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Eating a meal is associated with elevations in agreeableness and reductions in dominance and submissiveness

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HIGHLIGHTS

- We examined the effects of having a meal on interactions with others.
- Study participants repeatedly reported how they felt, behaved, and perceived others.
- Overall, social interactions during a meal were more positive than other interactions.
- Shared meals are characterized by affiliative bonding and less display of hierarchy.

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ABSTRACT

Many studies have shown that having a meal together with others increases food intake. In contrast, the effects of having a meal on interactions with others have rarely been examined. More specifically, it is unknown if having a social interaction during a meal alters how people feel, behave, and perceive others.

In the present study, 98 working individuals provided information on their everyday social interactions over a three-week period by filling in a form soon after each interaction. Record forms included items representing mood state, interpersonal behaviors, and perceptions of interaction partners. Participants also indicated whether interactions took place during a meal.

Engaging in an interaction that involved eating a meal was associated with decreased alertness and, particularly in women, with increased pleasant affect, compared to interactions that did not involve eating a meal. Independently of this, during a meal participants reported fewer dominant and submissive behaviors and more agreeable behaviors, and also perceived interaction partners as more agreeable. These results were largely independent of contextual factors such as the gender and role of the primary social interaction partner, the presence of multiple partners, and the location of the interaction.

Overall, social interactions during a meal were more positive in terms of how people felt, behaved, and perceived others. At the same time, agentic behaviors were reduced. These results suggest that shared meals are events in which affiliative bonds are strengthened in the context of weakened displays of hierarchy.

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1. Introduction

Eating with others is a universal phenomenon [1]. In humans, feasting goes back at least 12,000 years [2]. As might be expected, eating with others influences eating behavior. Both in laboratory settings [3] and in daily life [4], food intake is usually greater when eating with others than when eating alone. Social facilitation of food intake is seen at breakfast, lunch, and dinner, for snacks as well as meals, and occurs irrespective of where the meal is eaten and whether it is accompanied

by alcohol [5]. The presence of family and friends increases food intake more than the presence of other companions [6].

People eating with others adjust their food intake to that of their eating companions. For example, Goldman and colleagues found that participants in a laboratory study ate little when confederates ate little, even after 24 h of food deprivation [7]. This mimicry of eating behavior has been observed with more than just total food intake. Hermans and colleagues studied female dyads eating together and found that both women were more likely to take a bite within 5 s of the other than to eat at their own pace [8]. Mimicry of eating behavior appears to be related to the desire to please others, to be socially accepted, or to maintain social harmony [9,10]. If people eating with others adjust their eating behavior in a way that may be intended to please others, then this raises

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the question of whether they also adjust other behaviors. In the present study, we examined whether behavioral expressions of affiliation and expressions of hierarchy are altered during a meal.

The Social Behavior Inventory (SBI) was developed to measure interpersonal behavior along two dimensions, communion (ranging from agreeableness to quarrelsomeness) and agency (ranging from dominance to submissiveness) [11]. Communal behaviors serve to express affiliation and agentic behaviors serve to express hierarchy. The SBI has been administered to people eating meals together with the goal of examining how interpersonal behavior may be associated with food intake in the hospitalized elderly [12,13]. Dubé and colleagues found that when participants behaved in a more agentic way with their care providers during a meal, their total energy intake increased [13]. Additionally, the same group found that participants had a larger intake when their mealtime interactions with other patients involved more communal behavior [12]. This suggests that agency and communion during interactions that involve meals moderate how much people eat.

The SBI was developed for the intensive repeated measurement of interpersonal behavior in naturalistic settings [11] and has mostly been used in this context. An interpersonal grid for the repeated measurement of perceptions of others in terms of communion and agency was subsequently developed [14]. More specifically, Moskowitz and colleagues developed an approach for the recording of interpersonal behavior, perceptions, and mood state during interpersonal events occurring in everyday life; this method has been extensively validated [15]. In event-contingent recording studies, participants repeatedly fill in forms in response to specific recurring events, in this case social interactions as defined in Section 2.2. In the present study, we employed this event-contingent recording approach to see if social interaction events were different when working individuals were having an interaction during a meal compared to when they were having an interaction that did not take place during a meal. Since people alter their eating behavior in a way that seems designed to please others, our primary hypothesis was that participants would report more agreeableness and less quarrelsomeness during meals. We also hypothesized that their perceptions of others and mood state would be more positive.

2. Materials and methods

2.1. Participants

We used a combined sample of 97 participants recruited in the winter for a light administration study (Sample 1, $n = 59$) or in the summer for a naturalistic light exposure study (Sample 2, $n = 38$). Sample 1 data were taken from a study comparing early-morning bright light treatment to a placebo, consisting of early-morning exposure to a low level of negative ions, produced by an air purifier available in retail stores [16]; for the present study we used only the placebo data. Sample 2 data were taken from an unpublished study investigating the relation between natural exposure to bright light and social behavior. In Sample 1 (42% male) the mean age of the participants was 33.47 years ($SD: 15.66$), 58% had completed college or university, and 81% lived with others. In Sample 2 (39% male) the mean age of the participants was 33.34 years ($SD: 10.17$), 46% had completed college or university, and 71% lived with others.

Sample 1 and Sample 2 participants were recruited using advertisements in local newspapers and on local websites (e.g., McGill Classified Ads at www.mcgill.ca/classified). People who phoned and expressed interest in the study were given a detailed explanation and, if found willing to participate, invited for an interview in the laboratory. After providing written informed consent, participants were interviewed using the Structured Clinical Interview for DSM-IV, Non-Patient Edition (SCID) [17].

For both samples, the selection criteria were no current or past Axis I disorder according to the SCID [18], no significant self-reported major medical illness, no use of psychotropic medication, no pregnancy or

lactation, working at least 30 h per week, and not working alone (to ensure they had a range of social interactions).

The only difference between Samples 1 and 2 with respect to participant selection pertained to the use of the Global Seasonality Scale (GSS) of the Seasonal Pattern Assessment Questionnaire [19]. Sample 1 participants were required to score between 6 and 11, which indicates mild to moderate seasonal changes in functioning and includes about one-third of the population at latitude 40N [20]. Sample 2 participants were required to score 2 or less, which indicates no or only minor seasonal changes in functioning and includes about one-fourth of the population at latitude 40N [20]. There were 97 participants in the combined data set (40 men and 57 women), of whom 58 originated from Sample 1 and 39 originated from Sample 2.

2.2. Event-contingent recording

All participants reported on their behaviors, perceptions and mood during social interactions using event-contingent recording (ECR) [11]. Sample 1 participants and Sample 2 participants did so for 20 and 21 days, respectively. Events to be recorded were defined as social interactions that occurred in person, by telephone, or via internet chatting, and lasted at least 5 min. ECR allows for the collection of intensive repeated measurements in near real-time and in the participants' own environment, thereby reducing the recall bias of retrospective self-report. The one-page ECR forms contained items assessing interpersonal behaviors, perceptions of interaction partners, and mood states, and requesting information about situational characteristics of the social interaction such as time, location, and partner gender and role. For the present study, ECR forms also included the question "Did this interaction take place during a meal?" with checkboxes for Yes and No. Participants were asked to complete forms as soon as possible after an interaction and were provided with pre-paid envelopes to mail the forms to the laboratory each day.

2.2.1. Interpersonal behaviors

We used behavior items developed by Moskowitz [11] to measure agreeableness, quarrelsomeness, dominance, and submissiveness, which correspond to the major dimensions of the interpersonal circumplex model [21]. Each dimension was represented by 12 items. Examples are "I listened attentively to the other" for agreeableness, "I discredited what someone said" for quarrelsomeness, "I set goal(s) for the other(s) or for us" for dominance, and "I spoke only when I was spoken to" for submissiveness. Participants could check or not check an item to indicate whether they had engaged in the behavior in a specific interaction.

Each record form included 3 of the 12 items for each behavioral dimension, and there were four versions of the forms that were rotated daily to prevent participants from checking the same items for every interaction. To control for individual tendencies to consistently check many or few items on the form, we calculated ipsatized scores for each of the four behaviors for each event by (i) dividing the number of checked behavioral items (between 0 and 3) by the total number of behavioral items on each form (3); and (ii) subtracting from this behavioral score (between 0 and 1) the mean score of the four behaviors combined (between 0 and 1) [11]. These ipsatized scores indicate how often agreeable, quarrelsome, dominant and submissive items were checked after adjusting for the general rate of item checking. Given that people tend to check quarrelsome and submissive items less often than agreeable and dominant items, ipsatized scores for quarrelsomeness and submissiveness are generally lower than those for agreeableness and dominance, and are frequently negative. To ease interpretation, for the analyses we multiplied all ipsatized scores by 100.

2.2.2. Perceptions of interaction partners

Participants completed this part of the record form when there was a one-on-one interaction or when there was a group interaction but the

participant identified a primary partner with whom the participant spoke. To measure perceived affiliation and perceived status of the sole or primary interaction partner, participants placed a single mark on an 11 × 11 interpersonal grid [14]. To measure perceived affiliation, participants indicated on the horizontal dimension of the grid to what extent they perceived their interaction partner to be quarrelsome or agreeable. To measure perceived status, participants indicated on the vertical dimension of the grid to what extent they perceived their interaction partner to be dominant to submissive. For example, a partner could be perceived as agreeably dominant when giving praise and agreeably submissive when going along with the participant's views or opinions.

2.2.3. Mood state

For each social interaction participants placed a single mark on a 9 × 9 grid that measured affect valence and affect arousal [22]. To measure valence, participants indicated on the horizontal dimension of the grid to what extent they felt pleasant or unpleasant; scores higher than 5 indicate pleasant feelings. To measure arousal, participants indicated on the vertical dimension of the grid to what extent they felt sleepy or aroused.

2.3. Data analysis

Previous work had demonstrated that alcohol alters interpersonal behavior [23]; therefore, prior to the analyses, we excluded all social interactions recorded while participants were drinking alcohol during or in the hour before the interaction. Participants completed on average 6.03 forms per day (*SD*: 1.76). The total number of interactions which took place during a meal was 1078 in Sample 1 (the sample with more participants) and 766 in Sample 2. The percentage of social interactions involving a meal in Sample 1, $M = 17\%$, $SD = 13\%$, was similar to that of Sample 2, $M = 20\%$, $SD = 12\%$, $t(95) = 1.25$, $p > 0.21$.

We used multilevel models with maximum likelihood estimation (PROC MIXED in SAS 9.3) to examine the effects of having a meal on mood and interpersonal behavior. Each model included a random intercept with an unstructured covariance structure. The degrees of freedom for *F*-tests were computed according to Kenward and Roger [24]. Significant interaction terms were examined by testing the simple contrasts and applying a Tukey–Kramer adjustment to the resulting *p* values. We calculated the effect size correlation *r* for each significant effect of Condition using the formula $r = [F / (F + df)]^{1/2}$ [25] and Cohen's *d* values from the effect size correlation, $r^2 = d^2 / (d^2 + 4)$.

In preliminary analyses there were three predictors: Condition, Sample, and Sex. Condition (meal vs. no meal) was a within-subjects factor. Sample (1 vs. 2) and Sex (men vs. women) were between-subjects factors. Preliminary analyses revealed no significant effects of Sample on interpersonal behavior and mood, with the exception of a significant Condition by Sample interaction on affect valence. Post-hoc testing of this interaction revealed a positive effect of having a meal on affect valence in both Sample 1 ($t(11 * 10^3) = -6.89$, $p < 0.0001$, $d = 0.13$) and Sample 2 ($t(11 * 10^3) = -10.10$, $p < 0.0001$, $d = 0.19$). Given the similarity in results for Samples 1 and 2, for the primary analyses of the effects of having a meal on mood and interpersonal behavior, we entered as predictors Condition, Sex, and the two-way interaction.

We conducted secondary analyses to examine several contextual variables as potential moderators of the effect of having a meal on mood and interpersonal behavior. Previous research has shown eating to be influenced by group size [4] and interpersonal behavior to be influenced by location, partner sex, and partner role [11,26]. We therefore generated multilevel models with Condition, one of the contextual variables, and the interaction of Condition and Context, as predictors of mood and interpersonal behavior. We considered the following contextual variables: Location (home, work, elsewhere), Group (one partner, multiple partners), Partner sex (same sex, different sex; for primary partner only), and Partner role (boss, co-worker, friend, romantic

partner, family member, other; for primary partner only). Events for which participants did not indicate a location were assumed to have taken place away from home and work. Since most interactions with bosses and co-workers took place at work and most interactions with friends, romantic partners, family members, and others did not take place at work, we examined the moderating effect of Partner role within the relevant locations. In the secondary analyses of mood we statistically controlled for Sex. In the secondary analyses of interpersonal behavior and perceptions of interaction partners we controlled for Sex, affect valence, and affect arousal. As mood, behaviors, and perceptions, can vary over the course of a day we also examined time of day effects and how they interacted with the effects of meals.

Since meals can increase feelings of drowsiness [27] and also enhance memory [28], we explored the possibility that recordings of how participants felt, behaved, and perceived their interaction partners during a meal were altered by the postprandial state in which the recording of meal events was done. We did this by examining whether there were differences in mood state, interpersonal behaviors, and perceptions of interaction partners between social interactions that occurred in the hour after a meal compared to the interactions that occurred in the hour before a meal.

3. Results

Table 1 provides *F*-statistics for the primary analyses. Details including post-hoc analyses of significant interaction terms are subsequently presented.

3.1. Effects of a meal on mood state

3.1.1. Affect valence

There were significant main effects for Condition, $d = 0.22$, and for Sex, $d = 0.46$. The Condition by Sex interaction was also significant. In men, affect valence was more positive during a meal, $M = 8.11$, $SEM = 0.19$, than during other events, $M = 7.59$, $SEM = 0.18$, $t(11 * 10^3) = 6.29$, $p < 0.0001$, $d = 0.12$. In women, affect valence was also more positive during a meal, $M = 8.76$, $SEM = 0.16$, than during other events, $M = 8.03$, $SEM = 0.15$, $t(11 * 10^3) = 10.80$, $p < 0.0001$, $d = 0.21$. The difference between the two effect sizes was significant, $t(11 * 10^3) = 2.03$, $p < 0.05$, indicating that the effect of having a meal on pleasant affect was larger in women than in men.

3.1.2. Affect arousal

There was a significant main effect for Condition, $d = 0.07$. Participants reported lower levels of alertness during meals, $M = 7.01$, $SEM = 0.11$, than during other events, $M = 7.19$, $SEM = 0.11$. There

Table 1

F-statistics for Condition (having or not having a meal) and participant Sex on mood, interpersonal behavior, and perceptions of the interaction partner.

	Condition	Sex	Condition by Sex
Affect valence	137.48***	5.34*	4.12*
Affect arousal	13.17***	0.04	0.01
Quarrelsome behavior	0.13	0.51	0.00
Agreeable behavior	90.36***	2.71	4.06*
Dominant behavior	32.26***	0.10	0.43
Submissive behavior	14.48***	0.98	1.56
Perceived affiliation	36.51***	12.76***	0.47
Perceived status	0.27	2.90	0.37

The denominator degrees of freedom were $11 * 10^3$ for the Condition effect, 101–117 for the Sex effect, and $11 * 10^3$ for the Condition by Sex interaction. Increased scores were significantly associated with eating a meal for affect valence, agreeable behavior, and perceived affiliation, while decreased scores occurred during a meal for affect arousal, dominant behavior, and submissive behavior.

* $p < 0.05$.

*** $p < 0.001$.

was no significant main effect for Sex, $d = 0.04$. The Condition by Sex interaction was also not significant.

3.2. Effects of a meal on interpersonal behavior

3.2.1. Quarrelsomeness

There were no significant effects for Condition, $d = 0.01$, Sex, $d = 0.14$, or the interaction term.

3.2.2. Agreeableness

There was a significant main effect for Condition, $d = 0.17$. There was no significant main effect for Sex, $d = 0.33$. The Condition by Sex interaction was significant. Men reported more agreeable behavior during a meal, $M = 15.79$, $SEM = 1.40$, than during other events, $M = 11.72$, $SEM = 1.24$, $t(12 * 10^3) = 4.86$, $p < 0.0001$, $d = 0.09$. Women also reported more agreeable behavior during a meal, $M = 19.57$, $SEM = 1.17$, than during other events, $M = 13.31$, $SEM = 1.03$, $t(11 * 10^3) = 9.04$, $p < 0.0001$, $d = 0.17$. The difference between the two effect sizes was significant, $t(12 * 10^3) = 2.01$, $p < 0.05$; the effect of having a meal on agreeableness was larger in women than in men. However, after controlling for concurrent levels of affect valence and affect arousal, only the main effect of Condition remained significant, $F(1,11 * 10^3) = 46.13$, $p < 0.0001$, $d = 0.13$. The Condition by Sex interaction was no longer significant, $F(1,11 * 10^3) = 2.83$, $p > 0.09$. Thus, after taking mood state into account, the effect of a meal on agreeable behavior was similar for women and men.

3.2.3. Dominance

There was a significant main effect for Condition, $d = 0.11$. Participants reported less dominant behavior during meals, $M = 4.59$, $SEM = 0.70$, than during other events, $M = 7.70$, $SEM = 0.56$. There was no significant main effect for Sex, $d = 0.06$. The Condition by Sex interaction was also not significant. The main effect for Condition remained significant after controlling for concurrent levels of affect valence and affect arousal, $F(1,11 * 10^3) = 27.30$, $p < 0.0001$, $d = 0.10$.

3.2.4. Submissiveness

There was a significant main effect for Condition, $d = 0.07$. Participants reported less submissive behavior during meals, $M = -6.54$, $SEM = 0.71$, than during other events, $M = -4.55$, $SEM = 0.58$. There was no significant main effect for Sex, $d = 0.18$. The Condition by Sex interaction was also not significant. The main effect for Condition remained significant after controlling for concurrent levels of affect valence and affect arousal, $F(1,11 * 10^3) = 8.11$, $p < 0.005$, $d = 0.05$.

3.3. Effects of a meal on perceptions of interaction partners

3.3.1. Perceived affiliation

There was a significant main effect for Condition, $d = 0.12$. Participants rated their interaction partners as more agreeable during meals, $M = 8.57$, $SEM = 0.12$, than during other events, $M = 8.23$, $SEM = 0.11$. There was also a significant main effect for Sex, $d = 0.70$. Women, $M = 8.80$, $SEM = 0.14$, rated their partners as more agreeable than men, $M = 8.00$, $SEM = 0.17$. The Condition by Sex interaction was not significant. The main effect for Sex remained significant after controlling for concurrent levels of affect valence and affect arousal, $F(1,107) = 13.65$, $p < 0.0004$. However, the main effect for Condition did not, $F(1,9499) = 0.64$, $p > 0.42$, $d = 0.02$. This suggests that the finding that participants rated their interaction partners as more agreeable during meals can be explained by their mood state at that time.

3.3.2. Perceived status

There were no significant effects for Condition, $d = 0.01$, Sex, $d = 0.34$, or the interaction term.

3.4. Time of day effects and their interactions with the effect of meals

To exclude the possibility that time of day was confounded with the observed effects of a meal on mood state, interpersonal behavior, and perceptions of interaction partners, we repeated the primary analyses with Time and the Time by Condition interaction as additional predictors. Time of day was coded as morning (before noon), afternoon (from noon until 5 pm), and evening (after 5 pm). Social interactions were more likely to have taken place in the afternoon (36%) than in the morning (34%) or evening (30%, $X^2(2) = 71$, $p < 0.0001$). A similar percentage distribution was observed among meal events (36%, 35%, and 29%, respectively) and among non-meal events (37%, 30%, and 33%, respectively).

There were significant main effects of Time for Affect valence, $F(2,11 * 10^3) = 29.05$, $p < 0.0001$, Agreeableness, $F(2,11 * 10^3) = 4.31$, $p < 0.02$, and Perceived affiliation, $F(2,9447) = 8.69$, $p < 0.0003$; these variables had the highest values in the evening and the lowest values in the morning. There were also significant effects for Time for Dominance, $F(2,11 * 10^3) = 5.45$, $p < 0.005$, which was highest in the morning and lowest in the evening, and for Affect arousal, $F(2,11 * 10^3) = 31.28$, $p < 0.0001$, and Perceived status, $F(2,9445) = 3.23$, $p < 0.04$, which were lower in the morning than during the rest of the day.

The Condition by Time interaction was significant for Affect arousal, $F(2,11 * 10^3) = 6.18$, $p < 0.003$. Participants did not report altered levels of arousal during afternoon meals compared to other afternoon events, $t(11 * 10^3) = 2.32$, $p > 0.18$, and during evening meals compared to other evening events, $t(11 * 10^3) = -0.30$, $p > 0.99$. However, participants reported lower levels of arousal during morning meals than during other morning events, $t(11 * 10^3) = 4.58$, $p < 0.0001$. The Condition by Time interaction was also significant for Perceived affiliation, $F(2,9437) = 3.74$, $p < 0.03$. Participants did not rate their interaction partners as more or less agreeable during morning meals than during other morning events, $t(9465) = 1.89$, $p > 0.41$. However, participants rated their interaction partners as more agreeable during afternoon meals than during other afternoon events, $t(9450) = 5.59$, $p < 0.0001$, and during evening meals than during other evening events, $t(9441) = 3.28$, $p < 0.02$. These analyses indicate that the results comparing meal events to non-meal events, as presented in Sections 3.1–3.3, were not an artifact of time.

3.5. Contextual information

There was a total of 11,541 events in the data set, of which 31% occurred at home, 37% at work, and 32% elsewhere. Comparatively, of the 2014 meal events, 48% occurred at home, 20% at work, and 32% elsewhere. More than one-third of all events (37%) and 44% of meal events involved groups of interaction partners (with or without a primary partner). For 82% of all events participants indicated the gender of a primary interaction partner. Among these events, 53% involved same-sex partners and 47% involved opposite-sex partners. For meal events, this was 46% and 54%, respectively.

At work, 17% of all events (and 7% of all meal events) primarily involved a boss, 35% (41%) involved a co-worker, 3% (1%) a supervisee, and 45% (51%) involved other people. Outside of work, 28% of all events (and 25% of all meal events) primarily involved a friend, 19% (25%) involved a romantic partner, 14% (18%) a family member, and 39% (32%) involved other people.

3.6. Impact of contextual factors on social interaction during a meal

Table 2 provides a summary of the outcomes of the secondary analyses. Details are presented below.

3.6.1. Quarrelsomeness

There were no significant interactions between Condition and any of the contextual variables.

Table 2

F-statistics for Condition (having or not having a meal) and specific contexts (Location, Group, Partner Sex, Partner role) on interpersonal behavior, and perceptions of the interaction partner.

	Condition by Location	Condition by Group	Condition by Partner sex	Condition by Partner role (at work)	Condition by Partner role (not at work)
Quarrelsome behavior	0.44	0.40	0.08	0.25	1.04
Agreeable behavior	2.09	5.49*	0.28	0.09	0.96
Dominant behavior	4.30*	0.29	3.64	1.87	1.42
Submissive behavior	0.56	1.64	1.41	0.94	0.09
Perceived affiliation	1.47	2.10	0.28	2.09	0.80
Perceived status	3.11*	2.02	0.04	0.43	0.54

* $p < 0.05$.

3.6.2. Agreeableness

There was a significant Condition by Group interaction, $F(1,11 * 10^3) = 5.49, p < 0.02$. Participants reported more agreeable behavior during a meal in a group, $M = 17.52, SEM = 1.05$, than during other group events, $M = 12.34, SEM = 0.86, t(11 * 10^3) = 6.56, p < 0.0001, d = 0.13$. Participants also reported more agreeable behavior during a meal with one other person, $M = 15.93, SEM = 0.99$, than during other events that involved one other person, $M = 13.16, SEM = 0.82, t(11 * 10^3) = 4.08, p < 0.0001, d = 0.08$. The difference between the two effect sizes was significant, $t(11 * 10^3) = 2.34, p < 0.02$, indicating that the effect of having a meal on agreeableness was larger in groups than in events that involved one other person (see Fig. 1).

3.6.3. Dominance

There was a significant Condition by Location interaction, $F(2,11 * 10^3) = 4.30, p < 0.02$. At home, participants reported less dominant behavior during a meal, $M = 5.06, SEM = 0.87$, than during other events, $M = 7.93, SEM = 0.68, t(11 * 10^3) = -3.52, p < 0.0005, d = 0.07$. At work, participants also reported less dominant behavior during a meal, $M = 4.05, SEM = 1.18, t(11 * 10^3) = -4.69, p < 0.0001, d = 0.09$. At locations other than home or work, participants reported similar levels of dominant behavior regardless of whether an event took place during a meal, $M = 4.15, SEM = 1.00$, or not, $M = 5.16, SEM = 0.66, t(11 * 10^3) = -1.09, p > 0.27, d = 0.02$. Only the difference between the effect size for the work location and the effect size for the location elsewhere was significant, $t(11 * 10^3) = 2.93, p < 0.004$, suggesting that the effect of having a meal on dominance was largest at work (see Fig. 2).

3.6.4. Submissiveness

There were no significant interaction effects between Condition and any of the contextual variables.

Fig. 1. Effect of having a meal on agreeableness, for events involving single versus multiple interaction partners. *** $p < 0.0001$.

3.6.5. Perceived affiliation of interaction partners

There were no significant interaction effects between Condition and any of the contextual variables.

3.6.6. Perceived status of interaction partners

There was a significant Condition by Location interaction, $F(2,9438) = 3.11, p < 0.05$. However, in post-hoc analyses the effect of a meal on perceived status was not significant at home, $t(9470) = -1.02, p > 0.30, d = 0.02$, nor at work, $t(9446) = 1.87, p > 0.06, d = 0.04$, nor elsewhere, $t(9439) = 1.63, p > 0.10, d = 0.03$.

3.7. Mood, behavior, and perceptions before and after a meal

The data set contained 875 events that took place in the hour before a meal and 1575 events that took place in the hour after a meal. There was no significant difference between these two time periods for valence, $F(1,2454) = 0.86, p > 0.35$, arousal, $F(1,2463) = 1.52, p > 0.21$, quarrelsomeness, $F(1,2167) = 0.54, p > 0.46$, agreeableness, $F(1,2178) = 0.00, p > 0.96$, dominance, $F(1,2189) = 0.18, p > 0.66$, submissiveness, $F(1,2188) = 0.02, p > 0.89$, perceived affiliation, $F(1,2054) = 2.20, p > 0.13$, and perceived status, $F(1,2063) = 0.48, p > 0.48$. Thus, recordings of how participants felt, behaved, and perceived their interaction partners during a meal did not appear to be altered by the postprandial state in which the recording of meal events was done.

4. Discussion

Participants in this study reported greater agreeableness and less dominance and submissiveness during meals than at other times. There was also an increase in pleasant mood during a meal, with a greater effect in women than in men. The reason for this sex difference is not

Fig. 2. Effect of having a meal on dominance, for events taking place at home, at work, or elsewhere. *** $p < 0.0001$.

known. The interpersonal behavior results were independent of a meal-associated change in mood state, either in terms of pleasant affect or in terms of alertness. Participants also perceived their interaction partners as more affiliative, a finding that could be explained by the observed mood change. There are three potential explanations for our finding that having a meal during a social interaction can affect the quality of the interaction, namely (1) people may select whom to interact with while eating; (2) having a meal with others is associated with psychosocial factors, and (3) food ingestion is associated with biological changes.

Participants may have selected others they could be agreeable with during a meal to have a more pleasant experience; behaving agreeably is usually associated with a more positive mood state [29]. Moreover, as agreeableness tends to evoke agreeableness in others [30–32], greater agreeableness by the participants during their meals suggests that their interaction partners were also more agreeable during these meals. Consistent with these ideas, participants reported more pleasant affect and perceived their partners as more affiliative during a meal. However, there were also results indicating that the more positive mood state observed during interactions that involved eating was not only due to greater mutual agreeableness caused by selecting one's interaction partners. First, there was no eating-associated decrease in quarrelsomeness, which in addition to increased agreeableness is often associated with a more positive mood state [29]. Second, the analyses in which we considered partner role as a potential moderator of the observed effects showed that the changes in behavior and mood state during a meal were similar regardless of whether the participant was interacting with a romantic partner, friend, family member, or other person. Thus, even when interactions occurred with the same person (the romantic partner) the differences between having a meal and not having a meal were still present.

Psychosocial factors associated with having a meal with others include mimicry of eating behavior. The mimicry seen in those eating together has been attributed to the desire to please others, be socially accepted, and maintain social harmony [9,10]. This desire to maintain social harmony could explain our finding that having an interaction during a meal was associated with an increase in agreeableness. While there was no change in quarrelsomeness during a meal, quarrelsome behavior is relatively rare. Increased agreeableness may be more important for promoting social bonds at mealtime than decreased quarrelsomeness. However, social bonding is unlikely to be the sole explanation of why having a meal together affects the quality of social interactions. While Hermans and colleagues observed mimicry in pairs of women eating together [8], Robinson and colleagues reported that matching of food intake does not occur when both women score high on self-esteem or low on empathy [10]. Further, while mimicry of eating behavior may be observed in female dyads, it may be limited during other types of interactions. For example, behavioral mimicry is low when people interact with a person in higher status [33]. If mimicry of eating behavior was caused by the same factors that cause variations in social interaction quality, then we would have found meal-associated alterations in behavior and perceptions at work to vary as a function of partner role.

In addition to psychosocial factors, biological factors may alter interpersonal behavior during a meal. As food can influence psychological functioning [34], it is possible that the observed meal-associated changes in social interaction were due to the biological effects of the ingestion of food. Possible mediating factors include changes in sympathetic arousal, the hypothalamic–pituitary–adrenal system, and brain acetylcholine function. Further, the effects of eating on brain functioning involve many moderating factors, including the eater's nutritional state, the macronutrients ingested, and the context in which food intake occurred [34]. In experimental animals the oral movements that are associated with eating increase the firing of serotonin neurons and the synaptic release of serotonin in many brain areas [35]. In humans increasing serotonin by giving its dietary precursor tryptophan can increase agreeableness [36]. However, a more consistent effect of tryptophan is a decrease in quarrelsomeness [26,36], which in the present study was not

seen during a meal. If there is a biological factor associated with eating that is responsible for the meal-associated changes in social interaction, then it is probably not serotonin.

The mechanisms discussed previously are not mutually exclusive. All may operate to some extent, some of the time. For example, the possibility of inviting only congenial people might not often exist at mealtime in a work setting, whereas it may be more common to invite others to a meal at home. Future research could look for possible differences in the effects of meals on interpersonal behavior based on the extent to which participants had a role in choosing their interaction partners. As mealtime etiquette varies greatly between cultures, it would be interesting to know if the way meals influenced interpersonal behavior in our study is also found in other cultures. Finally, if biological factors due to food ingestion are responsible for some of the observed meal-associated changes in behavior, then food-related variables such as the total calories ingested would be expected to influence these changes.

The lower levels of both dominance and submissiveness during a meal were surprising. Dominant behaviors tend to elicit submissive behaviors in others, and vice versa [37,38]. This suggests that when the participants were interacting with others during a meal, overall there were fewer behavioral acts implying hierarchy. However, the perceived status of interaction partners was not altered during a meal. Moreover, as the SBI includes items such as “I assigned someone to a task” and “I asked others to do something” to assess dominance and items such as “I let others make plans or decisions” and “I avoided taking the lead or being responsible” to assess submissiveness [11], it is possible that the lower levels of dominant and submissive behaviors during meals were due to a tendency to avoid topics requiring planning and organization during meals, thereby causing an overall decrease in acts of hierarchy. Additional research is needed to explore this issue. For example, in laboratory experiment dyads or groups could be asked to organize a project during a meal or not during a meal. This type of study could also reveal if the planned outcomes and the rate at which they are achieved are different with the provision of food. Moreover, the results of this study could be particularly relevant for meals shared at work, as we found meal-associated decreases in dominance to be more pronounced at work than at home or elsewhere.

The findings of our study are of relevance to research on the influence of having a meal with others on food intake, as food intake might be moderated by how dominantly individuals behave when they eat with others [13] or by how agreeably individuals and their interaction partners behave when they eat together [12]. In our study, the increase in agreeableness during a meal was significantly larger when participants were interacting with a group during the meal than when participants were interacting with one other person. This is consistent with the finding that food intake increases with the number of others present during a meal [4,5]. In contrast, while the presence of family and friends has previously been shown to increase food intake more than the presence of other individuals [3,6], in our study partner role did not moderate the meal-associated changes in agreeableness, dominance, and submissiveness. However, as the moderating effects of partner role were examined in subsets of the data with smaller numbers of events, our findings should be interpreted with caution.

Our results may also be relevant to the association between family meals and mental health. For example, studies of adolescents have found associations between a higher frequency of family meals and reporting more personal strengths, higher levels of adjustment and emotional well-being, better relationships with parents, and fewer high-risk behavioral patterns such as substance use and conduct problems [39–42]. Whether this association is causal is not known, but it has been suggested that shared meals provide opportunities for parents to enhance communication and socialization, facilitate routine conversations and social support, and monitor and role model behavior [43–46]. Shared meals, routine conversations, and family rituals may promote a sense of closeness, connectedness, and stability [47,48]. If

interactions between adolescents and their parents at mealtimes result in more agreeable behaviors and a better mood state, as observed in the present study, then this might help explain why frequent shared meals can lead to better psychological outcomes. Future research could also examine whether adolescents and their parents tend to avoid contentious topics during interactions at mealtimes, and whether asking adolescents and their parents to discuss contentious topics while eating a meal results in a more harmonious outcome compared to when discussing these topics while not eating a meal.

One limitation of our study is that we do not know whether participants followed instructions and completed the forms immediately after a social interaction. This is a problem associated with all event-contingent methodologies; it is not possible to independently verify the time of the event. However, other methods such as signal-contingent or time-contingent recording may miss pertinent events. Thus, event-contingent recording is the suitable method for naturalistic recording of focal events.

We also do not know the amount or type of food eaten by the participants and their interaction partners at each meal. The amount presumably varied from interaction to interaction, and from situation to situation (e.g. between interactions at work and interactions at home). Laboratory studies in which the amount of food served is varied systematically while participants interact would reveal whether the effects of a meal on interpersonal behavior are influenced by the amount eaten.

In conclusion, we found that social interactions during a meal are generally more positive than social interactions that do not involve a meal, and less likely to involve expressions of hierarchy. These changes may help explain how having a meal with others influences food intake, and how eating with others may benefit mental health.

Acknowledgments

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