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Sensing eating mimicry among family members

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ABSTRACT
Family relationships influence eating behavior and health outcomes (e.g., obesity). Because eating is often habitual (i.e., automatically driven by external cues), unconscious behavioral mimicry may be a key interpersonal influence mechanism for eating within families. This pilot study extends existing literature on eating mimicry by examining whether multiple family members mimicked each other's bites during natural meals. Thirty-three participants from 10 families were videotaped while eating an unstructured family meal in a kitchen lab setting. Videotapes were coded for participants' bite occurrences and times. We tested whether the likelihood of a participant taking a bite increased when s/he was externally cued by a family eating partner who had recently taken a bite (i.e., bite mimicry). A paired-sample *t*-test indicated that participants had a significantly faster eating rate within the 5 s following a bite by their eating partner, compared to their bite rate at other times ($t = 7.32$, $p < .0001$). Nonparametric permutation testing identified five of 78 dyads in which there was significant evidence of eating mimicry; and 19 of 78 dyads that had p values < .1. This pilot study provides preliminary evidence that suggests eating mimicry may occur among a subset of family members, and that there may be types of family ties more prone to this type of interpersonal influence during meals.

Keywords

Eating, Mimicry, Family, Social influence, Permutation tests, Obesity

IMPLICATIONS

Practice: Social cues impact individual food intake, which highlights the importance of examining these effects of social influence, such as mimicry, on family eating behavior.

Policy: The influence of social cues on eating may be more dependent on context and individual differences than existing literature suggests, with implications for family- and group-based eating interventions.

Research: Although employing traditional analytic methods to identify eating mimicry replicates previous findings, more rigorous permutation methods suggest eating mimicry only occurs among some family pairs.

INTRODUCTION

Obesity is a global epidemic that has increased over the last three decades [1]. According to recent estimates, 18.5% of youth and 39.6% of U.S. adults are obese [2]. Children who are overweight and obese are at an increased risk of remaining overweight into adulthood [3] and developing many negative health consequences, including diabetes, stroke, heart disease, and hypertension [4]. The association between childhood obesity and major health risks in childhood and adulthood highlights the urgent need to improve our understanding of the behavioral factors and social processes that explain children's dietary intake patterns, and ultimately, obesity risk.

Families provide critical contexts for understanding child and adult eating patterns because obesity, along with many other complex chronic diseases, clusters in families due to family members' shared genetic, behavioral, and environmental risks [5]. Family members' engagement in similar eating behaviors is likely to partially explain similarities in their risk for overweight and other chronic disease. The majority of families eat together at least once per week [6–8], although the frequency of family meals varies by demographic characteristics [9]. There is evidence that family members tend to be similar in their food choice [10] and eating behaviors [11] and that similarities extend across multiple generations [12,13]. Shared eating behaviors, which likely result from and are a source of interpersonal social influence within family systems, should be examined to further improve our understanding of individual variability in weight or weight gain trajectory.

Many prominent theories of health behaviors and behavior change include social influence constructs, such as social cognitive theory and the theory of planned behavior [14,15]. The traditional conceptualization of social influence in these theories has emphasized the role that perceived social norms and social learning play in shaping value-expectancies, motivations, and *rational* decision making to engage in health behaviors. However, there is increasing evidence that a key mechanism of interpersonal influence on eating behavior is unconscious **behavioral mimicry**: when a person unconsciously, automatically, and immediately mimics the behavior of another. Eating behavior may be particularly prone to behavioral mimicry because it is an often automated, habitual behavior [16]. Eating occurs frequently throughout the day, and often in the same physical (e.g., at home or an office) and social environments (e.g., with the same family members, friends, or alone) [17,18]. Additionally, a great deal of eating behavior can often be characterized as "mindless": driven more by the unconscious influence of external cues rather than conscious, deliberate, and rational decisions [19]. Because people often eat with others, *social cues* are likely to have a strong impact on food intake through several mechanisms, including mindless imitation of others' eating behaviors and food matching; and to influence more conscious and rational decision making via modeling, and situational and cultural food norms [20–22].

There is evidence of **eating mimicry** in strangers [20] and parent–daughter pairs [23], in which participants were found to unconsciously mimic the eating rate [20] and type of food consumed [23] by their eating partner. Eating mimicry can subsequently impact risk for overweight or obesity by promoting unhealthy (or healthy) food consumption and/or faster eating rates that have been linked to increased energy intake [24] and excess weight [25]. However, research has not yet explored eating mimicry in entire families. Because eating behaviors are likely to be especially susceptible to automaticity in the family home context, given the frequency and repetition of family eating events, this paper focuses on the examination of eating mimicry (i.e., automated eating response to social cues) in families.

Behavioral mimicry often occurs among people who have an existing rapport (e.g., friends, family, close social ties, etc.) [26]; among those who have greater similarity (homophily) in opinions [27] and knowledge [28]; and can occur at extremely young ages [29,30]. Moreover, the literature suggests that a desire to affiliate with one another leads to more behavioral mimicry [31]. Given these moderators of behavioral mimicry in the literature, we further propose to investigate differences in eating mimicry among different family member roles (parent, child) and other individual-level demographic characteristics (gender, age) using novel analytic methods.

Identifying eating mimicry as a mechanism of interpersonal influence on *family* eating behavior could provide researchers with a deeper understanding of family eating systems and improve their strategies for targeting processes within these systems in order to promote healthy eating, and ultimately prevent and/or treat obesity.

Advantages of real-time, contextualized data

Our current understanding of human behavior is based on static "snapshots" of behavior and linear relationships between behavior change and its predictors, rather than on the dynamic nature of people's behavior in the context of the broader systems in which these behaviors are enacted [32]. There are emergent effects and processes in these social–ecological systems that are not observed nor understood by examining components of this system in isolation of each other, or in isolation of their chronology [33]. Emerging technologies, such as wearable and in-situ sensors, present the opportunity to examine microlevel phenomena of family eating behavior, such as eating mimicry, and contextual factors in real time. The current pilot data were gathered in the lab, using video recording of family eating events to capture temporally-dense real-time data of family eating phenomena. This pilot data will be used to inform the development of the *Monitoring and Modeling Family Eating Dynamics* (M2FED) system in the future, which utilizes wrist-worn and in-situ sensors for the examination of eating behavior in naturalistic (i.e., common and typical) settings over long periods of time [34].

Study objectives

This study explores eating mimicry among family members by measuring their bites of food during naturalistic meals. Specifically, the primary study objectives are to:

(1) Test for evidence of bite mimicry among family members during a shared meal. Based on findings from previous studies [20,23], we anticipate that family members will be more likely to take a bite within 5 s of another family member doing so;

(2a) Explore if there is significant evidence of bite mimicry within specific family dyads using permutating testing, in which we test if the timing of bites for a given family member is dependent on the bites of other family members they eat with;

(2b) Identify the extent to which the following individual- and dyad-level characteristics predict dyads exhibiting significant bite mimicry (in Aim 2a): age group, gender, and family member role (parent, child).

METHODS

Participants

Families were eligible for this study if they contained at least (i) three members total, (ii) one parent, and (iii) one child over the age of 11 living in Los Angeles, California. There were no demographic or disease/weight status exclusion criteria, but families that had one or more members who did not primarily speak English at home were excluded from participating. Families were recruited at public events and spaces within Los Angeles County from May 2017 to May 2018. Snowball sampling was also employed, such that participating families were asked to identify and refer other eligible families in their network. All families that expressed interest and met eligibility requirements were invited to participate in the study. An intake screening tool was administered over the phone by recruitment coordination staff to confirm eligibility; recruited families reported on demographics for each family member before receiving an invitation to the lab. Ten families (33 individuals) participated in this pilot study. This study was approved by the Institutional Review Board of the University of Southern California. All parents provided informed written consent, and all children provided assent.

Lab procedures

The current data come from the initial pilot phase of a larger study titled *Monitoring and Modeling Family Eating Dynamics* (M2FED) [34]. Ten families (33 individuals) were brought into an observation kitchen lab for an unstructured family meal (either breakfast, lunch, or dinner, depending on the time of day). Participants were told that the purpose of the study was to test out the accuracy of the M2FED equipment (smart watches) to automatically detect eating. The kitchen lab was furnished with a large, round dining table, five chairs, a refrigerator, a television, and cupboards supplied with cutlery and dinnerware.

Before coming into the lab, families gave the research staff their preference for local fast food restaurants (e.g., Denny's, McDonalds, Panda Express), and their meal was ordered from the restaurant they indicated. Before the meal, anthropometric measurements were taken for each family member using a Tanita scale and stadiometer. Then, the family was asked to eat an unstructured meal together at the table. They were videotaped while eating the meal. Families were asked to come in hungry and were given access to multiple types of food and drinks, including the main meal that was specifically ordered for them, and a range of additional snacks such as fruit, chips, and crackers. The hot food meal items were laid on a counter, and the participants were instructed to serve themselves and to eat at the table. They were free to eat however much they wanted and to act as they normally would during a meal (i.e., some watched TV, or were on their phones). Each participant received a $15 Visa gift card for their participation in the study.

The family meal sessions were video-recorded using the Noldus Media Recorder software. Although the main purpose of this pilot study was to refine the smart watch algorithms to detect eating, for the current analysis, we present results using the eating data captured by the video recordings.

Measures

Demographics

During a phone interview prior to the lab visit, one parent from each family reported on the current age, gender, and family member role (i.e., parent, child, etc.) of all participating family members. Each participant verified this information in the lab session.

Child age category

The American Academy of Pediatrics divides the stages of adolescent development into three age groups: early adolescence (ages 11–14), middle adolescence (ages 15–17), and late adolescence (ages 18–21). The median child age of our sample was 15 years old (range 11–25 years old), which was used as the demarcation for two categories: young child (11–14 years old) and older child (15+ years old). Therefore, our "young child" category is defined as those in early adolescence, and our "older child" category is defined as those in middle/late adolescence or young adulthood.

Anthropometrics

Height and weight were measured in all participants in a private lab room. A portable stadiometer was used to measure height, and a research-grade Tanita scale (model TBF 300) was used to measure weight. Parent (adult) body mass index (BMI) was calculated from their measured height and weight (kg/m^2). Age- and sex-specific BMI percentiles were calculated for the children under the age of 20 using the Centers for Disease Control and Prevention online BMI tool [35].

Eating (bites of food)

Video recordings of the lab-based family meals (three video angles per family; time-synched) were coded to identify and timestamp the bites of each participant using Chronoviz (version 2.0.2) software [36]. Coders annotated the exact times each participant placed food or beverage in their mouth. Each bite annotation represents the start of a bite (once food/beverage entered the mouth) but does not account for the length of the bite (e.g., if the individual leaves a utensil in their mouth for an extended period of time or takes long sip of a beverage). Nonconventional eating methods, such as pouring food into the mouth (usually from a chip bag) or licking food off the plate, were considered "bites." However, we did not categorize licking one's fingers as a bite. The majority (60%) of the videos were independently coded by two research assistants, and the remaining 40% were coded by a single research assistant. To assess observer agreement, a *time-unit kappa with tolerance* [37] was calculated for each subject (i.e., comparing Subject i bites from Coder 1 to Subject i bites from Coder 2), with a tolerance level of 1 s. The mean kappa value was $\kappa_{tolerance} = 0.90$ (range: 0.74, 1.00). In general, a kappa statistic above 0.80 indicates a strong level of agreement [38].

Analytic approach

Dyad-level analysis

To test for eating mimicry, whereby a Participant i is more likely to take a bite in response to an eating cue (bite) from their eating Partner j, each family's timestamped bite dataset (i.e., all bites taken during the eating session) was divided into all of the possible dyad combinations as the unit of analysis. For example, if a family contained three members (*i*, *j*, *k*), three dyad datasets were generated (containing *i* and *j*'s bites, *i* and *k*'s, *j* and *k*'s). The 10 families were initially partitioned into 39 dyads (undirected). We examined the possible mimicry effect in both directions, so the total number of dyads included in the analyses was 78 (directed).

Bite data manipulation

Participants were permitted to leave the dining table during the eating session; therefore, the "eating window" for each individual was not necessarily continuous. At the individual level, we defined the participant "eating window" interval(s) as the time period(s) in which they were (i) sitting at the table and (ii) had food in front of them that was either on their own plate or on communal/shared plates on the table. At the dyad level, we defined the "eating window" intervals as the intersection of the pair's individual eating windows (e.g., if Person *i* had an eating window from 10:05AM to 10:36AM and Person *j* had an eating window from 09:59AM to 10:24AM, then the dyad's overlapping eating window was 10:05AM–10:24AM). This intersected time frame is regarded as the time in which there is potential for eating mimicry to occur (eating mimicry cannot occur if one or both dyad members are not at the table or if there is no food available to one or both dyad members).

Lastly, as there may be multiple "eating window" intervals for the dyad (e.g., one or both members left the table one or multiple times), the bite timestamps were appropriately shifted over to create one continuous dataset per dyad. An artificial 1-s interval was placed between each interval, however, to prevent the potential creation of a false positive mimicked bite. A sensitivity analysis was performed, where 1- to 10-s intervals were inserted. Analyses using these 10 different datasets produced the same results; therefore, the 1-s interval insertion was used to generate the final dyad datasets.

Statistical analyses

Previous mimicry studies have examined whether participants are significantly more likely to place food in their mouths within a short period of time (i.e., typically 5 s) after their eating partners have done so (defined as "sensitive periods"), compared to all other periods of a shared eating event (defined as "nonsensitive periods") [20,23,39]. Similarly, for each "eating window" shared by a family dyad, we computed an "eating rate" for each individual within the dyad (i.e., the number of times a food item was placed in their mouth per minute), and compared the eating rate observed during sensitive periods (defined as all 5-s time windows following a bite from their eating partner) versus nonsensitive periods using a paired sample *t*-test.

Additionally, we used nonparametric permutation tests to determine if an individual *i* takes a bite *more quickly* after having been exposed to a bite cue by their eating partner *j,* compared to their bite rate observed during the entire shared eating widow. A key advantage of using this type of testing is that no assumptions were made about the underlying distribution of bites taken while eating with a companion. Rather, this approach frees us from imposing arbitrary time gaps to define mimicry (e.g., occurs within 5 s of the eating partner's bite), and allows us to test for mimicry relative to the person's natural bite rate that was observed. Furthermore, it allows us to test for the presence of mimicry at the dyadic level, and during a single meal, which is not possible with the *t*-test method. For each directed dyad, we tested the following:

H_0: The sequence of bites for Person *i* and *j* are independent (i.e., no mimicry)

H_1: The sequence of bites for Person *i* and *j* are not independent (i.e., mimicry)

To test this, we first calculated the observed average time gap between Person *i* and *j*'s bites. This value was compared to a null distribution of the same statistic, generated by randomly permuting (shuffling) the bite intervals (intervals between each bite taken) 500,000 times for each individual. This controlled for the individuals' bite rates. For each dyad, a *p*-value was calculated by comparing the observed average time gap with the distribution of the statistics calculated using the permuted data (simulated eating events). We evaluated the extent to which the observed average time gap was shorter than expected as if by chance, which allowed us to investigate the presence or absence of mimicry at the *dyad level* (Fig. 1).

For the moderation analysis, to test whether evidence of eating mimicry differed for any of the dyad relationship types (child mimicking (→) child, child → parent, parent → parent, or parent → child); gender relationship types (male → male, male → female, female → female, female → male); and age relationship types (young child → young child, young child → old child, old child → old child, old child → young child), we fit three logistic regression models at the dyad level to determine significant predictors, if any, of a dyad's likelihood to exhibit eating mimicry. The dependent variable in all three models, evidence of eating mimicry, was operationalized as a p-value < .05 = 1 and a p-value > .05 = 0 (this was also tested at a significance level of .10) from the permutation test. The independent variable for each model (dyad, gender, and age relationship type, respectively), was dummy-coded into the four binary variables described above. A young child was defined as being 11–14 years of age, whereas an old child was defined as being 15+ years of age.

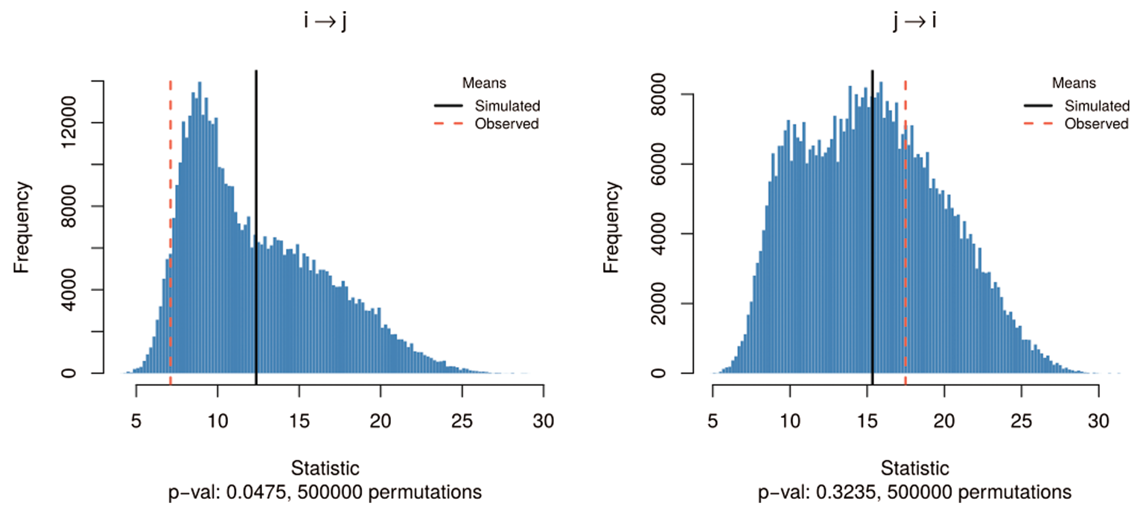

Fig 1 | An example of the null distributions for two directed dyads. (a) The null distribution presented indicates that the average time gap between Person *i* and *j*'s bites, calculated from the simulated data, is approximately 12 s. The average time gap calculated from the observed (real) data is approximately 7 s. The observed average time gap was shorter than expected as if by chance ($p = .0475$), which provides evidence for the presence of eating mimicry within this directed dyad (i → j). (b) Conversely, this dyad's observed average time gap was not shorter than expected as if by chance ($p = .3235$).

Table 1 | Individual-level characteristics of study participants ($n = 33$), by family member type

Characteristics	Children ($n = 19$)	Parents ($n = 14$)
	M (*SD*)/*n* (%)	
Age (years)	15.4 (3.7)	42.6 (7.6)
Gender, Female (%)	10 (52.6)	9 (64.3)
Race/Ethnicity (%)		
White	2 (10.5)	2 (14.3)
Asian	1 (5.3)	2 (14.3)
Black or African-American	9 (47.4)	6 (42.9)
Hispanic	7 (36.8)	4 (28.6)
BMI (kg/m^2)		31.3 (5.6)
BMI ≥ 85th percentile (%)*	10 (62.5)	
BMI ≥ 95th percentile (%)*	7 (43.8)	
Eating rate (bites/minute)	3.5 (0.9)	2.5 (0.9)
Total bites taken	67.1 (39.5)	64.1 (21.9)

*$n = 16$ due to one missing observation and two children with age ≥ 20 years.

There were no missing data for any of the measured and calculated variables.

RESULTS

Sample characteristics

The analytic sample included 10 families, seven of which contained three family members, and three of which contained four family members. A total of 19 children (M_{age} = 15.4, SD_{age} = 3.7 years) and 14 parents (M_{age} = 42.6, SD_{age} = 7.6 years) participated in the study (Table 1). Eight children were classified as a "young child" and 11 children were classified as an "older child." A little more than half of the participants were female (52.6% of children; 64.3% of parents). 45.5% of the participants identified as Black or African-American, 33.3% as Hispanic, 12.1% as White, and 9.1% as Asian. Parents' mean BMI value was 31.3 kg/m^2 (SD_{BMI} = 5.6); the majority of children's BMI values were greater than the 85th BMI-for-age percentile (62.5%), and 43.8% were greater than the 95th BMI-for-age percentile.

For analyses, the 10 families were initially partitioned into 39 dyads (pairs): 11 child–child dyads, five parent–parent dyads, and 23 child–parent dyads. We examined the possible mimicry effect in both directions, so the total number of dyads analyzed was 78.

Meal descriptives

The average length of a family's meal was 32.6 min (*SD* = 17.4), and the average number of bites taken per family meal was 215.6 bites (*SD* = 87.4). The total number of bites across all families in our sample was 2156 bites. The average eating rate across all individuals was 3.0 bites per minute (SD = 1.0), which is not unlike the rates reported in other papers examining eating mimicry. On average, children and parents did not differ in total bites taken (66.7 vs. 63.4 bites, respectively; $p > .05$), but children did have faster eating rates than parents (3.5 vs. 2.4 bites per minute, respectively; $p = .003$). Males and females had neither different total bites taken (68.2 vs. 63.2 bites) nor different eating rates (2.9 vs. 3.1 bites per minute, respectively; both $p > .05$).

On the dyad level, total bites taken by Person i and by Person j were correlated ($R = .39$, $p = .01$), and eating rates were marginally correlated ($R = .29$, $p = .06$).

Comparing sensitive periods vs. nonsensitive periods

Participants' average eating rate was 3.3 bites per minute (BPM) during sensitive periods (SD = 1.3) and 2.4 BPM during nonsensitive periods (SD = 0.92). Using a paired-sample t-test, we found that participants were significantly more likely to place food in their mouths (i.e., have a faster eating rate) within 5 s of their eating partners doing so, compared to eating windows in which their partners had not done so (M_{diff} = 0.9 BPM; $p < .0001$).

Comparing bite intervals using permutation tests

In our sample of directed dyads (N = 78), the average observed time between Person i's bites and Person j's bites was 9.0 s (SD = 3.9; range: 4.3, 28.1). In 5 of the 78 dyads, the average observed length of time that elapsed between Person i taking a bite, following a bite from Person j, was significantly shorter ($p < .05$) than the mean of the simulated null distributions of bite intervals, providing evidence for eating mimicry in these five dyads. The average observed length of time between Person i and j's bites in these five significant dyads was 6.3 s (SD = 1.7, range: 4.3, 8.6), and in the nonsignificant dyads was 9.2 s (SD = 3.9, range: 4.6, 28.1). These tests were also run with a significance level of 0.10, in which 19 of the 78 dyads had significant evidence for eating mimicry.

Dyad characteristics associated with eating mimicry

The 19 dyads with significant (α = .05) or marginally significant (α = .1) evidence of eating mimicry were a mix of dyad types (Table 2). Ten were dyads in which a child was mimicking their eating partner (mimicry was observed in 18.2% of dyads where a child was eating with a child, and 26.1% of dyads where a child was eating with a parent), and nine were dyads in which a parent was mimicking their eating partner (mimicry was observed in 30.0% of dyads where a parent was eating with a parent, and 26.1% of dyads where parent was eating with a child).

For gender differences, 11 dyads were males mimicking their eating partner (mimicry was observed in 33.3% of dyads where a male was eating with a male, and in 30.4% of dyads where a male was eating with a female) and eight dyads were females mimicking their eating partner (mimicry was

Table 2 | Characteristics of dyads (N = 78), by significance level

Characteristics	*Significance level α = .05 (N = 5 dyads)*	*Significance level α = .10 (N = 19* dyads)*
	Frequency (Row %)	
Dyad Type		
Child → Child (N = 22)	2 (9.1%)	4 (18.2%)
Child → Parent (N = 23)	1 (4.3%)	6 (26.1%)
Parent → Parent (N = 10)	1 (10.0%)	3 (30.0%)
Parent → Child (N = 23)	1 (4.3%)	6 (26.1%)
Gender		
Male → Male (N = 12)	1 (8.3%)	4 (33.3%)
Male → Female (N = 23)	1 (4.3%)	7 (30.4%)
Female → Female (N = 20)	2 (10.0%)	5 (25.0%)
Female → Male (N = 23)	1 (4.3%)	3 (13.0%)
Age		
Young child → Young child (N = 4)	1 (25.0%)	2 (50.0%)
Young child → Old child (N = 5)	1 (20.0%)	2 (40.0%)
Young child → Parent (N = 11)	0 (0.0%)	4 (36.4%)
Old child → Old child (N = 8)	0 (0.0%)	0 (0.0%)
Old child → Young child (N=5)	0 (0.0%)	0 (0.0%)
Old child → Parent (N = 12)	1 (8.3%)	2 (16.7%)
Parent → Young child (N = 11)	0 (0.0%)	2 (18.2%)
Parent → Old child (N = 12)	1 (8.3%)	4 (33.3%)

*These dyads are cumulative (include all dyads with $p < .10$).
Note: → indicates "mimics".

observed in 25.0% of dyads where a female was eating with a female, and in just 13.0% of dyads where a female was eating with a male). While examining differing child age groups, we found that young children mimicked all types of eating partners (n = 2 other young children, n = 2 old children, and n = 4 parents), but that old children only mimicked their parents (n = 2), and never young children or other old children (Table 2).

Logistic regression models were fit to determine if any of these dyad-level characteristics predicted the probability of eating mimicry (p values) in a dyad found by the permutation tests. Results indicate that none of the dyad relationship types (child → child, child → parent, parent → parent, or parent → child) were significant predictors of a dyad's likelihood to exhibit eating mimicry (Table 2). Furthermore, neither gender nor age group were significant predictors.

DISCUSSION

This pilot study used real-time video recordings to characterize the frequency and timing of two generations of family members' bites of food during a shared meal in order to detect eating mimicry, and builds on research considering behavioral mimicry as a process that facilitates social influence on eating. Using traditional statistical methods to identify eating mimicry, we found that family members were more likely to take a bite of food within 5 s of their eating partner doing so, compared to the periods of the eating event outside of this time frame. The novel application of nonparametric permutation tests provided a more rigorous test of mimicry for each family dyad and identified a smaller subset in which eating mimicry was exhibited.

The overall finding of eating mimicry occurring within 5 s of a bite by an eating partner is consistent with results from other studies of eating mimicry, which have employed the same definition of mimicry, used the same statistical testing procedures, and conducted the study in the same "naturalistic" lab settings (dining/kitchen labs) [20,23]. Hermans et al. found that female dyad members were more likely to take a bite of their meal following their eating partner's bites [20]; Sharps et al. found that adolescents were more likely to place the *same* type of food in their mouth if their parent had done so within 2, 5, and 15 s [23].

The literature has established a strong evidence base for social influence on eating behavior [40,41], and that interpersonal influence can occur through mechanisms such as normative influence [42] and social learning [40]. But there is a lack of research examining eating mimicry as a mechanism of social influence on eating in families, despite it likely being an important source of influence because of habit formation and automaticity processes. When replicating commonly applied statistical approaches, we find evidence of eating mimicry within 5 s among family members (p < .0001). But the results from our permutation tests suggest that eating mimicry is not as pervasive among family members as the existing literature would have us expect. Furthermore, the occurrence of mimicry in certain types of dyads is not well explained by the dyad characteristics we have explored. Other factors we did not measure, such as individual level of eating automaticity, distraction of other external cues like television, participant hunger level, type of meal (e.g., breakfast, lunch, or dinner), or other contextual factors may explain potential differences. This pilot study found evidence of eating mimicry among a small subset of family dyads within our sample, and the conditions in which mimicry occurs (for whom, and when) should be explored in future research.

Although dyad relationship type, gender, and age group were not significant predictors of the five dyads exhibiting mimicry, a few patterns emerged when considering the characteristics of dyads with marginally significant evidence for mimicry (a significance level of 0.10). About one third (30%) of parent–parent dyads exhibited marginally significant mimicry. The literature suggests that behavioral mimicry in adults serves important social functions, such as establishing and maintaining rapport with other individuals [26]. Adults mimic friends and close social ties more than strangers and mimic people in their "ingroup" more than outgroups [26]. Furthermore, mimicry can create increased affiliation, serving as a mechanism to express affiliation [31], which could be argued is an important function within a romantic relationship.

We also found there was more evidence for mimicry in dyads where a young child was the "mimicker," where there was marginal evidence for mimicry in 40% of these dyads, compared to dyads in which an old child was in this role. In the latter case, there was marginal evidence for mimicry in just 8% of these dyads, and this was only observed in dyads in which the old child was mimicking a parent. Although the number of dyads in each age category was relatively small, this nonetheless represents a trend that should be explored in future research. Literature on children and parent interactions suggests behavioral imitation during infancy [29,43] and childhood [44], and establishes child modeling of parents' eating behaviors [45]. Over and Carpenter argue that when children imitate a behavior, they learn how members of a group tend to and ought to behave (i.e., social norms), which could help explain our findings [44].

Study strengths and limitations

One limitation of our pilot study was the lab setting in which the families ate their meal; although attempts were made to arrange the lab similarly to a kitchen and dining room area, a complete replication of a family's natural home environment was unrealistic.

It is possible that because habits, such as eating behavior, are driven by automatic responses to environmental cues, mimicry was not exhibited at the expected rates due to an absence of typically-present environmental cues. However, we hope to address this limitation in the later phases of our study, in which bite data will be collected in the home environment. Another limitation was our use of dyadic analysis for data containing more than two people. And finally, due to a small sample size, we were unable to test for nuanced predictors of variability in mimicry (including more nuanced child development stages), and there might have been insufficient data to detect any significant differences in the types of dyads that exhibited eating mimicry in our study. Future studies with a larger sample should examine multiple eating contexts and eating events in order to elucidate for whom and when mimicry occurs. Future research could also be designed to test for associations between overweight status and eating mimicry.

A strength of the study was its use of rigorous testing using permutations. We did not assume a fixed number of seconds rule to classify bites as mimicry events; moreover, we did not use any such type of assumption at all, making the statistical method more robust. Instead of assessing whether eating mimicry was observed in the data as a whole (across families), the permutation test did such at the dyad level, which permitted us to focus our analyses only on those cases which our test identified as with evidence supporting eating mimicry.

Future directions

The ability to examine and model microlevel phenomena of family eating behavior, such as eating mimicry, and contextual factors in real time is transforming with the emergence of new technologies [32]. The creation of new data types not previously possible can contribute to novel ways to examine these phenomena dynamically and to develop analytic techniques that will allow us to examine family interactions and influence in depth. New technologies will also allow us to observe other documented influences on food intake, such as mood and stress [46], and how those might influence eating mimicry.

This pilot study demonstrates the feasibility of identifying eating mimicry within the family context in a lab setting, and future studies that utilize novel technologies to measure and model family dynamics in real time and in context could give us a better understanding of what is happening on a microlevel and identify potential opportunities for innovative interventions in the future. Clinical implications include the ability to identify moments of eating mimicry for specific dyads (eating partners), and to detect when mimicry occurs and in which contexts. Future work has the potential to test how eating mimicry contributes to overeating or undesirable eating behaviors within certain individuals, and intervene to reduce these unhealthy behaviors to improve health outcomes. The use of real-time technology will significantly improve our knowledge of these often overlooked and weakly measured contributors to child overeating.

CONCLUSION

This was among one of the first studies to examine eating mimicry as a mechanism of interpersonal influence on family eating behavior. Our findings indicate that eating mimicry among family members was not as prevalent as the existing literature would have us expect, and demonstrate that influence of social cues on eating may be more dependent on context and individual differences. Gaining a deeper understanding of family eating systems and identifying characteristics of family members that are more prone to mimicry might provide a novel target for future family- and group-based eating interventions.

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Compliance with Ethical Standards

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Conflicts of Interest: The authors declare that they have no conflicts of interest.

Human Rights: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The University of Southern California Institutional Review Board approved the study protocol (IRB #: UP-16-00227).

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Welfare of Animals: This article does not contain any studies with animals performed by any of the authors.

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