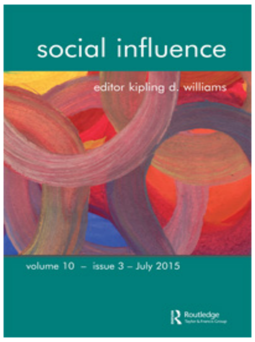

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Modeling of food intake: a meta-analytic review

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This meta-analysis provides a comprehensive quantitative assessment of research on modeling of food intake. Thirty-eight articles met inclusion criteria. Overall, there was a large modeling effect ($r = .39$) such that participants ate more when their companion ate more, and ate less when their companion ate less. Furthermore, social models appear to have stronger inhibitory effects than augmenting effects. Moderator analyses indicated that there were larger effects for correlational versus experimental studies, and for women versus men. There was no difference in effect sizes for studies using a live versus remote confederate, or for participants who were high or low in concern with eating appropriately. Together, these findings point to modeling as a robust and powerful influence on food intake.

Keywords: modeling; food intake; social influence; meta-analysis

Imagine that you are meeting a friend for lunch at a restaurant. You both order the daily special and, when the food arrives, your friend eats almost everything on her plate. The next day, you go for lunch at the same restaurant with another friend who eats almost nothing. How much would you eat in each of those situations? Although factors such as how hungry you are and how much you like the taste of the food will almost certainly play a role, considerable evidence suggests that how much your companion eats will also play an important role in determining how much you eat. In social situations, one's eating behavior can be influenced by the behavior of others in a variety of ways (see Herman, Roth, & Polivy, 2003, for a review). For example, social-facilitation research finds that people tend to eat more in larger groups than when eating alone (de Castro & Brewer, 1992; Herman, 2015), whereas the impression-management literature indicates that people can use their eating behavior to convey a particular impression of themselves to others (Vartanian, 2015; Vartanian, Herman, & Polivy, 2007). One of the most powerful social influences on food intake is modeling: people adjust their food intake to that of their eating companion, eating a little when their companion eats a little, and eating more when their companion eats more.

According to the normative account of food intake, modeling occurs because other people provide information about the appropriate amount of food to consume in a given situation (Herman et al., 2003). This account follows from the fact that, in social situations, the appropriate amount to eat is often ambiguous, and internal signals (i.e., hunger and satiety) that one would expect to help guide food intake are often unreliable (Herman & Polivy, 2005). Thus, in these situations, people may look to the example of others to help them decide how much food is appropriate to consume. More specifically, Herman et al. (2003) argued that people are often motivated to maximize their intake of palatable foods

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without appearing to eat excessively, with "excess" defined as eating more than what others are eating. Thus, a companion who eats very little can inhibit one's own food intake whereas a companion who eats a large amount can augment one's own food intake (or at least give one permission to eat an equally large amount). Support for the normative account of modeling comes from recent research showing that perceived norms of appropriate food intake mediate the influence of social models on food intake (Vartanian, Sokol, Herman, & Polivy, 2013). Such a normative account has also been used by some researchers to explain the spread of obesity in social networks (e.g., Christakis & Fowler, 2007).

One of the most notable features of the modeling of food intake is how robust the effect appears to be. Modeling is observed with unhealthy snack foods (Vartanian et al., 2013) and healthy snack foods (Hermans, Larsen, Herman & Engels, 2009), and also during meals (Hermans, Larsen, Herman, & Engels, 2012). Modeling occurs among people who have been food deprived for up to 24 hours (Goldman, Herman, & Polivy, 1991), among children (Bevelander, Anschütz, & Engels, 2012), and independent of individual differences in body weight (Rosenthal & McSweeney, 1979) and dietary restraint (Roth, Herman, Polivy, & Pliner, 2001). Modeling persists even when the other person is not physically present and participants are exposed only to a written indication of the amount of food eaten by supposed prior participants (a "remote" confederate; Roth et al., 2001; Vartanian et al., 2013); indeed, Feeney, Polivy, Pliner, and Sullivan (2011) found no difference in the strength of modeling whether the model was a live confederate or a remote confederate.

Researchers have also examined a variety of individual difference and contextual factors that should enhance or limit the extent to which people model the food intake of others. For example, individuals who are high in trait empathy (Robinson, Tobias, Shaw, Freeman, & Higgs, 2011) appear to model the behavior of their eating companion to a greater extent, as do individuals high in expressiveness (Brunner, 2012), but individuals high in extraversion or high in self-monitoring do not differ in the extent to which they model another person's food intake (Herman, Koenig-Nobert, Peterson, & Polivy, 2005). Furthermore, modeling tends to be stronger when the person's eating companion is an in-group member (Cruwys et al., 2012) and when the experimental confederate is lean (as opposed to obese; e.g., McFerran, Dahl, Fitzsimons, & Morales, 2010). Examining moderators of modeling is important in order to elucidate any possible boundary conditions of the effect.

The purpose of the present meta-analysis is to quantify the effects of social models on people's food intake. Herman et al. (2003) provided a qualitative review of social influences on food intake, but the literature was in its relative infancy at the time. Since then, there has been a proliferation of research on the modeling of food intake, and there is thus a critical mass of research allowing for a quantitative analysis of modeling effects. One recent meta-analysis (Robinson, Thomas, Aveyard, & Higgs, 2014) examined the impact of social norms on food choice and eating behavior and found that social norms exerted a moderate effect on the eating outcomes. However, that review was limited by the inclusion of only a small number of experimental studies (only eight studies that examined actual food intake), and the authors were unable to quantitatively assess any moderators of the modeling effect. Thus, we sought to provide a more comprehensive assessment of the effects of social models on the amount of food that people eat. Furthermore, we sought to develop a better understanding of the moderators of modeling effects by examining variation as a function of experimental design (correlational vs. experimental studies), as well as characteristics of the participant, characteristics of the model, characteristics of the eating context, and factors that might influence the extent of people's concern with eating appropriately. Doing so will not only provide a clearer picture of how, when, and why social models influence people's food intake, but should also provide direction for future research aimed at filling the gaps in the existing knowledge base.

Method

Literature search strategy

The literature search involved a multi-step process and was completed in August 2014. First, we searched three electronic databases (Scopus, PsycInfo, and Web of Science) for articles published through the end of 2013 to identify studies containing the terms *eating*, *food intake*, *consumption*, *ingestion*, and *food choice* in combination with *modeling*, *social influence*, *peer influence*, *matching*, and *confederate*. Second, the reference section of each retrieved article was searched to identify potentially relevant articles that were missed in the initial searches. Third, citations to the retrieved articles were searched to identify any recent relevant articles. Fourth, the electronic databases indicated above were further searched using the names of the first author, last author, and corresponding author of each eligible study. Fifth, the table of contents of key journals in the area (*Appetite*, *Eating Behaviors*, *Physiology & Behavior*, *Health Psychology*) were searched for any relevant articles that might have been missed through the other search steps.

The search process identified 110 articles which were then retrieved and reviewed in detail by two independent judges (the first and second author) to determine their eligibility for inclusion in this study. Note that, although the terms "modeling" and "matching" are often used interchangeably in the literature, we suggest that the term "matching" should refer specifically to the extent to which Person A eats an *identical amount* to Person B, whereas the term "modeling" should refer more generally to the process of adjusting one's intake upward or downward in line with the intake of one's eating companion (see also Spanos, Vartanian, Herman, & Polivy, 2014). In this article, we focus on modeling (i.e., studies that assess the correlation between the amounts eaten by individuals, or studies that examine how a confederate's intake affects participants' intake). Inclusion criteria for the current meta-analysis were as follows: (1) the article must have been published in English (1 article excluded); (2) the study must have measured the amount of food consumed by participants (as opposed to food choice, self-reported food intake, behavioral intentions, or other such measures; 28 articles excluded); and (3) for experimental studies, the study must involve at least two norm conditions (i.e., at least two of the following: low-intake model, high-intake model, no-intake model, or eat-alone/no-norm condition) and the norm conditions must specify the amount eaten by the confederates (10 articles excluded). Other reasons for excluding articles were that they were not modeling studies (e.g., social facilitation studies; 15 articles excluded), were only abstracts without sufficient information to code (9 articles excluded), were theoretical review papers (8 articles excluded), or duplicated a sample from another study (1 article excluded). A total of 38 articles (representing 44 separate studies and 67 independent effects) met the inclusion criteria and were included in the meta-analysis.

Effect size coding

We calculated effect sizes as *r*-values from the information available in the published reports, including means and standard deviations, correlation coefficients or intraclass correlations, *F*-values, and *p*-values. For experimental studies in which means for more than two groups were reported (e.g., low-intake norm, high-intake norm, and a control condition), we used the formulas for one-way contrasts described by Rosenthal, Rosnow, and Rubin (2000) to calculate an overall effect size. In each case, we ordered the norm conditions as follows (from lowest to highest): no-intake confederate, low-intake confederate, eat-alone control, and high-intake confederate. For studies that did not provide sufficient information to calculate precise effect sizes, we contacted the authors to obtain additional information (when possible), or used a conservative estimate of effect sizes. For example, effects described as "significant" were assigned a *p*-value of .05, and effects described as "non-significant" were assigned a *p*-value of .99. This conservative effect-size estimate was used in only two cases and allowed us to include as many studies as possible in the meta-analysis without potentially exaggerating any observed effects. Effect sizes were weighted by sample size. We interpreted an effect size of .10 as small, .25 as medium, and .40 or above as large (Lipsey & Wilson, 2001).

Meta-analytic procedures

To determine the magnitude and significance of the overall effect size, we fit a random-effects model. In contrast to a fixed-effects approach, which assumes that individual effect sizes differ from the population mean through sampling error alone, a random-effects approach assumes that variability among effect sizes is due to sampling error as well as unsystematic, random sources of error that vary across studies. Random-effects models are also more conservative and have substantially reduced Type 1 error rates compared to fixed-effects models (Field, 2003; Lipsey & Wilson, 2001), and allow for inferences to be drawn beyond the studies included in the meta-analysis (Field & Gillett, 2010).

The primary analysis was an examination of the overall modeling effect across all studies. Because there is considerable variability in the research design used in modeling studies, we also tested whether mean effect sizes differed for experimental studies (those in which the amount eaten by the model is determined by the experimenter) and correlational studies (in which the researchers simply calculated the degree of correspondence between the amounts eaten by two members of a dyad). For this analysis, we excluded no-norm (eat alone) control conditions from the experimental studies because there is no equivalent in correlational studies (the results are identical if the eat-alone condition is included). Furthermore, past theory and research suggests that social models might have an inhibiting effect more than they have an augmenting effect (Herman et al., 2003; Vartanian et al., 2013); we therefore computed the mean effect size separately for low-norm conditions versus no-norm/eat-alone control conditions, and for no-norm/eat-alone control conditions versus high-intake conditions.

The potential for publication bias was assessed by calculating Orwin's fail-safe *N* (the number of studies with a correlation of $r = .00$ that would need to be added to the meta-analysis to bring the overall effect size to a negligible level, defined as $r = .05$ in this case; Orwin, 1983). The fail-safe *N* was 451 studies, suggesting that these effects are robust to the so-called file-drawer problem.

Moderators

In addition to determining the overall effect size, we also evaluated the degree of heterogeneity in effect-size distribution by calculating the *Q* statistic, and followed up a significant *Q* statistic with a series of moderator analyses. Moderators were coded by two independent coders with any discrepancies resolved through discussion with the first author. The moderator coding for each study is displayed in Table 1.

Table 1. Study characteristics for each moderator included in the meta-analysis.

			Participant		Model			Eating context		
Authors	Year	Design	Gender	Age	Type	Weight status	Familiarity	Food type	Task type	Concern
Addessi, Galloway, Visalberghi, and Birch	2005	Exp.	Mixed	Children	Live	–	Familiar	Snack	Eating	–
Bevelander, Anschütz et al.	2013	Exp.	Mixed	Children	Remote	–	Unfamiliar	Snack	Non-eating	DNC
Bevelander et al.	2012	Exp.	Mixed	Children	Live	–	Unfamiliar	Snack	Non-eating	–
Bevelander, Meiselman, Anschütz, and, Engels	2013	Exp.	Mixed	Children	Live	–	Unfamiliar	Snack	Non-eating	–
Brunner	2010; Study 1	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Eating	–
Brunner	2010; Study 2	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Eating	–
Brunner	2012	Corr.	Female	Adults	–	–	Unfamiliar	Snack	Non-eating	L: Low expressive H: High expressive
Conger, Conger, Costanzo, Wright, and Matter	1980	Exp.	Mixed	Adults	Live	–	Unfamiliar	Snack	Eating	–
Cruwys et al.	2012	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Non-eating	L: Out-group H: In-group
Feeney et al.	2011	Exp.	Female	Adults	Live Remote	–	Unfamiliar	Meal	Non-eating	–
Florack, Palcu, and Friese	2013; Study 1	Exp.	Mixed	Adults	Live	–	Unfamiliar	Snack	Non-eating	–
Florack et al.	2013; Study 2	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	–
Goldman et al.	1991; Exp. 1	Exp.	Female	Adults	Live	–	Unfamiliar	Meal	Eating	–
Goldman et al.	1991; Exp. 2	Exp.	Female	Adults	Live	–	Unfamiliar	Meal	Eating	–
Herman et al.	2005	Corr.	Female	Adults	–	–	Unfamiliar	Snack	Non-eating	L: Low extraversion H: High extraversion
Hermans, Engels, Larsen, and Herman	2009	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Non-eating	L: Unsociable model H: Sociable model

(*Continued*)

Table 1 – *continued*

			Participant		Model			Eating context		
Authors	Year	Design	Gender	Age	Type	Weight status	Familiarity	Food type	Task type	Concern
Hermans, Herman, Larsen, and Engels	2010a	Exp.	Male	Adults	Live	–	Unfamiliar	Snack	Non-eating	–
Hermans, Herman, Larsen, and Engels	2010b	Exp.	Female	Adults	Live	–	Unfamiliar	Meal	Non-eating	–
Hermans et al.	2008	Exp.	Female	Adults	Live	Thin Normal	Unfamiliar	Snack	Non-eating	–
Hermans, Larsen, et al.	2009	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Non-eating	–
Hermans, Larsen, et al.	2012	Exp.	Female	Adults	Live	–	Unfamiliar	Meal	Non-eating	–
Hermans et al.	2013	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Non-eating	L: Low impulsivity H: High impulsivity
Hermans, Salvy, et al.	2012; Exp. 2	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Non-eating	–
Howland, Hunger, and Mann	2012; Study 2	Exp.	Mixed	Adults	Live	–	Familiar	Snack	Non-eating	–
Johnston	2002; Exp. 1	Exp.	Female	Adults	Live	Normal Obese	Unfamiliar	Snack	Eating	–
McFerran et al.	2010; Exp. 1	Exp.	Female	Adults	Live	DNC	Unfamiliar	Snack	Non-eating	–
McFerran et al.	2010; Exp. 2	Exp.	Female	Adults	Live	Thin Obese	Unfamiliar	Snack	Non-eating	–
Nisbett and Storms	1974; Exp. 1	Exp.	Male	Adults	Live	–	Unfamiliar	Snack	Eating	–
Pliner and Mann	2004; Exp. 1	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	–
Polivy, Herman, Younger, and Erskine	1979	Exp.	Female	Adults	Live	–	Unfamiliar	Meal	Eating	–
Robinson et al.	2013	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	L: Low empathy H: High empathy
Robinson et al.	2011; Study 1	Corr.	Female	Adults	–	–	Unfamiliar	Snack	Non-eating	L: Low empathy H: High empathy
Romero, Epstein, and Salvy	2009	Exp.	Female	Children	Remote	–	Unfamiliar	Snack	Non-eating	–
Rosenthal and McSweeny	1979; Exp. 2	Exp.	Male Female	Adults	Live	–	Unfamiliar	Snack	Eating	–

Rosenthal and Marx	1979	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Eating	–
Roth et al.	2001	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	–
Salvy et al.	2009	Corr.	Mixed	Children	–	–	Familiar Unfamiliar	Snack	Non-eating	–
Salvy, Jarrin, et al.	2007	Corr.	Male Female Mixed	Adults	–	–	Familiar Unfamiliar	Snack	Non-eating	–
Salvy, Kieffer, and Epstein	2008	Corr.	Mixed	Children	–	–	Unfamiliar	Snack	Non-eating	–
Salvy, Romero, Paluch, and Epstein	2007	Corr.	Female	Children	–	–	Unfamiliar	Snack	Non-eating	–
Salvy, Vartanian, Coelho, Jarrin, and Pliner	2008	Corr.	Mixed	Children	–	–	Familiar Unfamiliar	Snack	Non-eating	–
Vartanian et al.	2013; Exp. 1	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	–
Vartanian et al.	2013; Exp. 2	Exp.	Female	Adults	Remote	–	Unfamiliar	Snack	Eating	–
Vartanian et al.	2013; Exp. 3	Exp.	Female	Adults	Live	–	Unfamiliar	Snack	Non-eating	–

Notes: Corr, correlational study; Exp, experimental study; DNC, did not code moderator because insufficient data was provided in the study or because the design precluded inclusion in the moderator analysis; L, low concern with eating appropriately; H, high concern with eating appropriately.

Characteristics of the participant

Participant gender (only male, only female, or male and female combined) and participant age group (children vs. adults) were examined as potential moderators. Although the weight classification of participants would be of interest, only three studies (Bevelander et al., 2012; Nisbett & Storms, 1974; Salvy, Howard, Read, & Mele, 2009) provided data separately for overweight and normal-weight participants, and thus participant weight status was not included as a moderator.

Characteristics of the model

We compared effect sizes for studies involving live confederates versus remote confederates. Remote-confederate studies included those that provided participants with a list of the amount eaten by supposed previous participants (usually the 10 previous participants; e.g., Roth et al., 2001), as well as studies using a video or social-media presentation of the confederate (e.g., Bevelander, Anschütz, Creemers, Kleinjan, & Engels, 2013; Hermans, Salvy, Larsen, & Engels, 2012). We also examined the confederate's weight status as a moderator of the overall effect size in those studies that directly manipulated the confederate's weight. Hermans, Larsen, Herman, and Engels (2008) included a "slim" confederate (body mass index [BMI; kg/m^2] = 20.9) and a "normal-weight" confederate (BMI unspecified); McFerran et al. (2010) included a "thin" confederate (BMI = 19.2) and an obese confederate (apparent BMI = 33); and Johnston (2002) included a normal-weight confederate (BMI = 24) and an obese confederate (BMI = 35). Because of the differences in how these weight groups were defined, we compared effect sizes for thin (BMI < 21), normal-weight (BMI = 21–24), and obese confederates (BMI > 30). Finally, we examined whether familiarity with one's eating companion moderated the modeling effect.

Characteristics of the eating context

Studies were coded in terms of whether participants were served a meal or a snack. This designation was established by considering the food provided to participants and the description of the study context provided by the authors. Studies were also coded in terms of whether the study was framed for participants as an eating task (e.g., a taste test, a meal) or as a non-eating task in which they were given incidental access to food.

Concern with eating appropriately

Social models are thought to influence people's eating behavior by providing a norm of appropriate intake (Herman et al., 2003; Vartanian et al., 2013). A number of studies have examined factors that might make participants more or less concerned about eating in an appropriate manner and therefore more or less likely to model the intake of an eating companion. These studies were coded, based on the description provided by the authors, in terms of whether participants should experience high or low concern with eating appropriately (see Table 1). Two other relevant characteristics (sociotropy and self-esteem) were not included in the analysis because the specific study did not meet our inclusion criteria (Exline, Zell, Bratslavsky, Hamilton, & Swenson, 2012), the data duplicated another variable already included in the analysis (Robinson et al., 2011), or the study did not provide sufficient data to calculate relevant effect sizes (Bevelander, Anschütz, et al., 2013).

Results

Overall effect of modeling on food intake

As expected, social models had a significant effect on participants' food intake: Participants ate more food when the model ate a lot than when the model ate very little. The overall effect size across all studies was $r = .39$ ($p < .001$, 95% CI = .33 to .44), indicating that social models had what could be considered a "large" effect on the amount of food that participants ate (Figure 1).

A comparison of correlational and experimental studies showed that correlational studies ($r = .56$) produced larger effect sizes than did experimental studies ($r = .31$), $Q(1) = 12.94$, $p < .001$ (see Table 2). Note, however, that the effect size for experimental studies would still be considered moderate-to-large in magnitude.

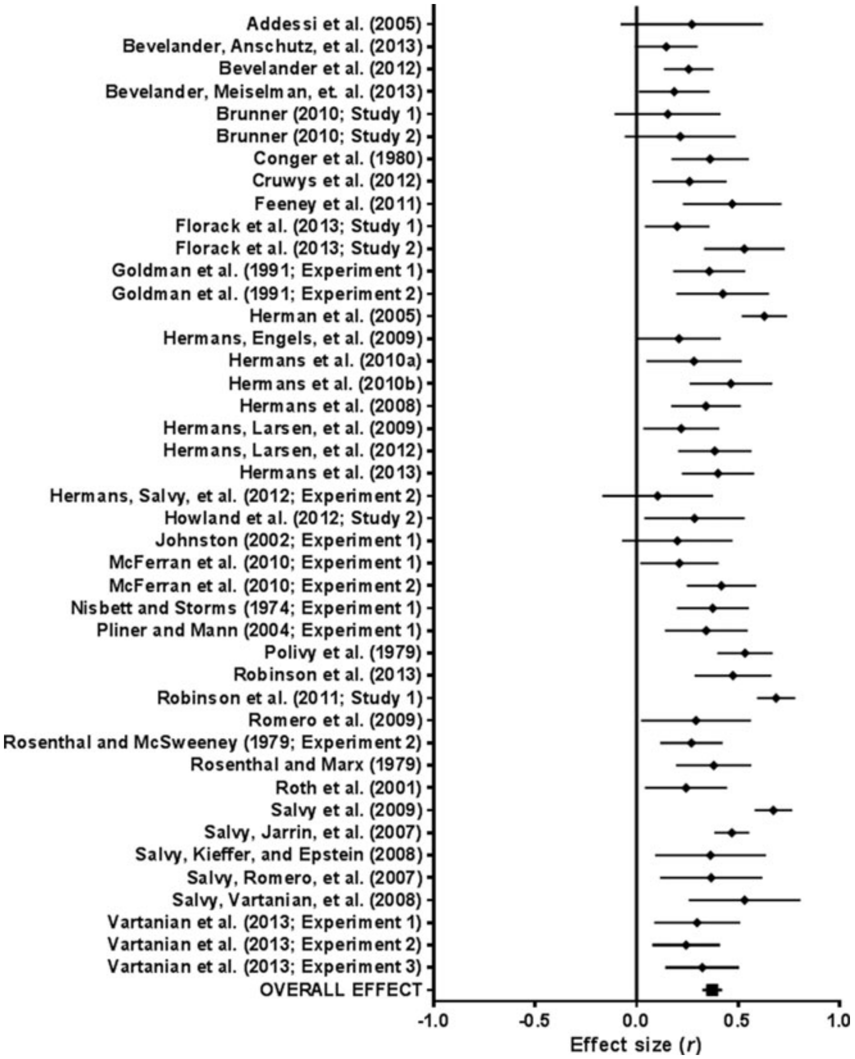

Figure 1. Forest plot of effect sizes for all studies included in the meta-analysis. For ease of presentation, an average effect size is provided for each individual study.

Table 2. Moderators of modeling effects.

Moderator	N_E	Effect size (r)	95% CI	Z	p
Study design					
Experimental	44	.313	.264, .360	11.91	<.001
Correlational	23	.557	.439, .656	7.82	<.001
Participant sex					
Female	43	.393	.329, .452	11.19	<.001
Male	5	.173	−.029, .362	1.68	.09
Mixed	19	.450	.320, .564	6.21	<.001
Age group					
Children	15	.470	.324, .594	5.75	< .001
Adults	52	.372	.310, .431	10.90	<.001
Model type					
Live model	33	.312	.256, .366	10.30	<.001
Remote confederate	10	.301	.193, .402	5.28	<.001
Model body size					
Thin	2	.406	.071, .659	2.35	.02
Normal weight	2	.432	.229, .599	3.95	<.001
Obese	2	.144	−.092, .365	1.20	.23
Familiarity					
Familiar	9	.528	.335, .679	4.82	<.001
Unfamiliar	58	.369	.310, .426	11.40	<.001
Food type					
Meal	6	.455	.375, .528	9.93	<.001
Snack	61	.381	.318, .440	11.01	<.001
Task type					
Eating task	23	.342	.274, .406	9.38	<.001
Incidental access	44	.422	.343, .495	9.53	<.001
Appropriateness concerns					
Low	7	.362	.157, .537	3.36	.001
High	7	.507	.258, .693	3.72	<.001

Note: N_E, number of effects.

Inhibiting versus augmenting models

We next examined the inhibiting and augmenting effects of a social model by comparing, separately, the effects of a low-intake confederate versus an eat-alone (no norm) control condition, and the effects of a high-intake confederate versus an eat-alone (no norm) control condition. These analyses were conducted separately because some studies included both low-intake and high-intake conditions along with the control condition, whereas others included only a low-intake or high-intake condition with the control condition. Thus, statistical comparison between the two mean effect sizes was not possible. The mean effect size for low-intake versus control was $r = -.23$ ($p < .001$, 95% CI $= -.11$ to $-.35$), indicating that low-intake models produce a moderate inhibiting effect on participants' food intake (see Figure 2). Consistent with previous theory and research, high-intake models did augment participants' food intake, but the mean effect size for high intake versus control was small ($r = .14$, $p = .001$, 95% CI $= .05$ to .22; see Figure 3).

Moderators of the modeling effect

There was significant heterogeneity of effect size distribution for the overall modeling effect, $Q(66) = 253.47$, $p < .001$, with effect sizes ranging from $-.18$ to .93. Therefore, we proceeded to examine the moderators of the overall modeling effect (see Table 2).

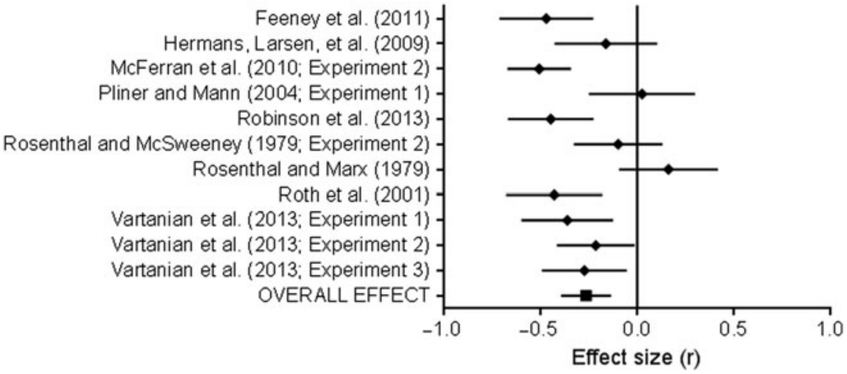

Figure 2. Forest plot of effect sizes for low-intake confederate condition versus control condition. For ease of presentation, an average effect size is provided for each individual study.

Characteristics of the participants

Among studies that provided data separately for female participants and for male participants, the mean effect size was larger among female participants ($r = .39$) than among male participants ($r = .17$), $Q(1) = 4.70$, $p = .03$. The mean effect size for studies that included both male and female participants ($r = .45$) was significantly larger than the mean effect size for studies with only male participants ($p = .02$) but did not differ from studies with only female participants ($p = .42$). Studies examining modeling effects among children ($r = .47$) and among adults ($r = .37$) did not differ in their mean effect size, $Q(1) = 1.56$, $p = .21$. Interestingly, a follow-up meta-regression for studies involving children showed that children's mean age was positively associated with the degree of modeling (slope = .06, SE = .02, $p < .001$).

Characteristics of the model

Studies involving a remote confederate produced a mean effect size ($r = .30$) that was virtually identical to that of studies using a live confederate ($r = .31$), $Q(1) = 0.03$,

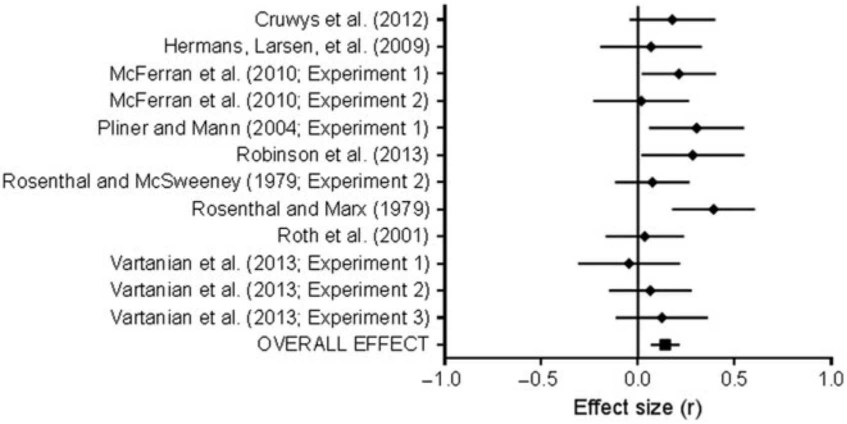

Figure 3. Forest plot of effect sizes for control condition versus high-intake confederate condition. For ease of presentation, an average effect size is provided for each individual study.

$p = .85$. As for the confederate's body size, thin confederates ($r = .41$) and normal-weight confederates ($r = .43$) produced equivalent effect sizes ($p = .88$). Furthermore, although thin confederates and normal-weight confederates produced larger mean effect sizes than did obese confederates ($r = .14$), these differences were not statistically significant (ps $> .05$), which is probably due to the small number of studies involved ($k = 2$ per group). Finally, the mean effect sizes for eating with a familiar companion ($r = .53$) and an unfamiliar companion ($r = .37$) did not differ significantly, $Q(1) = 2.49$, $p = .12$.

Characteristics of the eating context

There was no significant difference in mean effect size for meals ($r = .46$) compared to snacks ($r = .38$), $Q(1) = 2.17$, $p = .14$. There was also no significant difference in mean effect size when the task was presented as an eating task (e.g., a taste test; $r = .35$) or a non-eating task (e.g., incidental access to snack foods as part of a separate task; $r = .42$), $Q(1) = 2.04$, $p = .15$.

Concern with eating appropriately

Conditions that would be expected to elicit higher concern with eating appropriately ($r = .51$) did not differ from conditions that should elicit lower concern with eating appropriately ($r = .36$), $Q(1) = 0.92$, $p = .34$.

Discussion

Social factors play an important role in dictating how much food people will eat in a given situation. Our meta-analysis summarized the effect sizes from studies on the modeling of food intake, and found an overall mean effect size of $r = .39$, which corresponds to a large effect (Lipsey & Wilson, 2001). We also found that inhibiting models tend to have a greater effect on people's food intake than do augmenting models. Herman et al. (2003) argued that people are motivated to maximize their intake of palatable foods without appearing to eat excessively, and "excess" in social settings is defined as eating more than other people are eating. When the model eats very little, this sets a relatively low ceiling for acceptable food intake, leading people to suppress their food intake relative to how much they would eat if they were alone. In contrast, when the model eats a great deal, people essentially have the freedom to eat as much as they typically would and may even have permission to eat somewhat more than they typically would (as indicated by the relatively small difference between the high-intake conditions and the eat-alone control condition).

In addition to examining the overall effect size, we also examined a range of potential moderators of modeling effects. With respect to research design, we found that effect sizes were larger for correlational studies than for experimental studies. Of course, correlational studies are limited by the fact that there is no clear "model" in those studies and thus nothing can be said about causal effects on eating behavior; indeed, in these contexts, there is the potential for mutual influence by both members of the dyad. It is also the case, however, that correlational studies more closely approximate "natural" eating contexts because one rarely (if ever) eats with a confederate who has been instructed to eat a particular amount. Furthermore, correlational studies have the advantage of increasing variability in food intake because intake is not constrained by the experimenters' instructions, allowing researchers to examine the relationship between co-eaters' food intake (Salvy, Jarrin, Paluch, Irfan, & Pliner, 2007). It may be that the increased variability in participants' intake in correlational studies, as well as the reciprocal influence that each member of the dyad can have on the other person's food intake, accounts for the larger effect sizes observed in those studies compared to experimental studies. Capitalizing on the unique features of correlational designs, it would be interesting for future research to examine which factors determine who will lead and who will follow in naturally occurring social eating situations.

Very few other factors that we examined were significant moderators of the modeling effect. In terms of characteristics of the participant, we found that women showed larger effects than did men. Although this sex difference is consistent with research suggesting that women might be more concerned with how they are viewed by others while they are eating (Vartanian et al., 2007), other work suggests that men are more influenced by external eating cues, including portion size (Zlatevska, Dubelaar, & Holden, 2014), and that men show stronger social facilitation effects (Bellisle, Dalix, & de Castro, 1999). Thus, whether the observed sex difference in modeling effects reflects a genuine difference in the extent to which women's (relative to men's) food intake is influenced by social cues, or reflects something more mundane such as differences in how undergraduate male participants respond to free food, remains an open question. We also found that, among children, participants' mean age was positively correlated with the magnitude of the modeling effect. This finding is consistent with other research showing, for example, that older children are more likely to be influenced by portion size than are younger children (Rolls, Engell, & Birch, 2000), and suggests that a tendency to rely on external cues (and perhaps a tendency to want to eat "appropriately") is learned over time. Determining at what age children begin relying less on internal signals and more on normative signals with respect to their food intake would be an important direction for future research.

With respect to characteristics of the model, leaner models produced somewhat larger effects than did heavier models but this difference was not statistically significant, probably because of the small number of studies represented. It may be that obese models elicit less modeling because they are not seen as being relevant guides to appropriate behavior or that people somehow adjust for assumed baseline differences in how much obese people eat. We might also expect that participants' own weight status would interact with the confederate's weight status in predicting the degree of modeling. Future research is needed to clarify the effect of participants' and models' weight status on food intake, as well as the mechanisms underlying those effects.

An important finding from our meta-analysis is the fact that we observed identical effect sizes for studies that used a live model versus a remote confederate. How can modeling effects occur when the "model" is not actually present? Vartanian et al. (2013) found that both live models and remote confederates create and convey a norm of appropriate food intake, which in turn affects how much participants eat. However, it may be that some of the mechanisms underlying modeling effects differ between live models and remote confederates. For example, Robinson et al. (2011) and Robinson, Benwell, and Higgs (2013) have argued that empathy plays an important role in modeling the food intake of another person, but not in modeling of remote confederates. It might also be that some components of modeling (e.g., behavioral mimicry; Hermans, Lichtwarck-Aschoff, et al., 2012) are observed only with live models. Future research examining the different processes underlying modeling effects in live and remote confederate designs would help elucidate the mechanisms underlying the modeling of food intake.

Although we were able to examine a number of moderators of effect sizes, there are other factors that need to be considered in future research that would broaden our understanding of the scope and limits of modeling effects. For example, little is known about the modeling of healthy foods, such as fruits and vegetables. Most modeling studies employ highly palatable but unhealthy foods, such as pizza or cookies. Only one study has examined modeling of healthy snacks (Hermans, Larsen, et al., 2009) and, although modeling of vegetable intake was observed, it is not known how consistent that effect is, what the mechanisms are, or whether there are any moderators of the effect. Given that very few people meet their target recommendations for fruit and vegetable consumption (e.g., Guenther, Dodd, Reedy, & Krebs-Smith, 2006), research examining the modeling of healthy food intake would be an important direction for future research.

Why do people model other people's food intake? Herman et al. (2003) argued that the appropriate amount to eat is often ambiguous and that people therefore rely on the example of others to determine how much they themselves should eat. Furthermore, Vartanian et al. (2013) showed that perceived norms of appropriate intake mediated the link between a model's behavior and participants' own food intake. Surprisingly, our meta-analysis found no difference in the mean effect size for modeling between conditions that should elicit relatively high or relatively low concern with eating appropriately. Indeed, even conditions that are thought to "minimize" modeling effects (e.g., low appropriateness-concern conditions) still produce sizable effects (average $r = .36$). It should be noted, however, that those studies used experimental manipulations or self-report measures that only indirectly tapped into people's concern with eating appropriately (e.g., trait empathy or eating with an unsociable confederate). It may be that some of the methods used to either manipulate or measure appropriateness concerns do not adequately capture that construct. It is also possible that most of the participants in these studies—even many of those who were categorized as low in concern for appropriateness on the basis of a median split on some measure—were relatively high in concern for appropriateness. A more compelling test of the possible role of concern for appropriateness awaits direct manipulation of people's level of concern with eating appropriately, the identification of measures that adequately capture concern with behaving appropriately, and/or the identification of samples that are demonstrably high and low in this attribute.

Situating the findings of the current meta-analysis in the context of other external influences on food intake, a recent meta-analysis of the effect of portion size on people's food intake found that the mean effect size was $r = .22$ (a moderate effect; Zlatevska et al., 2014). Although direct comparisons between the two literatures are difficult due to various methodological differences, it is notable that the average modeling effect in our meta-analysis ($r = .39$) is considerably larger than the average portion-size effect reported by Zlatevska et al. (2014). The effect of larger portions has justly received a great deal of attention in the research literature and in the popular media, but the findings of the present meta-analysis suggest that modeling effects deserve just as much attention.

Conclusion

Social models provide a powerful influence on people's food intake, with implications for their ability to appropriately regulate food intake. First, eating with a low-intake model can lead people to restrict their food intake. Although in some cases restriction (or reduced "overconsumption") might be seen as healthy and desirable, in other cases it might exacerbate unhealthy restrictive eating patterns, particularly among individuals at risk for disordered eating. Second, eating with a high-intake model can lead to overindulgence and excess energy intake. The potential for overindulgence in social situations might be heightened by the contemporary food environment, characterized by widespread availability of high-calorie foods and oversized portions (Brownell & Horgen, 2004). Efforts to help people eat a healthy diet might potentially include using social models to promote the consumption of healthy foods, as well as helping people discern when a model's food intake is an appropriate guide to behavior and when it is not.

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