one condition, owing to absences from school or scheduling conflicts in the classroom. When this occurred, another child in the classroom who consented was included to form a complete group. Sixteen children were included in additional sessions for this purpose, and therefore had data for more than the two conditions originally assigned. All of these data (108 observations) were included in the analyses. For children participating in both conditions, the mean (SD) interval between conditions was 25.3 (21.3) days. Children who participated in only one condition did not differ by age, race or sex from those who participated in both conditions.

Snack procedure

A snack session, as opposed to a complete meal, was chosen as the observation period because using only a single food provided greater experimental control. Each child had fasted at least 1.5 h before the snack session. The snack, served during the regular snack time and supervised by the regular classroom teachers and a familiar research assistant, was served in a quiet room familiar to the children, but separate from the regular classroom and without distractions. The snack consisted of plain graham crackers (Keebler), with which all the children were familiar as it was served regularly as a snack in the preschool. Each child was given one whole graham cracker sheet broken in half into two squares (6.4×6.4 cm; 32.5 calories and 0.9 g of fat per square). Each portion was measured three times on a scale (Salter) with an accuracy of ± 0.1 g, and the average of these three weights was taken. The mean (SD) weight per portion was 14 (0.1) g. The preschool required that children be provided a beverage of the teacher's choice at each snack session. Each child drank the same beverage in both conditions. In all, 32 children drank milk, 12 juice and 2 water.

Each snack session was videotaped. Two cameras were placed unobtrusively in corners of the room, and children were generally oblivious to their presence. Children were seated at a child-sized table prearranged with the initial 14 g serving of graham crackers on a small plate before them. An additional 51.1 (2.3) g of graham crackers per child was placed at the centre of the table on a single plate in groups of three children, and divided between two plates, one at each end of the table, in groups of nine children. The children served themselves additional portions, which they were accustomed to doing at the preschool. There was no time or portion limit imposed, and the children never consumed all the graham crackers available at the table. One teacher sat at the table with the groups of three children and two teachers sat with the groups of nine. The teachers did not eat with the children.

Children were accustomed at the preschool to leaving the table when finished and returning to activities in the classroom. When a child finished his or her serving and neither left the table nor reached for another serving, the teachers were instructed to offer a prompt, as they would normally. The teachers remained at the table until the last child had returned to the classroom. Intake of each child was determined by counting from the videotape the number of graham cracker squares each child had eaten and weighing the remaining crackers (or portions of crackers) on the child's plate. We encountered no discrepancies using this method to determine the intake.

Covariates tested

Tapes were coded by two trained coders blind to study hypotheses, and inter-rater reliability exceeded an intraclass correlation coefficient of 0.7 for all measures. Snack duration was defined as the length of time the child remained seated at the table before leaving the room. Eating rate in grams per minute was calculated based on the length of time from the child's first to last bite. Latency to eating initiation was defined as the length of time between the child sitting at the table and taking the first bite. The number of adult prompts to eat delivered to an individual child per minute was defined as per methods used in previous research.[30] Social interaction was rated on a 4-point scale derived from the Mother-Child Structured Interaction Qualitative Scales in the National Institute of Child Health and Human Development Study of Early Child Care, with lower scores indicating lower levels of social interaction.[31] There are no definitive physiological or behavioural indices of arousal, and as children cannot reliably self-rate arousal level, these coded behaviours were used instead to infer arousal level.

Statistical analysis

We first performed univariate and bivariate statistics to evaluate differences in snack characteristics by group size, as well as the relationship between snack characteristics and amount eaten. We evaluated whether there was a non-linear relationship between each of the covariates (snack duration, latency to eating initiation, eating rate, adult prompts to eat per minute and social interaction rating) and amount eaten by testing the quadratic terms. Only eating rate had a non-linear relationship with amount eaten ($p = 0.005$ for the quadratic term) and was therefore indexed in quartiles in the analyses (quartile 1 $\leqslant$1.55 g/min, quartile 2 1.55–2.155 g/min, quartile 3 2.155–2.90 g/min and quartile 4 $\geqslant$2.90 g/min). To account for repeated measures within participants and allow for missing data, we used mixed models with random intercept to evaluate unadjusted and adjusted differences in amount eaten by group-size condition. We tested covariates snack duration, latency to eating initiation, eating rate quartile, adult prompting rate and social interaction individually in the model as potential confounders of the relationship between group size and consumption. An α level of 0.05 (two-tailed) was used to determine statistical significance.

RESULTS

The sample included 54 children; 68% boys, 74% white, 4.2 (1.1), mean (SD) years old (range 2.6–6.2). Table 1 shows the bivariate analyses comparing snack characteristics in small and large groups. Table 2 shows the bivariate analyses evaluating relationships between the snack characteristics and amount eaten.

Given the very high correlation between snack duration and amount eaten, which is consistent with prior studies,[1 26 32 33] we tested the relationship between group size and amount eaten, controlling for snack duration. Both group size and snack duration were significant and independent predictors of amount eaten in this model ($F(1, 52) = 5.04$, $p = 0.03$ for group size and $F(1, 52) = 100.33$, $p<0.001$ for snack duration). Controlling for snack duration, children ate slightly more when eating in larger groups than when eating in smaller groups (24.8 (15.9) vs 21.2 (13.4) g, $p = 0.03$). The effect of group size, however, differed significantly by snack duration, as evidenced by a significant interaction term between group size and snack duration in this model ($p = 0.02$). We therefore dichotomised snack duration at the median (11.4 min) and evaluated the relationship between group size and amount eaten in short and long snacks. There was no effect of group size on amount eaten in the short snacks (16.7 (11) in small groups versus 15.1 (6.6) in large groups ($F(1, 15) = 0.68$, $p = 0.42$)). In contrast, in long snacks, the amount eaten by children increased by nearly 30%

Table 1 Unadjusted means for snack characteristics by group size, accounting for repeated measures within subjects

	Groups of 3, n = 54*	Groups of 9, n = 54*	Cohen's effect size	p Value
	Mean (95% CI)	Mean (95% CI)		
Snack duration (min)	13.0 (11.0 to 15.0)	12.4 (10.4 to 15.4)	0.08	0.69
Amount eaten (g)	21.2 (17.3 to 25.1)	24.8 (20.9 to 28.7)	0.24	0.21
Eating rate (g/min)	2.4 (1.8 to 3.0)	2.9 (2.3 to 3.5)	0.23	0.34
Latency to eating initiation (min)	3.0 (2.2 to 3.8)	1.9 (1.3 to 2.5)	0.43	0.03
Adult prompts to eat per minute	0.35 (0.15 to 0.55)	0.90 (0.70 to 1.1)	0.74	0.0002
Social interaction rating	3.1 (2.9 to 3.3)	2.0 (1.8 to 2.2)	1.5	<0.001

*Number of observations.

when eating in large groups compared with small groups (34.5 (16) vs 26.5 (13.8); $F(1, 14) = 6.83$; $p = 0.02$). We tested the role of order of participation in each of the two conditions and the time period between participation in each condition as potential confounders of the relationship between group size and amount eaten, and found neither to be significant.

Of the potential confounders tested (latency to eating initiation, eating rate quartile, adult prompting rate and social interaction), latency to eating initiation, eating rate quartile and the child's social interaction during the snack all slightly reduced the group size effect as reflected by a reduction in the parameter estimate for group size ranging from 18.9% to 42.2%, and a p value for the group size effect that became just marginally non-significant ($p = 0.06$, 0.10 and 0.07, respectively). Adult prompting rate had no impact on the relationship between group size and amount eaten. Greater social interaction was associated with less eaten ($\beta = -4.74$ (SE 2.35), $p = 0.049$) in the longer snacks.

DISCUSSION

This study found that for a given snack duration, children consumed more in larger groups than in smaller groups, and the effect strengthened as the snack time lengthened. Snack initiation occurred more rapidly in larger groups, and eating rate was slightly greater in larger groups than in smaller groups. Therefore, we propose that the cumulative effective of beginning to eat sooner and having a marginally greater eating rate over time led to growing differences in the total amount consumed over time. To our knowledge, this study is the first to demonstrate social facilitation of quantity eaten in children.

The study also provides information about the mechanism of the group size effect in children. Our results do not support the time extension hypothesis. Larger group size was actually associated with less social interaction, and there was no difference in snack duration between the smaller and the larger groups. The pattern of our results is better explained by the arousal hypothesis. In the larger group, children initiated eating more rapidly, socialised less, and ate at a slightly faster rate than when they ate in the smaller groups.

Table 2 Unadjusted relationship between snack characteristics and amount eaten, accounting for repeated measures within subjects (n = 108 observations)

	Slope (β; SE)	r	p Value
Snack duration (min)	1.5 (0.14)	0.71	<0.001
Latency to eating initiation (min)	−1.5 (0.5)	0.26	0.04
Adult prompts to eat per minute	−0.7 (1.8)	0.04	0.63
Social interaction rating	−2.1 (1.5)	0.14	0.31
Eating rate (g/min) quartile*		0.41	0.01
Quartile 2 vs 1	5.1 (3.7)		0.17
Quartile 3 vs 1	16.3 (3.7)		<0.001
Quartile 4 vs 1	9.6 (3.7)		0.01

*Quartile 1 has the slowest eating rate.

There are several limitations to this study. Our sample size was small, and our power may therefore have been limited to detect more subtle effects. We did not have data on the prior meal children consumed at home or when it was consumed, which could have acted as a confounder. However, children's ability to tightly regulate intake in response to caloric preload is limited,[34 35] and prior research has shown that social facilitation easily disrupts post-prandial regulation of intake.[21] Finally, we did not collect data regarding the volume of beverages that children consumed. Nonetheless, each child was given the same beverage in both group size conditions in which he or she participated. The fact that beverage type was held constant across group size conditions in the individual child would indicate that beverage type could not act as a confounder of the group size effect.

In summary, our study has demonstrated that when children eat in groups of nine, they eat about 30% more than when in groups of three for the same length of time. The effect seems to be mediated by increased arousal. Preschool-aged children can be included as also responding to the social facilitation effect of group size on quantity of consumption, although the mechanism of effect seems to be different from in adults, and is open to empirical verification with physiological measures. It is not clear from our study whether large group size increased

What is already known on this topic

- Familiar behaviours increase when they occur in the presence of others performing the same behaviour. Adults and animals eat more when eating in the presence of a group of others also eating, although prior work has been limited by a lack of control of several important variables.
- It is unknown whether social facilitation operates on quantity of consumption in young children.

What this study adds

- Preschool-aged children eat about 30% more when eating in a group of nine versus in a group of three.
- The results provide evidence of higher methodological quality for the effect of group size on consumption in humans, and raise questions about the potential relationship between group eating behaviour and childhood obesity.

consumption to ''supra-physiological'' levels, or if small group size decreased consumption compared with ''typical'' intake. However, given that the social facilitation effect can overwhelm satiety mechanisms,[21] its potential role in contributing to overconsumption, and thereby increasing overweight risk in children, deserves consideration in future research.

From a clinical perspective, the results provide additional theory-driven support for frequent recommendations given to families regarding children's eating behaviour. The child who eats inadequate quantities may consume more when eating in a group (eg, with the family at the table for a planned mealtime) than when eating alone, as often occurs when children graze over the course of the day. For the child who overeats, overconsumption may be driven by having meals in over-stimulating busy or chaotic environments, as is often the case when eating out, particularly at fast food restaurants. Thus, the results also support recommendations to have mealtimes at home with the family, but for the purpose of providing a calm and peaceful eating environment.

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REFERENCES

1 **Herman CP**, Roth DA, Polivy J. Effects of the presence of others on food intake: a normative interpretation. *Psychol Bull* 2003;**129**:873–86.
2 **Allport FH**. *Social psychology*. New York: Houghton Mifflon, 1924.
3 **Triplett N**. The dyanmogenic factors in pacemaking and competition. *Am J Psychol* 1898;**9**:507–33, .
4 **Towler G**. From zero to one hundred: coaction in a natural setting. *Percept Motor Skills* 1986;**62**:377–8.
5 **delaCruz BA**. Laughter in children as a function of social facilitation. *Philippine J Psychol* 1981;**14**:55–63.
6 **Tolman C**, Wilson G. Social feeding in domestic chicks. *Anim Behav* 1965;**13**:134–42.
7 **Harlow HF**, Yuddin HC. Social behavior of primates I. Social facilitation of feeding in the monkey and its relation to attitudes of ascendance and submission. *J Comp Psychol* 1933;**16**:171–85.
8 **James WT**. The development of social facilitation of eating in puppies. *J Genet Pyschol* 1960;**96**:123–7.
9 **Harlow HF**. Social facilitation of feeding in the albino rat. *J Genet Pyschol* 1932;**43**:211–21.
10 **Hoyenga KT**, Aeschleman S. Social facilitation of eating in rats. *Psychonom Sci* 1969;**14**:239–41.
11 **Bellisle F**, Dalix AM, deCastro JM. Eating patterns in French subjects studied by the ''weekly food diary'' method. *Appetite* 1999;**6**:41–5.
12 **deCastro JM**. Social facilitation of duration and size but not rate of the spontaneous meal intake of humans. *Physiol Behav* 1990;**47**:1129–35.
13 **deCastro JM**. Social facilitation of the spontaneous meal size of humans occrs on both weekdays and weekends. *Physiol Behav* 1991;**49**:1289–91.
14 **deCastro JM**, Brewer E. Family and friends produce greater social facilitation of food intake than other companions. *Physiol Behav* 1994;**56**:445–55.
15 **deCastro JM**, *et al*. Culture and meal patterns: A comparison of food intake of free-living Americans, Dutch, and French students. *Nutr Res* 1997;**17**:807–29.
16 **deCastro JM**, *et al*. Social facilitation of the spontaneous meal size of humans occurs regardless of time, place, alcohol or snacks. *Appetite* 1990;**15**:89–101.
17 **deCastro JM**, Orozco S. Moderate alcohol intake and spontaneous eating patterns of humans: evidence of unregulated supplementation. *Am J Clin Nutr* 1990;**52**:246–53.
18 **Redd M**, deCastro JM. Social facilitation of eating: effects of social instruction on food intake. *Physiol Behav* 1992;**52**:749–54.
19 **Patel KA**, Schlundt DG. Impact of moods and social context on eating behavior. *Appetite* 2001;**36**:111–18.
20 **Berry SL**, Beatty WW, Klesges RC. Sensory and social influence of ice cream consumption by males and females in a laboratory setting. *Appetite* 1985;**6**:41–5.
21 **deCastro JM**. Spontaneous meal patterns in humans: influence of the presence of other people. *Am J Clin Nutr* 1989;**50**:237–47.
22 **Clendenen VI**, Herman CP, Polivy J. Social facilitation of eating among friends and strangers. *Appetite* 1994;**23**:1–13.
23 **deCastro JM**, Brewer E. The amount eaten in meals by humans is a power function of the number of people present. *Physiol Behav* 1992;**51**:121–5.
24 **Klesges RC**, Bartsh D, Norwood JD, *et al*. The effects of selected variables on the eating behavior of adults in the natural environments. *Int J Eat Disord* 1984;**3**:35–41.
25 **Zajonc R**. Social facilitation. *Science* 1965;**149**:269–74.
26 **Feunekes G**, deGraaf C, vanStaveren W. Social facilitation of food intake is mediated by meal duration. *Physiol Behav* 1995;**58**:551–8.
27 **Hedley AA**, Ogden CL, Johnson CJ, *et al*. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA* 2004;**291**:2847–50.
28 **Peth-Pierce R**. *The NICHD Study of early child care*. Bethesda, MD: NICHD, 1998.
29 **Helburn S**, Bergmann B. *America's child care problem: the way out*. New York, NY: Palgrave MacMillan, 2002.
30 **Klesges RC**. Parental influences on children's eating behavior and relative weight. *J Appl Behav Anal* 1983;**16**:371–8.
31 **Anonymous**. NICHD study of early child care phase I instrument document Bethesda: National Institute of Child Health and Human Development 1991:101–3. http://secc.rti.org/instdoc.doc (accessed 26th January 2007).
32 **Bell R**, Pliner PL. Time to eat: the relationship between the number of people eating and meal duration in three lunch settings. *Appetite* 2003;**41**:215–18.
33 **Pliner P**, Bell R, Kinchla M, *et al*. *Time to eat? The impact of time facilitation and social facilitation on food intake*. Boston, MA: Pangborn Sensory Science Symposium, 2003.
34 **Birch LL**, McPhee LS, Bryant JL, *et al*. Children's lunch intake: effects of midmorning snacks varying in energy density and fat content. *Appetite* 1993;**20**:83–94.
35 **Birch LL**, Johnson SL, Andresen G, *et al*. The variability in young children's energy intake. *N Engl J Med* 1991;**324**:232–5.