UNIVERSITY OF BIRMINGHAM

Social modelling of food intake. The role of familiarity of the dining partners and food type

Kaisari, Panagiota; Higgs, Suzanne

Accepted Manuscript

Title: Social modeling of food intake: The role of familiarity of the dining partners and food type

Author: Panagiota Kaisari, Suzanne Higgs
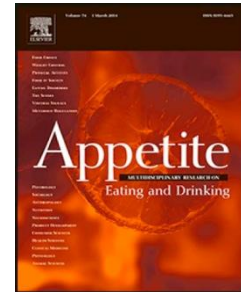
Please cite this article as: Panagiota Kaisari, Suzanne Higgs, Social modeling of food intake: The role of familiarity of the dining partners and food type, *Appetite* (2014), http://dx.doi.org/doi: 10.1016/j.appet.2014.09.020.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

1   **Social modeling of food intake: The role of familiarity of the**

2   **dining partners and food type**

3

4   Panagiota Kaisari and Suzanne Higgs

5

6   School of Psychology, University of Birmingham, Edgbaston, Birmingham,

7   B15 2TT

8

9

10   Dr Suzanne Higgs, PhD, School of Psychology, University of Birmingham, Edgbaston,

11   Birmingham, B15 2TT

12   Tel: 0121 4144907

13   Fax: 0121 4144897

14   email: s.higgs.1@bham.ac.uk

15

16   Running title: Social modeling and food intake

17

18

19 **Highlights:**

20 • Modeling is observed in dyads composed of friends and dyads composed of

21 strangers.

22 • Social modeling of food intake is similar whether eating partners are eating the

23 same versus different high-energy snack foods

24 • Social modeling is a robust phenomenon

25

ABSTRACT

In a social eating context, people tend to model the food intake of their dining companions. In general, people tend to eat more when their dining companion eats more and less when their eating companion eats less. In the present paper we investigate 1) whether familiarity of dining partners affects modeling and 2) whether modeling is affected by whether familiar partners consume the same versus different foods. In both studies, female dyads completed a task together whilst having access to high energy dense snack foods. Modeling was observed regardless of the familiarity of the dining partners and food types consumed. These findings confirm that social modeling of food intake is a robust phenomenon that occurs even among familiar dining partners and when partners are consuming different types of snack food.

42 **Introduction**

43

44 Human eating is a highly complex behavior that is the outcome of the integration of

45 many different inputs, including sensory, somatic, affective, contextual and socio-cultural

46 information (Higgs 2005). Social factors have attracted significant interest recently and

47 this is not surprising because food and eating are intertwined with our social lives

48 (Robinson et al. 2013). It has been reported that individuals model the food intake of their

49 eating companions, such that they tend to eat more when others eat more and less when

50 others eat less (Herman, Roth, & Polivy, 2003). This phenomenon, known as social

51 modeling of food intake, is so powerful that Goldman, Herman, and Polivy (1991)

52 reported that participants ate minimally in the presence of a low-intake model, even when

53 participants had been food-deprived for 24 hours.

54

55 The effects of modeling on food intake are well documented but the mechanisms

56 underlying these effects remain unclear. Because many meals are eaten in a social

57 context, even from early childhood, understanding the mechanisms underlying social

58 influences on eating may be helpful in the development of new more effective strategies

59 to promote healthy eating behaviors. Herman and colleagues (2003) proposed a

60 normative model of social influence on eating, which suggested that external cues play a

61 significant role in determining people's eating behavior. Thus, in a social context, people

62 may use the intake of others as an example of appropriate eating and adjust their own

63 food intake accordingly.

64

65   One motivation underlying modeling may be the desire to avoid the appearance of eating

66   excessively (Herman et al. 2003). There are negative stereotypes associated with eating to

67   excess (Vartanian et al. 2007), which may be avoided in a social situation if one does not

68   eat more than do others. This desire to avoid looking like one is overconsuming may

69   result in modeling of a companion's intake, especially in situations where there is

70   uncertainty about what constitutes an appropriate amount to eat. The provision of clear

71   normative information about the eating of others has been reported to provide a brake on

72   consumption (Leone et al. 2007). Hence, there is evidence that when people are uncertain

73   of how much they should eat, they model their eating companions to ensure that they do

74   not appear to be eating too much.

75

76   It has also been proposed that modeling of food intake is driven at least in part by basic

77   processes related to the links between perception and action (Robinson et al. 2011). This

78   idea is based on the finding that perceiving another person's movements activates one's

79   own motor programmes for the same movements, which promotes imitative actions

80   (Iacoboni et al. 1999). It is possible that as people eat together, their movements become

81   synchronized regardless of other salient goals or intentions (Cook et al. 2011) and this

82   explains why dyadic partners model each other's eating. In support of this idea, video

83   analysis of eating partners has confirmed a link between initiation of eating by one

84   partner and a similar action by their eating companion (Hermans et al. 2012). Hermans

85   and colleagues (2012) found that modeling was more likely within 10 seconds of a model

86   picking up food, which is consistent with the suggestion that modeling effects may be

87   driven in part by mechanisms linking perception with action (Chartrand & van Baaren,

88   2009; Dijksterhuis & Bargh, 2001).

89

90   Another factor that may underlie social modeling of food intake is that it serves to ease

91   social interactions (Hermans, Engels, Larsen, & Herman, 2009; Robinson, Tobias, Shaw,

92   Freeman, & Higgs, 2011; Salvy, Jarrin, Paluch, Irfan, & Pliner, 2007). Hermans et al.

93   (2009) found that participants modeled their dining partner's intake but only in the

94   condition where the partner (a confederate of the experimenter) was acting in an

95   unsociable manner, whereas in the situation where participants were exposed to a friendly

96   confederate, no modeling was observed. Robinson and colleagues (2011) also found that

97   in the presence of a high eating confederate, modeling decreased when participants were

98   primed to feel socially accepted, suggesting that modeling is in part driven by affiliation

99   concerns.

100

101   Most studies on modeling have been conducted with participants who do not know each

102   other (e.g. Goldman et al. 1991; Hermans et al 2009, 2010; for a review see Cruwys et al.

103   this issue) and only a small number of studies have examined modeling among both

104   friends and strangers (Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008; Salvy et al.

105   2007). Research on children aged 5-11 showed that modeling of food intake was

106   extremely high among strangers, but low and not significant among siblings (Salvy et al.,

107   2008). In contrast, Salvy et al. (2007) did not find a difference in the degree of intake

108   modeling in dyads of adult strangers and friends. Howland and colleagues (2012) have

109   reported recently that a low intake norm set by friends resulted in the consumption of

110   fewer cookies, both during a social interaction and immediately after, but the authors did

111   not compare the responses of friends and strangers.

112

113   Our aim here is to further investigate modeling effects in dyads composed of friends

114   versus strangers to shed more light on the role of dyad relationships in modeling effects

115   and provide more insight about possible underlying mechanisms of social modeling. In

116   Study 1, we compared the degree of modeling of food intake in natural dyads of friends

117   and strangers using a free eating paradigm. If modeling of food intake is used as a

118   strategy to gain social approval, then it might be expected that the degree of modeling

119   would differ between friends and strangers because of the greater importance of

120   ingratiation concerns when eating with a stranger than when eating with someone who

121   knows one well (Jones & Pittman, 1982). On the other hand, if modeling is more

122   motivated by concerns about avoiding eating to excess or is the result of behavioural

123   mimicry, then we might expect to see no difference in modeling as a function of

124   familiarity with an eating partner.

125

126   A question that has yet to be investigated is how modeling effects are influenced by the

127   type of food consumed by dyadic partners. In modeling studies, the foods provided have

128   been the same for both partners, but in real eating situations we may consume different

129   foods than our dining companions do and it is unclear whether modeling would occur in

130   this scenario. Although other studies have examined modeling of food choices where a

131   number of foods are available for selection (Hermans et al. 2010; Robinson and Higgs,

132   2013), to our knowledge, there has been no examination of modeling of food intake when

133   participants are provided with one food to consume but this is not the same food as that

134   provided to their partners. If we use the intake of another as a specific guide to

135   appropriate intake, then consumption of different foods should undermine modeling

136   because what your partner eats is a less useful guide if she is eating something different.

137   Alternatively, the food type may matter less if modeling is driven by a general rule about

138   not eating excessively, as suggested in the normative model of eating (Herman et al.

139   2003).

140

141   In Study 2, we examined whether eating the same or different snack food influenced the

142   degree of modeling of food intake in natural dyads of friends who had access to snack

143   food whilst completing a problem solving task. To the best of our knowledge, this is the

144   first study that examines whether food type is an important factor that can influence the

145   levels of modeling of food intake. We hypothesized that the degree of modeling might be

146   stronger between co-eaters who had access to the same food than between co-eaters who

147   had access to different food because in this case the partner's eating would provide both a

148   specific and general cue about appropriate consumption.

149

150   **Study 1**

151   **Materials and methods**

152   Participants

153   One hundred and ten female participants from the University of Birmingham were

154   recruited in exchange for course credit (mean age = 18.8 yrs, s.d. = 1.0). BMI was within

155   the normal range (mean BMI = 22.1 kg/m^2, s.d. = 3.1). We tested only female

156   participants because our sample was taken from a largely female population

157   (undergraduate psychology students). Participants gave informed consent and the study

158   protocol was approved by the University of Birmingham Research Ethics Committee.

159

160   Design

161   The independent variable in the study was whether the dyad was made up of friends or

162   strangers and the dependent variable was the degree of modeling of food intake. To

163   reduce demand characteristics, the study was advertised as research examining mood and

164   social interaction. Participants signed up for sessions online either with a friend or

165   individually. Participants who signed up individually were paired with another participant

166   by the experimenter to form the stranger dyads.

167

168   Snack food

169   Across both conditions, participants had access to the same snack food (chocolate

170   minstrels) during the testing sessions. A bowl of 100g of minstrels was provided to each

171   participant within a dyad (approximately 37 pieces of minstrels; 505 kcal per 100g), so

172   that the bowl was close to being full.

173

174   Measures

175   The relationship between the eating partners was assessed through the use of a social

176   interaction questionnaire [2 questions; ''How well do you know your partner in the

177   study?''(6-point Likert scale, possible answers: I have never seen her before, I recognize

178   her but we have never spoken, We have spoken a few times, We sit together in lectures

179   but do not socialize outside the lectures, We are friends, We live together), ''How

180   comfortable did you feel around your partner?'' (8cm long horizontal scale, anchors;

181   ''Not at all'' and "Extremely")].

182

183   Procedure

184   Sessions took place between 2pm and 6pm on weekdays. When the participants arrived at

185   the reception of the lab facilities, they were greeted by the experimenter and were taken

186   to a room where they were seated at opposite ends of a small table before being asked to

187   complete demographic questionnaires and a mood/appetite questionnaire, the aim of

188   which was to corroborate the cover story and provide a baseline measure of appetite.

189   Mood and appetite items (calm, anxious, excited, upset, tired, hungry, thirsty, stressed)

190   were rated using a 10 cm visual analogue line rating scale (VAS) with "Not at all" and

191   "Extremely" as end anchors and the question "How…do you feel right now?" (centered

192   above the line scale). The experimenter then returned and instructed participants that for

193   the next part of the experiment they were each required to answer a set of questions

194   related to a poster titled "A student's guide to: Being green". A copy of the poster and a

195   question sheet were then provided to each participant and the experimenter asked

196   participants to provide written answers to all the questions and then discuss their answers

197   with each other. Before leaving, the experimenter placed two bowls of chocolate

198   minstrels, one next to each participant, and informed the pair that they could eat during

199   the task if they felt like it. Participants were left for ten minutes to complete the task.

200

201   On completion of the task, the experimenter removed the bowls of minstrels and the

202   participants were asked to complete the same hunger and mood rating scales as described

203   earlier as well as the Three Factor Eating Questionnaire, to check for differences in eating

204   habits between groups (Stunkard & Messick, 1985), and a snack liking scale (8cm long

205   horizontal scale, anchors; "Not at all" and "Extremely"), to check for differences in

206   acceptability of the snacks. Finally, participants were asked to guess the aims of the

207   study, before weight and height were measured using electronic digital scales and a

208   stadiometer to calculate BMI. Intake was measured by weighing and then counting the

209   remaining pieces of minstrels in the separate bowls.

210

211   Analysis

212   To examine overall intradyadic similarity (the degree of modeling of food intake within

213   dyads) intraclass correlation coefficient (ICCs) were used. ICCs were computed using a

214   one-way random model. Fisher r-to-z transformation was used to assess the significance

215   of the difference in the degree of modeling between the two experimental conditions. T-

216   tests were used to examine whether the two experimental groups were matched for

217   hunger ratings at the start of the session (baseline hunger), BMI, age, cognitive

218   disinhibition (TFEQ), cognitive restraint (TFEQ) and Hunger (TFEQ). The mean

219   difference within dyads was calculated for the two experimental conditions. Any

220   differences within the dyads for the liking of the snack foods were also assessed for the

221   two experimental conditions. Statistical significance was set at $p < 0.05$. Data were

222   analyzed using SPSS version 20.0 software (SPSS Inc., Chicago, IL).

223

224   Results

225   Thirty-one pairs of friends and twenty-four pairs of strangers completed the study. Six

226   participants indicated that they had guessed the aims of the experiment and so the data for

227   those dyads were excluded from the final analysis. In total, data from twenty-nine pairs of

228   friends and twenty pairs of strangers were analysed. On average, participants in the

229   friends condition scored 4.23 on the six-point Likert scale for familiarity, whereas

230   participants in the strangers condition scored significantly less 0.45 ($t(54)= -27.67$,

231    $p<0.001$), suggesting that participants in the friend condition knew each other much

232   better than did participants in the stranger condition. In addition, participants in the

233   friends condition reported that they felt significantly more comfortable (7.0 ± 0.9) around

234   their partner during the testing session than did the participants in the strangers condition

235   (5.6 ± 1.2) ($t(88)= - 6.16$, $p<0.001$). Participants in the friends condition consumed on

236   average 32 g of minstrels (s.d.= 23.6) (12 minstrels), whereas participants in the strangers

237   condition consumed significantly less; 18.5 g of minstrels (s.d. = 15.8) (7 minstrels)

238   [$t(96)= -3.1$, $p=0.002$]. Ten participants did not consume any of the snack food. Of these

239   ten participants, seven non-eaters were in the stranger condition and three were in the

240   friend condition.

241

242   Participant characteristics

243   Table 1 shows participant characteristics by experimental condition. These potentially

244   confounding variables did not differ significantly between conditions. Specifically, a t-

245   test showed that the difference between partners was similar across the two experimental

246   conditions for BMI ($t(47)= -0.88$, $p = 0.39$), baseline hunger ($t(40)= 0.39$, $p = 0.70$),

247 restraint (t(47)= 1.84, p = 0.07), disinhibition (t(31)= 0.80 , p = 0.43), hunger (t(47)=

248 1.22, p = 0.23) and liking of the snack food (t(38) = -0.2 , p = 0.84) (see Table 2). The

249 age difference between the eating partners was significantly greater in the stranger

250 condition than the friend condition although the actual difference was less than one year

251 on average (t(23)= 2.42, p = 0.024). Insofar as age similarity is found among friends, it is

252 to be expected that friends who signed up together to take part in the study would be

253 closer in age than would participants who signed up individually and were paired with a

254 stranger.

255

256 Modeling

257 The overall degree of modeling within dyads was high, with an intradyadic correlation of

258 0.86 (df = 49, p < 0.001). In the friends condition (n=29) the correlation was 0.82 (df =

259 29, p < 0.001), whereas in the strangers condition (n=20) the correlation was 0.92 (df =

260 20, p < 0.001). The difference between these two correlations coefficients was not

261 significant (Z = -1.39, p =0.16).

262

263 The presence of a non-eating observer has been reported to have an inhibitory effect on

264 eating and so we re-ran the analysis with and without the non-eaters (Conger et al., 1980).

265 When we removed the non-eaters from the analysis the pattern of the results did not

266 change. The overall degree of modeling within dyads was high, with an intradyadic

267 correlation of 0.82 (df = 43, p < 0.001). In the friends condition (n=27) the correlation

268 was 0.79 (df = 27, p < 0.001), whereas in the strangers condition (n=16) the correlation

269   was 0.89 (df = 16, p < 0.001). The difference between these two correlations coefficients

270   was not significant (Z = -1.02, p =0.31).

271

272

273   **Study 2**

274   **Materials and methods**

275

276   Participants

277   Eighty-two female participants (undergraduate students from the University of

278   Birmingham) were recruited in pairs of friends in exchange for course credit (mean age =

279   19.4 yrs, s.d. = 0.1). BMI was within the normal range (mean BMI = 22.8, s.d. = 2.7).

280   Participants gave informed consent and the study protocol was approved by the

281   University of Birmingham Research Ethics Committee.

282

283   Design

284   A between-participants design was used, with participant pairs randomly assigned to one

285   of two experimental conditions: partner eating the same food versus partner eating a

286   different food. Across both conditions, pairs of friends were tested. Participants were

287   informed that the study was investigating "The effect of food-type on problem solving".

288

289   Snack foods

290   In the same food condition both participants had access to chocolate minstrels during the

291   testing session, whereas in the different food condition one participant had access to

292 chocolate minstrels and the other participant has access to mini-cheddars (a savory

293 snack). The quantity of the snack foods provided was the same across both conditions

294 and did not differ between the minstrels and the mini cheddars (30 items of snack food).

295 The quantity was chosen to permit enough eating in the time frame of the ten minutes that

296 the testing session was planned to last. These snack foods were chosen because they are

297 widely liked and typically eaten as snacks. In addition, they have almost the same energy

298 density (chocolate minstrels: 503 Kcal per 100g, mini-cheddars: 522 kcal per 100g)

299 ensuring that any differences in food intake between the two participants within a pair are

300 not due to differences in the energy density of the provided food items.

301

302 Measures

303 A familiarity questionnaire was administered to ensure that no strangers took part in the

304 study [3 questions included; "How long have you known the other person taking part in

305 the study?" (open question; no answers provided), "How often do you see the other

306 person taking part in the study?'' (Possible answers: Every day, Once a week, Twice a

307 week, Once a month, Occasionally, Rarely) "What is your relationship with the other

308 person taking part in the study?" (Possible answers: Housemate, Close Friend, Friend,

309 Acquaintance, Just go to lectures with them, Strangers)].

310

311 Procedure

312 Sessions took place between 10 am and 12 pm or 2 pm and 4 pm, when snack foods are

313 typically eaten. Both participants were met in the reception of the lab facilities by the

314 experimenter and were accompanied to two different rooms where they were asked to

315   read an information sheet about the study. After reading the information sheet and

316   completing demographics, participants completed the hunger rating scale and a set of 3

317   rating scales assessing mood e.g. "how relaxed do you feel right now" as a cover for the

318   aims of the study (100mm horizontal scale, anchors; "Not at all" and "Extremely").

319

320   Participants were then informed that they would complete the problem-solving task (the

321   game called hangman) together and were led into a testing room with a desk and two

322   chairs either side of the table to create a comfortable environment. Participants received

323   instructions for the game and the experimenter also explained that this is a paper and

324   pencil word guessing game in which one player tries to work out a word by guessing

325   individual letters one at a time. Each participant in the dyad was given ten celebrity

326   names, for example "Jennifer Aniston", a pen and a sheet of A4 paper to write on and

327   they were then informed that they had ten minutes to play as many games as they liked.

328   The experimenter then left two bowls of the snack foods (one in front of each participant)

329   in reaching distance only to that individual to avoid sharing. Each bowl was pre-weighed

330   and contained 30 items of the snack food (either chocolate minstrels or mini-cheddars) so

331   that the bowl was close to being full. Before leaving, the experimenter told the participant

332   that if she felt like eating any she should feel free to do so from her own bowl.

333

334   After ten minutes the experimenter returned to the testing room and removed the

335   hangman materials and the bowls. The intake of each participant was calculated by

336   weighing the remaining snack food in their bowl. Participants were then again taken to

337   separate rooms to complete the hunger and mood rating scales as described earlier. At

338   this point, participants were also asked to complete the Three Factor Eating

339   Questionnaire (Stunkard & Messick, 1985), ratings of the palatability of the snack foods

340   (5 possible responses on a Likert scale; 1 = disagree strongly, 2 = disagree somewhat, 3 =

341   neutral, 4 = agree somewhat, 5 = agree strongly) and the familiarity questionnaire. They

342   were then asked separately what they believed the purpose of the experiment was.

343   Finally, weight and height were measured, using electronic digital scales and a

344   stadiometer to calculate BMI (kg/m^2).

345

346   **Analysis**

347   To examine overall intradyadic similarity (the degree of modeling of food intake within

348   dyads) intraclass correlation coefficient (ICC's) were used. ICCs were computed using a

349   one-way random model. Fisher r-to-z transformation was used to assess the significance

350   of the difference in the degree of modeling between the two experimental conditions. t-

351   tests were used to examine whether the two experimental groups were matched for

352   hunger ratings at the start of the session (baseline hunger), BMI, age, cognitive

353   disinhibition (TFEQ), cognitive restraint (TFEQ) and Hunger (TFEQ). The mean

354   difference within dyads was also calculated for the two experimental conditions.

355   Statistical significance was set at $p<0.05$. Data were analyzed using SPSS version 20.0

356   software (SPSS Inc., Chicago, IL).

357   **Results**

358   On average, participants answered that they had known their eating partner for almost 1

359   year (s.d. = 0.9). 85.4% of the participants reported that they see their eating partner on a

360   daily basis and 14.6% once or twice a week. None of the participants reported any other

361   of the possible answers (once a month, occasionally, rarely). 61% of the participants

362   characterized their eating partner as a close friend, 33% as an acquaintance and 6%

363   reported that their eating partner was a housemate. On average, participants ate 8 food

364   items (s.d.= 5.8) in the same snack food condition and 10 food items (s.d. = 7.1) in the

365   different snack food condition. Six participants did not consume any of the snack food.

366   Of these six participants, three non-eaters belonged to the same snack food condition and

367   three to the different snack food condition.

368

369   Participant characteristics

370   Table 3 shows participant characteristics by experimental condition. These potentially

371   confounding variables did not differ significantly between conditions. Specifically, a t-

372   test showed that the difference between partners was similar across the two experimental

373   conditions for BMI ($t(39)$= -0.1, $p = 0.91$), age ($t(39)$= -1.4, $p = 0.16$), baseline hunger

374   ($t(39)$= 1.8, $p = 0.08$), restraint ($t(39)$= 0.75, $p = 0.46$), disinhibition ($t(39)$= -0.42, $p =$

375   0.68) and hunger ($t(39)$= -1.4, $p = 0.18$) (see Table 4). Participants' palatability ratings of

376   the snack foods differed more in the different snack food condition that in the same snack

377   food condition ($t(39) = -2.2, p = 0.04$).

378

379

380

381

382

383

384

385

386

387 Modeling

388 The overall degree of modeling within dyads was moderate, with an intradyadic

389 correlation of 0.67 (df = 41, p < 0.001). In the same snack food condition (n=19) the

390 correlation was 0.52, which was only marginally significant (df = 19, p = 0.063), whereas

391 in the different snack food condition (n=22) the correlation was 0.74 (df = 22, p = 0.002).

392 The difference between these two correlation coefficients was not significant (Z = -1.1, p

393 = 0.27).

394

395 When we removed the non-eaters from the analysis the pattern of the results did not

396 change. However, the intradyadic correlation in the same snack food condition (n=16)

397 became significant (r = 0.58, df = 16, p = 0.047). The overall degree of modeling within

398 dyads remained moderate, with an intradyadic correlation of 0.66 (df = 35, p = 0.001). In

399 the different food condition (n=19) the correlation was 0.67 (df = 19, p = 0.010). The

400 difference between the degree of modeling in the two experimental conditions was not

401 significant (Z = -0.4, p =0.69).

402

403 **Discussion**

404 Studies on social modeling of food intake have shown consistently that individuals tend

405 to eat more when others eat more and eat less when others eat less (Herman et al., 2003).

406 The aim of the present study was to investigate whether the type of relationship between

407   co-eaters and the type of food consumed affects modeling. We found that young women

408   modeled the food intake of their eating companion whether the companion was a friend

409   or a stranger and whether that companion was eating the same or a different snack food.

410   These findings are in agreement with the results of the other similar studies and taken

411   together the data suggest that modeling of food intake is a robust phenomenon (Herman,

412   Koenig-Nobert, Peterson, & Polivy, 2005; Herman et al., 2003; Robinson et al., 2011;

413   Rosenthal & Marx, 1979; Rosenthal & McSweeney, 1979).

414

415   In Study 1, we found similar modeling effects regardless of whether the dyadic partners

416   were familiar with each other or not. This result cannot be explained by the fact that we

417   failed to recruit friends versus strangers, because the friend dyads were significantly more

418   familiar with each other than were the stranger dyads. The groups were also matched on

419   other characteristics and so it is also unlikely that factors such as age, BMI, dietary

420   restraint and hunger masked any differences between the groups. However, we note that

421   recruitment was different for friends and strangers. Friends signed up together in pairs,

422   whereas strangers were paired by the experimenter. As a result of the recruitment process

423   there could have been differences in the psychological characteristics of the dyads of

424   friends and strangers that we did not assess, and these factors might have had a

425   significant influence on modeling. For example, participants who signed up alone

426   (strangers) might have been less concerned about impression management than

427   participants who signed up in pairs (friends). It is possible that had we been able to

428   randomly allocate participants to the friends versus strangers condition, differences

429   between the two groups in modeling might have emerged. Although modeling effects

430   have been reported to be stronger in siblings versus strangers, other studies have found

431   similarly strong modeling in both friends and strangers (Salvy et al. 2007).

432

433   The lack of difference between the friends and strangers in modeling might be taken to

434   suggest that affiliation concerns are not a main driver of modeling effects because

435   affiliation concerns would be expected to be greater for strangers than for friends (Jones

436   & Pittman, 1982). Our present results might suggest that processes such as behavioural

437   synchronization play a more important role in social modeling of food intake than do

438   affiliation concerns. Perhaps the participants were mirroring each other's eating actions

439   because observation of these actions triggered activation in the motor neuron system of

440   the observer and facilitated imitative behavior (Iacoboni et al. 1999; Rizzolatti &

441   Craighero 2004). However, it is also likely that there was a degree of uncertainty about

442   how much to eat in the experimental situation and so all participants, friends and

443   strangers, looked to each other as a guide for appropriate eating (Herman et al. 2003).

444

445   In Study 2, modeling of food intake was found in the overall sample, which confirms that

446   modeling is a robust phenomenon even among friends. However, no significant

447   difference in the degree of modeling was found between eating companions who had

448   access to the same type of snack food and those who had access to different snack foods.

449   This result suggests that participants may use the eating of a partner as a general guide for

450   appropriate eating even when the foods are not the same. These data are also consistent

451   with the idea that the main motive in these eating situations is to avoid appearing to eat

452   excessively rather than modeling the amount eaten of a specific food type (Herman et al.

453   2003). Modeling could arise if there is uncertainty about the appropriate portion size for

454   a particular food. In this case, modeling should be specific to a food type. However, it

455   may be that underlying modeling is a more general concern about not appearing to eat to

456   excess, in which case, regardless of the food type, a person may follow a general eating

457   norm that is set by their eating companion (e.g. consumption of a certain proportion of a

458   serving of food or not having a second helping). Taken together, the results of Study 1

459   and Study 2 are supportive of the normative model of eating (Herman et al. 2003)

460

461   The finding that modeling effects are robust among friends suggests that they may occur

462   in friendship groups outside of the lab, thus offering a mechanism for how friendship

463   networks might influence weight (Christakis & Fowler, 2007). This suggests that

464   modeling of healthy eating could be target for intervention to improve dietary habits even

465   in groups of people known to each such as families and peers (Bevelander et al., 2012,

466   2013).

467

468   Some limitations of the present study should be noted. We assessed modeling in young

469   women from the same social group in a setting involving completion of a secondary task,

470   the purpose of which was to disguise the aims of the study. It would be informative to

471   examine modeling effects in a wider range of participant groups and settings. In addition,

472   it is possible that modeling effects are strong but variations in modeling due to factors

473   such as familiarity with one's dining companion and the food types eaten are weak and

474   much larger sample sizes are required to detect significant effects. Although the existing

475   evidence does not support modeling of food intake in males (Salvy et al. 2007; Hermans,

476 Herman, Larsen, and Engels 2010) the reasons for this are unclear. Men may have a

477 greater drive for distinctiveness than women, which leads to nonconformity in eating

478 (Cross & Madson, 1997). On the other hand, it might be that women may possess greater

479 interests in facilitating positive social bonds than do men (Eagly & Carlie 1981). The

480 foods used in Study 2 were both high energy dense snack foods and so we cannot rule out

481 that less modeling would have occurred if participants were consuming very different

482 food types e.g. high versus low energy dense items. It would be interesting for future

483 studies to investigate whether individuals match their co-eater's food intake by choosing

484 to consume the same type of food as their partner or whether it is the total amount of food

485 consumed that is matched between eating partners. Future studies might benefit from

486 using a modeling paradigm to examine social influence on food intake from a buffet,

487 rather than from a single snack food. If modeling effects for fruit and vegetables are

488 found to be as strong as modeling effects for energy-dense snacks, then new interventions

489 could be developed to promote their consumption.

490

491 In conclusion, modeling of food intake was found across two studies. The fact that

492 modeling was observed for both friends and strangers and regardless of the type of food

493 that was available for consumption adds to the literature suggesting that it is a robust

494 phenomenon.

495

496

497

498 **Acknowledgements**

502

503

504   **References**

505

506   Bevelander, K. E., Anschütz, D. J., & Engels, R. C. M. E. (2012). Social norms in food
507   intake among normal weight and overweight children. Appetite, 58(3), 864–72.
508   doi:10.1016/j.appet.2012.02.003
509   Bevelander, K. E., Engels, R. C. M. E., Anschütz, D. J., & Wansink, B. (2013). The
510   effect of an intervention on schoolchildren's susceptibility to a peer's candy intake.
511   European Journal of Clinical Nutrition, 67(8), 829–35. doi:10.1038/ejcn.2013.122
512   Chartrand, T. L., & van Baaren, R. (2009). Human mimicry. Advances in experimental
513   social psychology, 41, 219-274.
514   Christakis, N. A., & Fowler, J. H. (2007). The spread of obesity in a large social network
515   over 32 years. The New England Journal of Medicine, 357, 370–379.
516   Clendenen, V. I., Herman, C. P., & Polivy, J. (1994). Social facilitation of eating among
517   friends and strangers. Appetite, 23(1), 1-13. doi: 10.1006/appe.1994.1030
518   Conger, J. C., Conger, A. J., Costanzo, P. R., Wright, K. L., & Matter, L. A.
519   (1980). The effect of social cues on the eating behavior of obese and
520   normal subjects. Journal of Personality, 48, 258–271.
521   Cook R, Bird G, Lunser G, Huck, Heyes C. Automatic imitation in a strategic context:
522   players of rock-scissors imitate opponents' gestures. Proc R Soc B 2011;
523   doi:10.1098/rspb.2011.1024.
524   Cross, S. E., & Madson, L. (1997). Models of the self: self-construals and
525   gender. Psychological bulletin, 122(1), 5.
526   Dijksterhuis, A., & Bargh, J. A. (2001). The perception-behavior expressway: Automatic
527   effects of social perception on social behavior. Advances in experimental social
528   psychology, 33, 1-40.
529   Eagly, A. H., & Carli, L. L. (1981). Sex of researchers and sex-typed communications as
530   determinants of sex differences in influenceability: a meta-analysis of social
531   influence studies. Psychological Bulletin, 90(1), 1.
532   Goldman SJ, Herman CP, Polivy J. Is the effect of a social model attenuated by hunger?
533   Appetite;17:129–140.
534   Herman, C. P., Koenig-Nobert, S., Peterson, J. B., & Polivy, J. (2005). Matching effects
535   on eating: do individual differences make a difference? Appetite, 45(2), 108-109.
536   doi: 10.1016/j.appet.2005.03.013
537   Herman, C. P., Roth, D. A., & Polivy, J. (2003). Effects of the presence of others on food
538   intake: a normative interpretation. Psychol Bull, 129(6), 873-886. doi:
539   10.1037/0033-2909.129.6.873

540   Hermans, R. C., Engels, R. C., Larsen, J. K., & Herman, C. P. (2009). Modeling of
541   palatable food intake. The influence of quality of social interaction. Appetite,
542   52(3), 801-804.
543   Hermans, R. C., Herman, C. P., Larsen, J. K., & Engels, R. C. (2010a). Social modeling
544   effects on young women's breakfast intake. Journal of the American Dietetic
545   Association, 110(12), 1901-1905.
546   Hermans, R. C., Herman, C. P., Larsen, J. K., & Engels, R. C. (2010b). Social modeling
547   effects on snack intake among young men. The role of hunger.Appetite, 54(2),
548   378-383.
549   Hermans R, Lichtwarck-Aschoff A, Bevelander KE, Herman PC, Larsen JK, Engels
550   CME. Mimicry of food intake: the dynamic interplay between eating companions.
551   Plos One 2012;7: e31027.
552   Higgs, S. (2005). Memory and its role in appetite regulation. Physiology &
553   behavior, 85(1), 67-72.
554   Howland, M., Hunger, J. M., & Mann, T. (2012). Friends don't let friends eat cookies:
555   Effects of restrictive eating norms on consumption among friends.Appetite, 59(2),
556   505-509.
557   Iacoboni M, Woods RP, Brass M, Bekkering H, Mazziotta JC, Rizzolatti G. Cortical
558   mechanisms of human imitation. Science 1999;286:2526-2528.
559   Jones, E. E., & Pittman, T. S. (1982). Toward a general theory of strategic self-
560   presentation. In J. Suls (Ed.), Psychological perspectives on the self, Vol. 1 (pp.
561   231–262). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
562   Lakin, J. L., & Chartrand, T. L. (2003). Using nonconscious behavioral mimicry to create
563   affiliation and rapport. Psychological science, 14(4), 334-339.
564   Leone, T., Pliner, P., & Peter Herman, C. (2007). Influence of clear versus ambiguous
565   normative information on food intake. Appetite, 49(1), 58-65.
566   Rizzolatti G, Craighero L. The mirror-neuron system. Annual Rev Neurosci
567   2004;27:169-162.
568   Robinson, E., Tobias, T., Shaw, L., Freeman, E., & Higgs, S. (2011). Social matching of
569   food intake and the need for social acceptance. Appetite, 56(3), 747-752.
570   Robinson, E.L. and Higgs, S. (2013). Food Choices in the Presence of "Healthy" and
571   "Unhealthy" Eating Partners. British Journal of Nutrition, 109, 765-771.Robinson,
572   E., Blissett, J., & Higgs, S. (2013). Social influences on eating: implications for
573   nutritional interventions. Nutrition research reviews, 26(2), 166
574   Rosenthal, B., & Marx, R. D. (1979). Modeling influences on the eating behavior of
575   successful and unsuccessful dieters and untreated normal weight individuals.
576   Addict Behav, 4(3), 215-221.
577   Rosenthal, B., & McSweeney, F. K. (1979). Modeling influences on eating behavior.
578   Addict Behav, 4(3), 205-214.
579   Salvy, S. J., Vartanian, L. R., Coelho, J. S., Jarrin, D., & Pliner, P. P. (2008). The role of
580   familiarity on modeling of eating and food consumption in children. Appetite,
581   50(2-3), 514-518. doi: 10.1016/j.appet.2007.10.009
582   Salvy, S.-J., Jarrin, D., Paluch, R., Irfan, N., & Pliner, P. (2007). Effects of social
583   influence on eating in couples, friends and strangers. Appetite, 49(1), 92-99.

584 Stunkard, A.J., & Messick, S.(1985). The Three Factor Eating Questionnaire to measure
585   dietary restraint, disinhibition and hunger. Journal of Psychometric Research, 29,
586   71-84.
587 Vartanian, L. R., Herman, C. P., & Polivy, J. (2007). Consumption stereotypes and
588   impression management: How you are what you eat. Appetite, 48(3), 265-277.
589 Vartanian, L. R., Herman, C. P., & Wansink, B. (2008). Are we aware of the external
590   factors that influence our food intake? Health Psychol, 27(5), 533-538. doi:
591   10.1037/0278-6133.27.5.533
592 Vartanian, L. R., Sokol, N., Herman, C. P., & Polivy, J. (2013). Social Models Provide a
593   Norm of Appropriate Food Intake for Young Women. PloS one, 8(11), e79268.

594

595 **Table 1** Participant characteristics by experimental condition

	Friends condition (n=29)	Strangers condition (n=20)
	Mean ± Standard Deviation	Mean ± Standard Deviation
BMI (kg/m^2)	22.0 ± 3.0	21.9 ± 3.2
Age (years)	18.6 ± 0.8	18.9 ± 1.1
Baseline hunger (0-8cm scale)	3.7 ± 1.7	3.2 ± 2.2
Restraint (TFEQ) (0-21 scale)	8.3 ± 5.8	8.8 ± 5.7
Disinhibition (TFEQ) (0-16 scale)	6.9 ± 2.9	7.9 ± 3.3
Hunger (TFEQ) (0-14 scale)	6.5 ± 3.2	7.8 ± 3.7
Liking of snack food (0-8cm scale)	6.3 ± 1.5	5.9 ± 1.8

596

597

598

599

600 **Table 2** Mean differences within dyads concerning potential confounding factors:

601 Comparison between the two experimental conditions

	Friends condition (n=29)	Strangers condition (n=20)
	Mean Difference within dyads ± Standard Deviation	Mean Difference within dyads ± Standard Deviation
BMI (kg/m^2)		

	3.5 ± 3.1	2.7 ± 2.8
Age (years)	0.2 ± 0.4	0.8 ±1.0*
Baseline hunger (0-8cm scale)	1.9 ± 1.2	2.0 ± 1.2
Restraint (TFEQ) (0-21 scale)	4.8 ± 4.5	7.3 ± 5.2
Disinhibition (TFEQ) (0-16 scale)	3.5 ± 2.2	4.2 ± 3.3
Hunger (TFEQ) (0-14 scale)	2.7 ± 2.4	3.7 ± 2.9
Liking of snack food (0-8cm scale)	1.3 ± 1.1	1.2 ± 1.2

602 * Indicates significant difference between the two experimental conditions

603

604

605

606 **Table 3** Participant characteristics by experimental condition

	Same snack food condition (n=19)	Different snack food condition (n=22)
	Mean ± Standard Deviation	Mean ± Standard Deviation
BMI (kg/m^2)	22.1 ± 2.7	22.6 ± 3.7
Age (years)	19.2 ± 1.0	19.5 ± 1.0
Baseline hunger (0-100mm scale)	39.9 ± 27.5	38.8 ± 24.8
Restraint (TFEQ) (0-21 scale)	9.6 ± 6.3	7.9 ± 5.2
Disinhibition (TFEQ) (0-16 scale)	5.9 ± 2.8	6.7 ± 3.4
Hunger (TFEQ) (0-14 scale)	5.6 ± 2.8	6.3 ± 3.5
Palatability of snack food (1-5 Likert scale)	4.1 ± 0.6	4.1 ± 0.8
Familiarity (years)	0.8± 0.8	1.1± 1.0

607

608 **Table 4** Mean differences within dyads concerning potential confounding factors:

609 Comparison between the two experimental conditions

	Same snack food condition (n=19)	Different snack food condition (n=22)
	Mean Difference within dyads ±	Mean Difference within dyads ±

	Standard Deviation	Standard Deviation
BMI (kg/m^2)	3.3 ± 2.5	3.4 ± 3.2
Age (years)	0.4 ± 0.5	0.7 ± 0.6
Baseline hunger (0-100mm scale)	33.5 ± 23.5	22.0 ± 17.4
Restraint (TFEQ) (0-21 scale)	7.1 ± 5.4	6.0 ± 4.4
Disinhibition (TFEQ) (0-16 scale)	3.5 ± 2.8	3.9 ± 3.0
Hunger (TFEQ) (0-14 scale)	2.9 ± 2.1	4.0 ± 3.1
Palatability of snack food (1-5 Likert scale)	0.6 ± 0.6 *	1.1 ± 0.8 *

610   * Indicates significant difference between the two experimental conditions

611

612