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## Research report

## Social modeling of eating: A review of when and why social influence affects food intake and choice

Tegan Cruwys<sup>a,\*</sup>, Kirsten E. Bevelander<sup>b</sup>, Roel C.J. Hermans<sup>c</sup><sup>a</sup> School of Psychology, University of Queensland, St Lucia 4072, Australia<sup>b</sup> Communication Science Department, Behavioural Science Institute, Radboud University Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands<sup>c</sup> Developmental Psychopathology Department, Behavioural Science Institute, Radboud University Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands

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## ABSTRACT

A major determinant of human eating behavior is social modeling, whereby people use others' eating as a guide for what and how much to eat. We review the experimental studies that have independently manipulated the eating behavior of a social referent (either through a live confederate or remotely) and measured either food choice or intake. Sixty-nine eligible experiments (with over 5800 participants) were identified that were published between 1974 and 2014. Speaking to the robustness of the modeling phenomenon, 64 of these studies have found a statistically significant modeling effect, despite substantial diversity in methodology, food type, social context and participant demographics. In reviewing the key findings from these studies, we conclude that there is limited evidence for a moderating effect of hunger, personality, age, weight or the presence of others (i.e., where the confederate is live vs. remote). There is inconclusive evidence for whether sex, attention, impulsivity and eating goals moderate modeling, and for whether modeling of food choice is as strong as modeling of food intake. Effects with substantial evidence were: modeling is increased when individuals desire to affiliate with the model, or perceive themselves to be similar to the model; modeling is attenuated (but still significant) for healthy-snack foods and meals such as breakfast and lunch, and modeling is at least partially mediated through behavioral mimicry, which occurs without conscious awareness. We discuss evidence suggesting that modeling is motivated by goals of both affiliation and uncertainty-reduction, and outline how these might be theoretically integrated. Finally, we argue for the importance of taking modeling beyond the laboratory and bringing it to bear on the important societal challenges of obesity and disordered eating.

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## Introduction

The consumption of food has implications beyond merely providing nutrients and energy needed to sustain life. Food and eating are also intertwined with our social lives. Most eating takes place in the presence of other people and is often perceived as an enjoyable part of our cultural experience (Rozin, 2005). Therefore, it should not be surprising that one's eating behavior is profoundly affected by social factors. In addition to processes such as social facilitation and impression management (also reviewed in this issue of *Appetite*), another social influence phenomenon is modeling of food intake, whereby people directly adapt their food intake to that of their eating companion. It was forty years ago that evidence first

began to accumulate that modeling<sup>1</sup> is a primary determinant of eating behavior. Nisbett and Storms (1974) demonstrated that young males consistently ate more when their eating companion ate a large number of crackers and less when the other person ate minimally (compared to when eating alone). This so-called modeling effect caught the attention of other researchers and in subsequent years several other attempts were made to identify boundary conditions for the effect. This early modeling research was influenced by the externality hypothesis (Schachter, 1971), which stated that overweight people are more vulnerable to external food-related cues (such as the social environment) rather than internal cues (such as hunger or satiety). However, and in accordance with the work of Nisbett and Storms (1974), no differences were found between healthy and overweight people, or between restrained and unrestrained eaters, in their extent of modeling (Conger, Conger, Costanzo, Wright, & Matter, 1980; Polivy, Herman, Younger, & Erskine, 1979; Rosenthal & Marx, 1979; Rosenthal & McSweeney, 1979). Researchers therefore concluded that Schachter's externality hypothesis cannot distinguish between healthy-weight and overweight people

\* Corresponding author.

E-mail address: [t.cruwys@uq.edu.au](mailto:t.cruwys@uq.edu.au) (T. Cruwys).<sup>1</sup> This review uses the term *modeling* to refer to social modeling, that is, behavioral conformity of eating, not statistical modeling.

in the case of modeling, because both groups are influenced by normative external cues (Herman & Polivy, 2008). Instead, these effects were found to have a strong and pervasive influence on both healthy-weight and overweight individuals' eating behaviors. Although the reproducibility of these effects was easily and repeatedly demonstrated, the question of *why* modeling occurs has proved more difficult to answer definitively. That is, what purpose does modeling serve, psychologically, that might explain why it is so strongly preserved and generalizable?

Over the decades of modeling research, a variety of explanations have been put forward to understand the effect. The most dominant interpretation, however, is that modeling of food intake is an example of a broader phenomenon of social influence and that general theories of normative behavior might help to understand why people adapt their food intake to that of others. Using a normative approach, Herman and his colleagues proposed that the principal regulatory influence on eating in social contexts is people's beliefs about what or how much is appropriate to eat (Herman & Polivy, 2005; Herman, Roth, & Polivy, 2003b). According to this model, people conform to others' eating because they see the amount eaten by others as an indicator of how much one can or should eat without eating excessively.

Although the literature seems to approach consensus on the utility of this normative model, there has not been a systematic review of modeling studies. The lack of a comprehensive review impedes our ability to ascertain from the extant modeling literature: (a) when and why social modeling shapes eating behavior, and (b) how to translate this knowledge to inform applied practice aimed at increasing healthy eating behavior. Therefore, our overarching aim is to review the literature on how people's food choice and intake is affected by modeling and, on the basis of these findings, propose new research directions that might help us to gain insight into the robustness or underlying mechanisms of modeling. We start by reviewing typical methodological approaches to the study of modeling, before summarizing the key findings from our systematic review of 69 modeling experiments. We then discuss theoretical and practical implications of these findings.

### Modeling: methodological approaches

In past research, several strategies have been used to investigate modeling effects on eating. Both observational as well as correlational studies have found that people adapt their intake to that of their eating companion, and that those who are eating together converge upon an eating norm (e.g., Salvy, Romero, Paluch, & Epstein, 2007c; Salvy, Vartanian, Coelho, Jarrin, & Pliner, 2008b). This occurs such that the variance among participants in their food intake is reduced when eating together. However, both statistical and theoretical concerns arise when interpreting research where participants model one another. Firstly, because food intake is non-independent between participants, an appropriate statistical method of analysis would be multi-level modeling (Luke, 2004) – although often this is not performed. Furthermore, without random assignment, it is difficult to rule out the possibility that non-social factors, such as pre-existing similarity or eating attitudes, are responsible for conformity effects between eating companions. Finally, in a scenario in which both co-eaters are free to choose the type or amount of food to consume, it is difficult to determine which person is modeling and which person is being modeled. In part because of these concerns, an experimental design in which the intake and/or choice of one co-eater (i.e., the confederate) is pre-determined by the experimenter has arguably become the gold-standard for research on the modeling of food intake. This paradigm enables researchers to investigate modeling behavior without any potential confounds related to selection or non-social processes. In some studies, participants are provided with a non-food related cover

story for the experiment (e.g., Bevelander, Anschutz, Creemers, Kleinjan, & Engels, 2013a; Cruwys et al., 2012; Hermans, Salvy, Larsen, & Engels, 2012c). In these experiments, participants believe that food is incidental to the research question. In other studies, participants are told that they are participating in a taste-test study and are asked to complete questionnaires related to their experience of the food items (e.g., Goldman, Herman, & Polivy, 1991; Vartanian, Sokol, Herman, & Polivy, 2013). In these studies, participants are aware of the centrality of the food to the experiment; however, the researchers' interest in social influence and the amount of food consumed remains opaque.

The sheer robustness of modeling has allowed researchers to also develop a more "light-touch" technique for communicating social norms to participants, known as the remote-confederate paradigm (cf., Roth, Herman, Polivy, & Pliner, 2001). In studies utilizing this design, the confederate providing the norm for food choice or intake is not physically present. Rather, participants are provided normative information (while concealing the aim of the study with a cover story) by exposing them to either written information about the amount consumed by previous participants (e.g., in the form of a list on a table, which was supposedly used to determine how much food needed to be ordered by the experimenters) or by exposure to a remote model selecting or eating food on a video or computer screen (Bevelander et al., 2013a; Bevelander, Anschutz, & Engels, 2012b; Hermans et al., 2012c; Romero, Epstein, & Salvy, 2009). Given that both live and remote confederate designs have been found to induce modeling effects on eating (cf. Feeney, Polivy, Pliner, & Sullivan, 2011) and are able to infer strong cause and effect relationships, we summarize findings of studies in which the eating norm is induced by either type of confederate.

### Inclusion criteria

To find relevant English-language empirical research on modeling effects on food choice and food intake, a literature search of PubMed and Google Scholar was conducted using the following key words: 'modeling'; 'matching'; 'social influence'; 'normative influence'; 'eating'; 'food choice'; 'food intake'. These key words were used in combinations of two to include one theoretical keyword (i.e., modeling, matching, social influence, normative influence) and one behavioral keyword (i.e., eating, food choice, food intake). The reference lists and citations of eligible publications were also reviewed to identify pertinent literature. A criterion for inclusion in the review was that the study had an experimental design in which either food choice or food intake was experimentally manipulated by a social referent (using either a live or remote confederate). Studies in which participant dyads or groups were examined in a free eating paradigm without a confederate were therefore not included (e.g., Salvy, Jarrin, Paluch, Irfan, & Pliner, 2007b; Salvy, Kieffer, & Epstein, 2008a). Furthermore, we included only those studies with a dependent variable that was amount of food consumed or food choice (measured in a concrete behavioral fashion; not intentions only). Table 1 shows a complete list of all the modeling studies that were included in this review. Where possible, however, we also discuss studies in our review that did not meet our inclusion criteria, but which provided additional insight into the dynamic process of modeling. Sixty-nine studies (in 49 articles) were identified that met these selection criteria, reporting on over 5800 experimental participants. Of these, the majority (58) measured food intake, or whether participants ate at all, as the dependent variable of interest, whereas only 11 investigated participants' choice between at least two food alternatives. As can be seen in Table 1, studies conducted with live confederates (42) or with some form of remote confederate (27) are well represented.

**Table 1**  
Summary of 69 modeling studies identified for the review.

Study	Authors	Year	Outlet	Design	N	Participant age	Participant gender	Model live (L) vs. remote (R)	DV amount (A) vs. choice (C)	Evidence of modeling?	Moderators/mediators identified
1	Nisbett and Storms	1974	Book	3 (alone, low norm, high norm) × 3 (participant weight)	?	Young adult	M	L	A: Crackers	Y	Weight status (underweight, healthy, overweight) did not moderate. Familiarity: Increased willingness to try foods that the child's mother, rather than a stranger, had modeled consuming.
2	Harper and Sanders	1975	<i>Journal of Experimental Child Psychology</i>	S1: 2 (mother vs. stranger model) × 2 (model ate food vs. offered only)	80	1–4	Boys + girls	L	C: Novel foods; Blue tortilla with ham + cheese, macadamia, date	Y	
3				S2: 2 (male vs. female stranger model) × 2 (model ate food vs. offered only)	140	3–4	Boys + girls	L	A: Crackers	Y	
4	Rosenthal and Marx	1979	<i>Addictive Behaviors</i>	3 (participant dieting status) × 3 (low norm, high norm, no-model)	81	18–56	F	L	A: Crackers	Y	Dieting status (successful, unsuccessful, non-dieter) did not moderate.
5	Rosenthal and McSweeney	1979	<i>Addictive Behaviors</i>	S1: 2 (model's eating rate: slow vs. fast) × 2 (participant weight)	31	17–24	F	L	Rate of eating	Y	Weight status: Overweight participants did not model as much as healthy weight participants in fast intake conditions. Sex of model: High-intake female model had less influence.
6	Polivy, Herman, Younger, and Erskine	1979	<i>Journal of Personality</i>	S2: 2 (participant sex) × 2 (model's sex) × 2 (low norm, high norm)	79	17–28	M + F	L	A: Crackers	Y	
7				2 (dieting status of model) × 2 (low vs. high norm) × 2 (participant restraint high vs. low)	86	Young adult	F	L	A: Sandwich quarters	Y	Participant restraint and model's dieting status did not moderate.
8				2 (participant sex) × 2 (model's sex) × 2 (participant weight) × 3 (no intake norm, low norm, high norm) + 4 controls	114	Young adult	M + F	L	A: Crackers	Y	
9	Birch	1980	<i>Child Development</i>	Intervention to seat children with children who had opposite food preferences for 4 days vs. no intervention	39	3–10	Boys + girls	L	C: Preferred vs. non-preferred foods	Y	Sex: Stronger modeling effect for male participants. Similarity: Subjects ate more when model was of same-sex. Weight status did not moderate. Age: Younger children showed more modeling.
10	Goldman, Herman, and Polivy	1991	<i>Appetite</i>	S1: 3 (hunger: low, moderate, high) × 2 (low norm, high norm)	86	Young adult	F	L	A: Bite-size sandwiches, fruit, cookies	Y	Hunger did not moderate. Food type: No modeling of fruit intake.
11				S2: (hunger: low, high) × 3 (control, low norm, high norm)	63	Young adult	F	L	A: Bite-size sandwiches, fruit, cookies	Y	
12	Hendy and Raudenbush	2000	<i>Appetite</i>	S2 and S3: Silent teacher model eating vs. not eating	34	M = 4.7	Boys + girls	L	C: Lunch meal, familiar foods	N	No evidence of modeling when teacher ate but did not interact with children. Similarity: Peers modeled more than teachers (S5).
13					23	M = 4.4	Boys + girls	L	C: Lunch meal, unfamiliar foods	N	
14				S4: Teacher model enthusiastically eating vs. non-eating teacher	26	M = 4.4	Boys + girls	L	A: Mangos and cranberries	Y	
15				S5: Enthusiastic teacher vs. peer	14	M = 4.3	Boys + girls	L	A: Unfamiliar fruit	Y	
16	Roth, Herman, Polivy, and Pliner	2001	<i>Appetite</i>	2 (alone vs. observed) × 3 (norm: no, low, high)	134	M = 23	F	R	A: Cookies	Y	Presence of others: Modeling did not occur when participants observed.
17	Johnston	2002	<i>Social Cognition</i>	S1: 2 (model: obese vs. non-obese) × 2 (low norm, high norm)	48	Unclear	F	L	A: Ice cream	Y	Similarity: Normal weight participants were not influenced by obese model. Facial birthmark of model did not moderate.
18				S2: 2 (model appearance: birthmark vs. no-birthmark) × 2 (low norm, high norm)	84	Unclear	F	L	A: Ice cream	Y	

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Table 1 (continued)

Study	Authors	Year	Outlet	Design	N	Participant age	Participant gender	Model live (L) vs. remote (R)	DV amount (A) vs. choice (C)	Evidence of modeling?	Moderators/mediators identified
19	Hendy	2002	<i>Appetite</i>	Intervention: participants exposed to no model or model (boy vs. girl)	22	3–6	Boys + girls	L	A: Papaya, cranberry, dried apple	Y	Sex of model: Females were modeled more closely.
20	Horne et al.	2004	<i>European Journal of Clinical Nutrition</i>	Intervention: participants exposed over 16 days to video of heroic peers who enjoy eating fruit and vegetables vs. no intervention	749	5–11	Boys + girls	R	A: Fruit and vegetable intake	Y	
21	Pliner and Mann	2004	<i>Appetite</i>	S1: 3 (no norm, low norm, high norm) × 2 (palatable vs. unpalatable food available)	72	M = 19.9	F	R	A: Cookies	Y	Food type: Modeling only occurred for food intake (S1) and not food choice (S2); modeling only occurred for palatable but not unpalatable food.
22				S2: Model chose palatable vs. unpalatable; +control	37	M = 19.3	F	R	C: Cookies	N	
23	Addressi, Galloway, Visalberghi, and Birch	2005	<i>Appetite</i>	Familiar adult eating nothing vs. eating novel different colored food vs. same colored food as participant	27	2–5	Boys + girls	L	A: Colored semolina	Y	Similarity: Children only modeled when food color matched that of the adult model.
24	Leone, Pliner, and Herman	2007	<i>Appetite</i>	S1: 2 (number of prior participants; 3 vs. 9) × 2 (low norm, high norm)	75	M = 19.3	M + F	R	A: Distribution of cookies eaten (not directly comparable to other studies)	Unclear	Ambiguity: Variation in intake among models reduces social influence, leads to disinhibition.
25				S2: 4 norm conditions (low norm, high norm, mixed low/high norm, very mixed low/medium/high norm)	114	M = 20.8	M + F	R	A: Donuts	Y	Sex and restraint status did not moderate.
26	Yamasaki, Mizdzuno, and Aoyama	2007	<i>Japanese Journal of Social Psychology</i>	Low norm vs. high norm	45	M = 18.9	Female	R		Y	Modeling persisted even though participants believed that their eating could not be observed by the experimenter.
27	Hermans, Larsen, Herman, and Engels	2008	<i>Appetite</i>	3 (no eating norm, low norm, high norm) × 2 (model weight slim vs. normal weight)	102	M = 20.50	F	L	A: M&Ms	Y	Similarity: Participants more likely to model normal weight confederate.
28	Greenhalgh et al.	2009	<i>Appetite</i>	Four eating occasions. 3 (model positive and ate novel food vs. negative non-eating model and later positive eating model vs. control)	35	5–7	Boys + girls	L	A: Colored novel foods and other snack foods (i.e. grapes, cheese, pitta bread and carrot)	Y	Negative modeling can be overridden by later positive modeling (in 5–7 year olds).
29					44	3–4	Boys + girls	L	A: Cookies (S1 + S2)	Y	
30	Romero, Epstein, and Salvy	2009	<i>Journal of American Dietetic Association</i>	2 (participant weight) × 2 (low norm, high norm)	44	8–12	Girls	R		Y	Weight status did not moderate.
31	Hermans, Larsen, Herman, and Engels	2009	<i>Appetite</i>	3 (no eating norm, low norm, high norm) × 2 (model weight) + control condition	116	M = 20.28	F	L	A: Vegetables	Y	Model weight status did not moderate. Healthy food: Size of effect possibly attenuated for healthy food.
32	Hermans, Engels, Larsen, and Herman	2009	<i>Appetite</i>	2 (low norm, high norm) × 2 (confederate social nature: warm vs. cold) + control condition	100	18–27	F	L	A: M&Ms	Y	Social nature of model: Only participants exposed to cold confederate modeled.
33	McFerran, Dahl, Fitzsimons, and Morales	2010	<i>Journal of Consumer Research</i>	2 (model weight) × 2 (low norm, high norm) + 1 control (no confederate)	115	Young adult	F	L	A: Candy	Y	Similarity: Less modeling of obese confederate.

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**Table 1** (continued)

Study	Authors	Year	Outlet	Design	N	Participant age	Participant gender	Model live (L) vs. remote (R)	DV amount (A) vs. choice (C)	Evidence of modeling?	Moderators/mediators identified
34	Burger et al.	2010	<i>Journal of Social and Clinical Psychology</i>	Healthy norm, unhealthy norm, control	120	Young adult	F	R	C: Healthy versus unhealthy	Y	Presence of others did not moderate.
35					75	Young adult	F	R	C: Healthy versus unhealthy	Y	
36	Hermans, Herman, Larsen, and Engels	2010	<i>Appetite</i>	3 (no eating norm, low norm, high norm)	59	M = 21.73	M	L	A: Nuts	Y	Hunger: Modeling only apparent in the conditions where men were food deprived.
37	Hermans, Herman, Larsen, and Engels	2010	<i>Journal of the American Dietetics Association</i>	3 (no eating norm, low norm, high norm)	57	M = 21.15	F	L	A: Breakfast foods	Y	Meal type: Size of effect possibly attenuated for breakfast foods
38	Brunner	2010	<i>Appetite</i>	2 (low norm, high norm) × 2 (weight cues; present vs. not-present)	54	M = 20.8	F	L	A: Chocolate	Y	Weight-related cues: Eating was suppressed by weight-related cues, such that modeling no longer occurred. Remote vs. live confederate did not moderate.
39					51	M = 21.3	F	L		Y	
40	Feeney, Polivy, Pliner, and Sullivan	2011	Eating behaviors	3 (no confederate, remote confederate, live confederate)	32	M = 18.6	F	Manipulated	A: Pizza	Y	
41	Bevelander, Anschutz, and Engels	2011	<i>Appetite</i>	3 (model buys low, average or high calorie products)	89	10–12	F	L	A: Total energy in food purchases	Y	
42	Exline, Zell, Bratslavsky, Hamilton, and Swenson	2012	<i>Journal of Social and Clinical Psychology</i>	2 (participant sociotropy low vs. high) × 2 (low norm, high norm)	109	M = 18.6	M + F	L	A: Candy	Y	Sociotropy: Modeling enhanced among participants more concerned with maintaining social harmony
43	Hermans, Larsen, Herman, and Engels	2012	<i>British Journal of Nutrition</i>	2 (model portion size small vs. large) × (model intake low, medium, large)	85	M = 20.85	F	L	A: Meal	Y	Source of norm (portion size vs. model intake) did not moderate.
44	Bevelander, Anschutz, and Engels	2012	<i>Appetite</i>	No eating norm, low norm, high norm	223	6–11	M + F	L	A: Snack foods	Y	Overweight participants were more responsive to high norm condition; healthy weight participants were more responsive to no eating norm condition. Time delay did not moderate (participants modeled both immediately and in delayed testing session).
45	Stok, de Ridder, de Vet, and de Wit	2012	<i>Psychology &amp; Health</i>	2 (low frequency norm, high frequency norm) × 2 (low identified vs. high identified with reference group) + control	119	M = 21.7	M + F	R	A: Fruit	Y	Group membership: High identifiers with referent group showed more modeling of majority norm (and divergence from minority norm).
46	Howland, Hunger, and Mann	2012	<i>Appetite</i>	2 (low intake norm, control)	44	18–29 yrs	M + F	L	A: Snacks	Y	Presence of others did not moderate.
47					47	18–26	M + F	L		Y	
48	Bevelander, Anschutz, and Engels	2012	<i>British Journal of Nutrition</i>	Familiar food norm vs. unfamiliar food norm vs. control	316	M = 7.13	M + F	R	C: Snacks (computer based)	Y	Peer increased willingness to try unfamiliar foods but children preferred high energy dense foods.
49	Cruwys et al.	2012	<i>Appetite</i>	2 (ingroup vs. outgroup model) × 2 (no eating norm, high norm) + control	119	17–25	F	L	A: Popcorn	Y	Group membership: Modeling did not occur for outgroup confederate.

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Table 1 (continued)

Study	Authors	Year	Outlet	Design	N	Participant age	Participant gender	Model live (L) vs. remote (R)	DV amount (A) vs. choice (C)	Evidence of modeling?	Moderators/mediators identified
50	Hermans, Salvy, Larsen, and Engels	2012	Eating behaviors	S1: no eating norm, eating norm	77	M = 20.29	F	R	A: Candy	N	Shared social context: No evidence of modeling when confederate in a different situation to participant
51				S2: no eating norm, low norm, high norm	51	M = 20.43	F	R	A: M&Ms	N	
52	Prinsen, de Ridder, and de Vet	2013	<i>Appetite</i>	S1 and S2: food wrappers of previous participant present vs. absent	144	Unclear	M + F	R	Food intake (Y or N) (S1 and S2)	Y	Healthy goal prime did not moderate.
53				S3: wrapper of unhealthy vs. healthy snack present	65	M = 21.58	M + F	R	C: Healthy or unhealthy in Study 3	Y	
54					90	M = 21.87	M + F	R	A: Cookies	Y	Trait empathy did not moderate.
55	Robinson, Benwell, and Higgs	2013	<i>Appetite</i>	Low norm, high norm, control	64	M = 19.2	F	R	C: Salad or burger	Y	Type of norm: Descriptive norm more effective than injunctive norm.
56	Mollen, Rimal, Ruiters, and Kok	2013	<i>Appetite</i>	Norm type (healthy descriptive norm, unhealthy descriptive norm, healthy injunctive norm) + control	231	17–34	M + F	R	C: Low energy dense and high energy dense foods	Y	Food type: Modeling was most noticeable for low-energy dense food – participants were readily influenced to not choose these foods. Impulsivity: Modeling attenuated for those high in self-reported impulsivity. Attention to eating cues and response inhibition did not moderate. Current mood: Participants modeled norm, but not in neutral video condition.
57	Robinson and Higgs	2013	<i>British Journal of Nutrition</i>	Unhealthy model vs. healthy model vs. control	100	M = 19.9	F	L	A: M&Ms	Y	
58	Hermans et al.	2013	<i>British Journal of Nutrition</i>	No eating norm, low norm, high norm	85	M = 20.20	F	L	A: M&Ms	Y	
59	Bevelander, Meiselman, Anschütz, and Engels	2013	<i>Appetite</i>	2 (no intake vs. standardized intake) × 3 (happy, sad or neutral movie)	110	7–10	M + F	L	A: Candy	Y	Children model via video interaction with remote confederate. Self-esteem: High implicit self-esteem and low body esteem associate with greater modeling. Modeling mediated by perceived norm for appropriate intake in 3 studies.
60	Bevelander, Anschütz, Creemers, Kleinjan, and Engels	2013	<i>PLoS One</i>	No eating norm, low norm, high norm	118	M = 11.14	M + F	R	A: Candy	Y	
61	Vartanian, Sokol, Herman, and Polivy	2013	<i>PLoS One</i>	Low norm, high norm, control	78	Young adults	F	R	A: Cookies (S1 and S2)	Y	Regulatory focus: Modeling effect was more pronounced when participants had a prevention focus. Type of norm: Descriptive norm was more effective than injunctive norm.
62					126		F	L	A: M&Ms	Y	
63					94		F	L	A: Cookies	Y	Regulatory focus: Modeling effect was more pronounced when participants had a prevention focus. Type of norm: Descriptive norm was more effective than injunctive norm.
64	Florack, Palcu, and Friese	2013	<i>Appetite</i>	2 (regulatory focus, prevention vs. promotion) × 2 (no eating norm vs. eating norm)	142	18–49	M + F	L	A: Ice cream	Y	
65					40	M = 29.49	F	R	A: Fruit	Y	
66	Stok, de Ridder, de Vet, and de Wit	2014	<i>British Journal of Health Psychology</i>	Descriptive norm, injunctive norm, control	80	14–17 yrs	M + F	R	C: Healthy vs. unhealthy	Y	Self-control: Low self control associated with greater modeling.
67	Salmon, Fennis, de Ridder, Adriaanse, and de Vet	2014	<i>Health Psychology</i>	2 (high control, low control) × 2 (healthy descriptive norm ['social proof heuristic'], no norm control)	177	M = 20.47	M + F	R	A: Fruit and vegetables (S1 and S2)	Y	Type of norm: Descriptive norm was more effective than injunctive norm. Food preferences: Low consumers of fruit and veg were influenced by norm.
68	Robinson, Fleming, and Higgs	In press	<i>Health Psychology</i>	Pro-veg norm vs. health message (control)	71	M = 19.6	M + F	R		Y	
69				Pro-veg descriptive norm vs. pro-veg injunctive norm vs. health message (control)	70	M = 19.1	M + F	R		Y	

## Review of the literature

### *Robustness of modeling*

One immediate conclusion that can be drawn from these 69 studies is that social modeling is a profound and robust phenomenon that can determine what and how much people consume. Of the 69 studies that were reviewed, only five studies (in three articles) found limited evidence of modeling effects on food choice or intake (Hendy & Raudenbush, 2000; Hermans et al., 2012c; Pliner & Mann, 2004). This is despite diverse samples including males and females, a wide range of ages, ethnicity, weight and restraint status, and hungry and satiated individuals. Furthermore, it emerges that many efforts to establish boundary conditions for modeling have failed. For instance, researchers have hypothesized that modeling might be moderated by a person's body weight or sex (Conger et al., 1980; Nisbett & Storms, 1974), dieting status (Rosenthal & Marx, 1979), personality factors (Herman, Koenig-Nobert, Peterson, & Polivy, 2005) and hunger (Goldman et al., 1991), and in all cases it has been found that these variables did *not* moderate the strength of modeling. Below, we review key conclusions that can be drawn from the 69 identified studies, grouped broadly into sections on contextual factors, individual factors, and social factors. We aim to provide insight into the circumstances under which modeling operates and how the magnitude of the effect can be affected by a variety of factors.

### *Contextual factors*

#### *Type of food*

Most studies examining modeling of food intake among adults as well as young people have largely focused on the intake of high-energy-dense palatable foods (snacks), such as small cookies (Leone, Pliner, & Herman, 2007; Roth et al., 2001), chocolate coated peanuts (Bevelander, Meiselman, Anschutz, & Engels, 2013d; Hermans, Larsen, Herman, & Engels, 2008), popcorn (Cruwys et al., 2012), and ice cream (Florack, Palcu, & Friese, 2013; Johnston, 2002). These studies have all found the same pattern: people eat more or less when their eating companions eat more or less of these snack foods. Given the substantial number of such studies, it seems safe to conclude that people model their intake of energy-dense snack food on that of others.

Although modeling effects on vegetable and fruit consumption have been found among children and adults (Horne et al., 2004; Howland, Hunger, & Mann, 2012; McFerran, Dahl, Fitzsimons, & Morales, 2010a; Robinson & Higgs, 2013; Salvy et al., 2008a), there is some evidence that people are less likely to model their eating partner for healthy or unpalatable foods. For example, Hermans and colleagues (Hermans, Larsen, Herman, & Engels, 2009b) found that the size of the effect of modeling was small when participants were offered cucumber and carrots, and three studies have found no evidence of modeling for healthy foods (Goldman, Herman & Polivy, 1991 S1 & S2; Pliner & Mann, 2004). In children, the majority of studies have focused on modeling to encourage consumption of novel/non-preferred, low-energy-dense foods (Reverdy, Chesnel, Schlich, Köster, & Lange, 2008). These studies have utilized various types of models, including live or remote peer models (Birch, 1980; Greenhalgh et al., 2009; Horne et al., 2004), (un)familiar adult models (Addressi, Galloway, Visalberghi, & Birch, 2005; Harper & Sanders, 1975) and teacher models (Hendy, 2002; Hendy & Raudenbush, 2000). Although modeling effects do occur in all but two of these studies, repeated exposure was often needed to maintain the effect, whereas a study using snack food showed that children readily modeled, and social influence was maintained a few days later after a single exposure (Bevelander et al., 2012b; Bevelander, Engels, Anschutz, & Wansink, 2013b).

Notably, while there is considerable literature on modeling effects on food intake, much less is known about modeling of food choices, for example, when both low- and high-energy-dense foods are offered. We identified only 11 studies with a dependent variable of food choice. Although the majority of these studies have shown that modeling does occur (e.g., Mollen, Rimal, Rutter, & Kok, 2013; Prinsen, de Ridder, & de Vet, 2013; Salmon, Fennis, de Ridder, Adriaanse, & de Vet, 2014), three studies found no significant modeling effects on food choice (Hendy & Raudenbush, 2000 S2 and S3; Pliner & Mann, 2004 S2). However, given that these studies were statistically underpowered (particularly given the dependent variable is binary; Ferraro & Wilmoth, 2000), we do not want to overstate the importance of these null findings.

Nevertheless, theoretical reasons have been suggested for why modeling of food choice may be less prominent than modeling of food intake (Pliner & Mann, 2004). That is, it has been proposed that people may feel more certain about their food likes and dislikes than they do about the appropriate amount of consumption in various circumstances, and therefore do not look to others for guidance in determining their choice. An example of where people's pre-existing personal preferences might reduce modeling is when people have clear eating routines or scripts regarding regular meals such as breakfast and lunch. These scripts reflect what people have learned is an appropriate, expected or desirable amount to consume, and under these circumstances people may be less susceptible to new normative information. This line of reasoning is supported by the findings of Hermans, Herman, Larsen, and Engels (2010a), who found that breakfast intake was affected by the low- and no-intake norm, but not by the high-intake norm. The absence of the standard small-large modeling effect might indicate that these females were less susceptible to the normative information conveyed by the large-intake model. In line with this, it has been found that lunch intake was less influenced by others compared to the intake of palatable snack food (Clendenen, Herman, & Polivy, 1994; Salvy, Elmo, Nitecki, Kluczynski, & Roemmich, 2011), and that choices of lunch foods were less influenced than choice of snack foods (Bevelander, Anschutz, & Engels, 2011).

Notwithstanding these considerations, it should be clear that modeling persists in the context of meals (de Castro & Brewer, 1992; Hermans, Larsen, Herman, & Engels, 2012a; Horne et al., 2009). We propose, however, that degree of certainty is the critical moderator here, whereby people model to a lesser extent when they already have strong established preferences, routines or norms within a particular eating context. For instance, the consumption of breakfast is often based on preferences and social norms a person might have learned across many years, whereas snacking behavior may be less routinized. People may therefore be less reliant on the new normative information conveyed by the intake of the model as a means to reduce uncertainty regarding how much one should appropriately consume. Given the lack of research on this topic, however, it is difficult to ascertain whether different mechanisms may underlie modeling of food choice and intake and whether modeling of food choice is less prominent than modeling of food intake. We return to this issue in the Theoretical Implications section.

### *Live versus remote confederate*

As can be seen in Table 1, modeling has been studied both using live confederates (42) as well as using some form of remote confederate (27). Both types of model have been found to influence eating behavior; that is, people adapt their intake to both live and remote confederates (cf. Feeney et al., 2011). Although live and remote confederates were originally quite distinct categories (confederate physically present vs. not), a number of recent studies blur this distinction. For instance, studies have utilized a video confederate (Hermans et al., 2012a, 2012b, 2012c; Romero et al., 2009), social media (Bevelander et al., 2013a) or participants speaking with

a live confederate but not observing the confederate eating (Cruwys et al., 2012). These variants have generally found evidence of the same modeling effect as in live confederate studies. Yet, it is worth noting that two (Hermans et al., 2012c S1 and S2) of the three studies that utilized a remote video confederate did not find any evidence of modeling. In these two studies the confederate was shown in a different environment than the participants and ate a different kind of snack food than was available to the participants, which perhaps created contextual differences that were too large for modeling to occur (Hermans et al., 2012c). In a related finding, a study with children found that participants modeled more closely when the model ate the same color food as the participants – that is, when the contextual differences were reduced (Addressi et al., 2005). Therefore, it seems likely that these non-significant effects reveal the importance of shared social context, rather than the physical presence of the model being necessary.

The success of the remote confederate paradigm has very important implications for our understanding of modeling (rather than merely being a more convenient experimental design). More specifically, one motive that has been proposed for modeling is that individuals might model in order to affiliate or ingratiate themselves with others (Herman et al., 2003b; Hermans, Engels, Larsen, & Herman, 2009a; Robinson, Kersbergen, Brunstrom, & Field, 2014a; Robinson, Tobias, Shaw, Freeman, & Higgs, 2011). That is, people attempt to become more attractive or likable to another person through modeling. However, participants adhere to the social norm provided by remote confederates even when eating alone, when they believe their food intake cannot be observed by researchers, and when they do not expect to have any future interaction with the model (Burger et al., 2010; Roth et al., 2001; Yamasaki, Mizdzuno, & Aoyama, 2007). Ergo, it is implausible that people model purely to elicit social approval or achieve liking. Indeed, several researchers have argued that it is more likely that people model because others provide a *point of reference* in uncertain situations about what constitutes appropriate eating behavior (Cruwys et al., 2012; Herman & Polivy, 2005; Robinson, Sharps, Price, & Dallas, 2014b). This is an important point that we revisit in the Theoretical Implications section below.

#### Individual factors

Individual differences that could potentially affect modeling are multifold. In this section, we review those that have received the most research attention to date, specifically: hunger and satiety, sex, age, body weight, and the traits of impulsivity/self-control and goals related to eating.

#### Hunger and satiety

An early explanation of modeling effects, the zone of biological indifference model (Herman & Polivy, 1988), proposed that hunger would moderate social influence on eating. This model stated that biological signals are not typically a primary determinant of eating behavior, only becoming important at the extremes of hunger and satiety (Heatherton, Polivy, & Herman, 1991). In the context of social influences on eating, however, not much evidence has been found that supports the idea that modeling is moderated by hunger. That is, it has been found that modeling persists even in circumstances where individuals are very hungry (Goldman et al., 1991) or very full (Herman et al., 2003a). Furthermore, in many experimental studies, subjective hunger ratings (measured either before or after the study) have been included as covariates in the analyses. Only one of these studies has found a moderating effect of hunger. That is, Hermans and colleagues (Hermans, Herman, Larsen, & Engels, 2010b) found that males who, at the end of the experimental session, reported high pre-experimental hunger were *more* likely to adjust their intake to that of their eating companion – therefore hunger

had the opposite effect to that proposed by the zone of biological indifference model. An important limitation, however, is that the sample size of this study is small and therefore lacks sufficient statistical power to draw firm conclusions. Moreover, given that this is the only study that has found an effect of hunger on the likelihood of modeling and the findings have not yet been replicated, at this stage, it seems safe to conclude that social influences on eating are not moderated by one's level of hunger or satiety.

#### Sex

To date, a considerable amount of literature has been published investigating modeling effects among women, suggesting that women generally adapt their food intake to that of others. Although there are many studies that have included males in their design (32 out of 69 reviewed), only two studies have recruited a male-only sample (Hermans et al., 2010b; Nisbett & Storms, 1974). Very few studies have been conducted with sufficient power to compare male and female participants. This is in part for theoretical reasons, such as the much greater vulnerability of women to various kinds of disordered eating (Hoek & van Hoeken, 2003). However, it has also been for practical reasons – psychology undergraduate populations that are easiest for researchers to access are predominantly female (although this was not always the case; Nisbett & Storms, 1974 was conducted at a time and place where undergraduates were predominantly male). Given these constraints, it is difficult to conclude whether males model to the same degree as females. Of the research that has examined sex differences, however, there is some indication that men may show an attenuated modeling effect. For example, Hermans et al. (2010b) found that modeling might be weaker among men. This is consistent with some evidence from research with children that modeling is weaker among boys than girls (Hendy & Raudenbush, 2000). However, the majority of studies with children have found no sex differences (Bevelander et al., 2013a; Bevelander, Anschütz, & Engels, 2012a; Bevelander et al., 2012b, 2013d; Salvy, Coelho, Kieffer, & Epstein, 2007a; Salvy et al., 2008a, 2008b) and one study found that men showed a stronger modeling effect (Conger et al., 1980).

It has been argued that women's motivations related to eating are complicated by the "thin ideal". This refers to a cultural value placed on thinness, which is equated with success and attractiveness, and applies predominantly to women (Garner & Garfinkel, 1980; Grogan, Bell & Conner, 1997; Thompson & Stice, 2001). Consistent with the notion that women – more than men – are under pressure to conform to this thin ideal (Rodin, Silberstein, & Striegel-Moore, 1984), it has been argued that impression management related to food and eating may be more important for women than for men (Herman & Polivy, 2010; Roth et al., 2001; Vartanian, Herman, & Polivy, 2007). Therefore, we would expect that women would attend more closely to normative information regarding appropriate food intake and choice. This will lead women to adjust their eating more readily to that of others, leading to increased modeling. There is plentiful evidence that eating minimally allows women to convey an impression of femininity (see Vartanian et al., 2007 for a review), whereas less is known about males' intentions in this regard.

Taken together, although there are theoretical reasons why men might be less likely to consider their eating companion's intake as a guide for their own behavior, the empirical data do not provide a clear picture of possible sex differences in the vulnerability to modeling effects on intake. Therefore, it is not surprising that numerous scholars have suggested a more systematic look at differences between males and females in eating behavior as an important area for future research (Exline, Zell, Bratslavsky, Hamilton, & Swenson, 2012; Herman & Polivy, 2010; Leone, Herman, & Pliner, 2008).



## Age

Studies to date have been run with children (15) and young adults (43), with two studies looking at adolescents. This diversity allows us to be confident that modeling is unlikely to be limited to a particular age group, as studies have shown that modeling emerges for children as young as 1 year old (Harper & Sanders, 1975). There is also evidence for developmental stability in modeling, although one study did find that younger children showed more marked modeling than older children (Birch, 1980). Some factors that are known to moderate the strength of modeling differ across age groups, such as self-esteem, which changes across the lifespan (Robins, Trzesniewski, Tracy, Gosling, & Potter, 2002); however, moderators of modeling have never been investigated in different age ranges within a single study. In addition, few studies have investigated modeling in people beyond the age of young adult. Although we have no theoretical reason to expect that modeling would occur differently for older adults, at present there is little empirical evidence pertaining to modeling in adults above the age of 30.

## Body weight

Several studies have investigated whether the body weight of confederates or participants moderates the degree of modeling. Of the studies we reviewed, four (Conger et al., 1980; Nisbett & Storms, 1974; Romero et al., 2009; Rosenthal & McSweeney, 1979) found no evidence that body weight of participants moderated the modeling effect – that is, all participants exhibited modeling, regardless of whether they were slim, healthy weight, overweight or obese. Although the findings of Bevelander et al. (2012a) were largely the same, with both normal and overweight children modeling the intake of their peers, there was some indication that normal-weight children were more likely to restrict in the no-eating norm condition, whereas overweight children were more likely to overeat in the high norm condition. These differences, however, did not persist over time. All in all, these studies suggest that body weight does not, on the whole, determine the degree of modeling – in contradiction to the externality hypothesis that motivated early modeling research.

There is, however, evidence that the *interaction* between participant body weight and the model's body weight can influence the degree of modeling. Five studies (De Luca & Spigelman, 1979; Hermans et al., 2008; Johnston, 2002; McFerran et al., 2010a; Rosenthal & McSweeney, 1979) found evidence of a similarity effect, where modeling was enhanced when the model was of the same weight status as the participant. That is, healthy-weight participants adapted their intake to that of the model, but not when the model was very thin (Hermans et al., 2008) or obese (Johnston, 2002; McFerran et al., 2010a), whereas obese participants modeled only the intake of an obese participant (De Luca & Spigelman, 1979). We will revisit these findings in the broader discussion of similarity and shared group membership below.

## Impulsivity

Most recently, evidence has been found that individual differences in the extent to which people are able to control their eating behavior might also affect the extent of modeling. Hermans et al. (2013) showed that low-impulsive women, but not high-impulsive women, modeled the food intake of their same-sex eating companion. High-impulsive women ate the same amount of food regardless of how much the other was eating. Moreover, they were less accurate in their estimations of the amount eaten by the other person, suggesting that they paid less attention to the other's intake. It is possible that lack of impulsivity enabled women to attend to others' intake and control their own behavior in pursuit of a deliberate goal, such as affiliation. However, this conflicts with findings of Salmon et al. (2014), who found that women who were low in self-control were more subject to normative influence. Therefore it is difficult to draw firm conclusions on this point. Research on

this topic needs to be undertaken to determine whether individual differences in self-control or impulsivity increase or decrease modeling, as this issue has implications for whether modeling is a conscious or automatic process. Specifically, if modeling is conscious and effortful we would expect it to be associated with high self-control or low impulsivity, and reduced under cognitive load. This issue is discussed further below.

## Eating goals

Four studies have demonstrated that restraint status does not moderate modeling (Leone et al., 2007; Polivy et al., 1979; Rosenthal & Marx, 1979; Roth et al., 2001). That is, people who have a chronic history of dieting and struggling to maintain their desired weight are as susceptible to modeling as people with no such history. Similarly, participants who were primed with a healthy eating goal showed the same degree of modeling as did participants who experienced no such prime (Prinsen et al., 2013). On the contrary, however, Florack et al. (2013) found that participants showed a greater degree of modeling when they had been primed with a health prevention focus. Relatedly, Brunner (2010) found that cues that reminded participants of their weight led them to inhibit their intake and attenuated the modeling effect. In sum, although there is no evidence that dietary restraint moderates modeling, the current evidence is mixed for the effect of other types of eating-related goals.

## Social factors

### Type of social norm

There is some evidence that the kind of norm communicated by the model plays a part in determining the degree of modeling. Specifically, three studies that have compared descriptive norms (what others do) and injunctive norms (what others think you *should* do) demonstrated that descriptive norms are more effective in inducing modeling (Mollen et al., 2013; Robinson, Fleming, & Higgs, 2013b; Stok, de Ridder, de Vet, & de Wit, 2014). Relatedly, Hermans and colleagues (Hermans et al., 2012a) found that social norms led to comparable modeling effects regardless of whether they were communicated through portion size or actual intake. However, ambiguous or mixed norms seem to have a disinhibiting effect, such that participants no longer model (Leone et al., 2007). Importantly, Vartanian et al. (2013) have demonstrated that the perceived norm for appropriate intake mediates the modeling effect. Overall, the few studies that have examined the influence of different types of norms on food intake support the centrality of descriptive norms and show promise for elucidating the specific normative content participants attend to.

### Desire to affiliate

It has been proposed that modeling reflects an attempt to develop a social bond with one's eating companion (e.g., Exline et al., 2012; Hermans et al., 2009a; Robinson et al., 2011). It follows, then, that individual differences in the desire to affiliate with others – related to traits such as self-esteem, empathy or sociotropy (the need to please others and maintain social harmony) – could affect the magnitude of the modeling effect.

Self-esteem plays an important role in social interactions and social bonding (Baumeister & Leary, 2000; Heatherton & Wyland, 2003; Leary, Tambor, Terdal, & Downs, 1995). For example, people with high self-esteem may feel less need to affirm their social worth than do people with low self-esteem, because they worry less about how they are perceived by others and perceive a lower probability of rejection (Baumeister & Leary, 1995; Bohrnstedt & Felson, 1983; Heatherton & Vohs, 2000; Heatherton & Wyland, 2003; Kenny & DePaulo, 1993). One study investigated the potential relationship between modeling and the need for social acceptance by conducting two experiments focusing on two individual traits (i.e., empathy

and self-esteem) that could influence modeling (Robinson et al., 2011). Self-esteem and empathy were indeed found to be associated with the degree of modeling, with lower self-esteem and higher empathy scores associated with a greater degree of modeling. In addition, they found that priming feelings of social acceptance led to an elimination of the modeling effect. The findings of Bevelander et al. (2013a) further support the idea that individuals' level of self-esteem can affect their degree of modeling. Children with lower explicit body-esteem appeared to be more motivated to model than did those with higher levels of body-esteem. However, implicit self-esteem was found to have the opposite effect on modeling, such that those with higher implicit self-esteem were more likely to adjust to the intake of a peer than were those with lower implicit self-esteem. However, given the limited number of studies assessing the relationship between modeling and self-esteem (particularly implicit self-esteem), further work needs to be undertaken to verify these relationships.

The results of a study on sociotropy by Exline et al. (2012) further corroborate the assumption that people might adjust their food intake to that of others in order to affiliate with them. These researchers demonstrated that those women with a higher need to please others and maintain social harmony ate more when they believed that their eating companion wanted them to eat more and reported greater effort to model their food intake on that of their eating companion.

Relatedly, Hermans and colleagues (Hermans et al., 2009a) examined whether the quality of the social interaction affected the magnitude of the modeling effect. When the confederate was friendly and warm, modeling was attenuated. Only when the confederate was unresponsive and cold did participants show the usual modeling effect. Again, this suggests the possibility that the enhanced modeling in the unsociable condition may reflect an attempt at ingratiation. Studies have been mixed, however. In a result that would seem to contradict the result of Hermans et al. (2009a), dyads with low scores on expressiveness have been found to model less (Brunner, 2012). There have also been studies that showed no moderating effect of variables related to sociability, such as extroversion, self-monitoring (Herman et al., 2005) and empathy (Robinson, Benwell, & Higgs, 2013a). Therefore, we might tentatively conclude that there is some, but conflicting, evidence to support the notion that modeling of food intake reflects an attempt to affiliate with the eating companion.

#### Familiarity

The majority of social modeling studies in adolescents and adults involve designs in which participants are paired with strangers in unfamiliar laboratory settings. This is done in order to isolate the specific social influences of interest; when eating with familiar others, common eating norms could already have been established between persons and therefore effects could reflect selection rather than influence processes. However, people eat among family and friends most of the time, and so it is important that modeling research is conducted in these eating contexts. Only one study among adults has used an experimental design to demonstrate that modeling occurs in pre-existing friendship groups (Howland et al., 2012). In studies with children, however, it has been more common for research to utilize familiar eating models, such as peers, parents, or teachers (e.g. Addessi et al., 2005; Bevelander et al., 2012a, 2012b, 2013a, 2013d; Birch, 1980; Harper & Sanders, 1975; Hendy & Raudenbush, 2000). Only one of these studies found any evidence that familiarity with the model moderated modeling effects. That is, Harper and Sanders (1975) found that children were more willing to try novel foods when their mother (as opposed to a stranger) offered the food. All in all, on the basis of these findings, we can conclude that people model the eating of familiar, as well as unfamiliar, eating companions.

#### Similarity and shared group membership

One finding that has emerged across multiple studies is that modeling appears to be enhanced when individuals are similar, either in terms of sex (Conger et al., 1980), weight (Hermans et al., 2008; Johnston, 2002; McFerran et al., 2010a; Rosenthal & McSweeney, 1979) or age (Hendy & Raudenbush, 2000). This is exactly what would be predicted from modern social-psychological theories of social influence, which state that other people are seen as providing a relevant reference point (e.g., for appropriate eating behavior) only when they are categorized as *similar to the self* on dimensions that are contextually relevant. This notion was confirmed in a study by Cruwys et al. (2012), which found that, when participants self-categorized in terms of their university student identity, they modeled confederates who identified themselves as students of the same university but did not model confederates who identified themselves as students of another university. Similarly, Stok, de Ridder, de Vet, and de Wit (2012) found that participants modeled the eating behavior of majority group members and diverged from the behavior of minority group members, particularly when the participants were highly identified with the reference group. Therefore, we may conclude that perceived similarity is an important moderator of modeling effects. Critically, in both these studies, the moderating identities were made salient to participants in the moment – it is only when participants see themselves in terms of their university student identity that we would expect them to model only those from the same university.

Attending to shared group membership can also explain why in some circumstances participants might react *against* an eating norm provided by others. Berger and colleagues (Berger & Heath, 2008; Berger & Rand, 2008) found that individuals were more likely to eat healthily when an undesirable out-group provided a norm for unhealthy eating. This complements the findings of Oyserman, Fryberg, and Yoder (2007), who found that individuals were less likely to eat healthily when they were reminded that out-group members had a healthy eating norm. That is, because people do not seek to affiliate with and may wish to distance themselves from out-group members, we do not find modeling, and may sometimes even expect reactance, in such circumstances. Therefore, an important consideration in interpreting modeling effects is the similarity between the model and participants, and perhaps more importantly, the *perceived* shared group membership.

#### Is modeling conscious or automatic?

Several studies have shown that people report that they are not personally susceptible to modeling (Crocker, Whitaker, Cooke, & Wardle, 2010; Vartanian, Herman, & Wansink, 2008). This is consistent with a broader research finding that, although people generally acknowledge that external elements influence others, they report that these elements do not influence their own behavior (the third-person effect; Davison, 1983). What is not clear at this stage, however, is whether this represents a lack of *awareness* of modeling (that is, it occurs unconsciously) or whether this lack of reporting is due to motivated denial (that is, people deny that they model for unknown reasons; Spanos, Vartanian, Herman, & Polivy, 2013).

Evidence supporting the idea that modeling might be automatic and outside of awareness comes from studies of mimicry. It has been suggested that people process the behavior of others and engage in imitation unconsciously (Bargh & Chartrand, 1999; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). There is also evidence that mimicry of gestures occurs unconsciously, and moreover, functions as a way of affiliating with others (Iacoboni, 2009). Several studies have provided evidence that people are more likely to reach for food (Bevelander, Lichtwarck-Aschoff, Anschutz, Hermans, & Engels, 2013c), or take a bite or sip immediately after witnessing someone else do so (Hermans et al., 2012b; Koordeman, Kuntsche,

Anschutz, van Baaren, & Engels, 2011; Larsen, Engels, Granic, & Overbeek, 2009). However, mimicry of eating is also responsive to affiliation goals in a similar way to traditional social modeling studies. For example, these studies have also shown that people are more likely to imitate at the start of a social interaction than at the end, and that humans automatically and unconsciously try to prevent imitation when they do not want a bond with another person (van Baaren, Holland, Kawakami, & van Knippenberg, 2004). Therefore, if mimicry is a predominantly automatic process, modeling must also be at least partially automatic, at least to the degree that it is mediated by direct behavioral mimicry (although this probably only applies to food intake rather than food choice).

Further evidence that modeling is at least partially automatic comes from studies looking at cognitive load. Cognitive load theory states that conscious, effortful tasks require higher-level cognitive resources such as attention and self-control. It follows that if a person is pre-occupied with a task that uses these (limited) cognitive resources, they will be unable to perform other conscious, effortful tasks (Bargh, 1984; Sweller, Ayres, & Kalyuga, 2011). A study by Bevelander et al. (2013d) demonstrated that, among children, watching television led to increased modeling of a peer, but only when the content of the program was emotionally laden. This is consistent with the findings of other studies (Bellisle, Dalix, & Slama, 2004; Temple, Giacomelli, Kent, Roemmich, & Epstein, 2007). Given that previous research has argued that processing emotions requires cognitive attention, causing people to act automatically or mindlessly in other ways (Baumeister, Vohs, DeWall, & Zhang, 2007; Wansink & Sobal, 2007), this study provides evidence that modeling can occur without conscious effort.

On the other hand, evidence that modeling is enhanced when participants are less impulsive (Hermans et al., 2013) or better at self-monitoring (Berger & Rand, 2008) suggests that people are capable of monitoring and exerting control over their modeling behavior. Recent evidence has also shown that people can accurately report that social influence determines *other* people's eating, and that some people are strategically motivated to deny social influences over their eating (Spanos et al., 2013). In addition, this study found that participants could accurately report instances of mimicry in observed dyads, but not of modeling of intake across the course of meals.

All in all, the evidence to date would suggest that although modeling can be automatic, it is also accessible to conscious control. It is unlikely that the majority of modeling behavior is strategic or intended, but individuals are obviously capable of attending to and modifying their own eating behavior, and therefore there are circumstances in which people might intentionally increase or decrease intake in response to their eating companion. Furthermore, although modeling might be mediated by automatic processes such as mimicry, this cannot account for modeling effects shown in studies using a design in which written information is provided about how much previous participants have consumed. To gain more insight into the possible (non-)automaticity of modeling behavior, more research is needed to (1) conclusively determine how automatic modeling is, and (2) assess the degree to which mimicry underlies modeling.

## Theoretical implications

### *Boundary conditions versus mechanism*

A strong effort has been made by previous research to identify a substantial number of moderators that qualify the modeling effect. These studies have been empirically sound and have successfully identified a large number of candidate variables. For example, there has been a thorough investigation into the way in which weight of both the model and the participant play a role in determining the

degree of modeling. However, what is sometimes lacking is an integrated and parsimonious model that is able to explain why each of these moderators might exist. A theoretical formulation that specifies the scope of the modeling effect (and therefore what moderators we should expect) would also assist in the interpretation of seemingly contradictory findings in studies investigating moderators of modeling. For example, how are we to interpret the findings that modeling is enhanced among people who are not impulsive (Hermans et al., 2013), but also not self-controlled (Salmon et al., 2014)? A strong focus on moderators in the absence of a unifying theory is problematic because while researchers focus on questions of when modeling will *not* occur, they are necessarily less concerned with explaining *why* modeling is so robust, and *how* people's eating is socially influenced by others. Of course, investigating moderators can, in some circumstances, be a means of investigating process. That is, if a moderator is theorized to be a necessary condition for modeling to occur and an experimental paradigm can 'disable' the moderator (or prevent it from functioning), then it is possible to provide an experimental test of mechanism that is empirically superior to mediation (Jacoby & Sassenberg, 2011). There are examples of this approach being successfully applied in the modeling literature. For instance, if experimentally-induced high self-control reduces the modeling effect (Salmon et al., 2014), it follows that modeling is not a psychologically effortful behavior. Similarly, if modeling persists when both the experimenter and fellow participants are believed to be unaware of the participant's intake (Yamasaki et al., 2007), it follows that modeling is not purely due to affiliation motives. Unfortunately, however, the hunt for moderators has been unsystematic and the lengthy list of potential moderators identified by this review may leave researchers feeling like the modeling effect is not so robust after all. Therefore, a key agenda for future research must be the question of which mechanism(s) underlie(s) modeling effects on eating. Although broadly understood to be the result of normative influence (Herman et al., 2003b), there is a clear need for research specifically testing the possible mechanisms underlying modeling effects on food intake, and studies that contrast one mechanism against another.

### *Implications for normative theory*

The dominant theoretical framework that has aimed to explain modeling effects is the normative theory of Herman and colleagues (2003b, 2005). The authors aimed to reconcile literature on social facilitation, impression management and social modeling processes, based on the existing studies in (mostly female) young adults before 2003 (Herman et al., 2003b). The normative framework has been widely used in research on social norms in eating with these two articles receiving over 370 scientific citations to date. Moreover, it has clearly been generative – 47 of the 69 experimental studies that we review were published after 2003. These studies provide a number of clues for how we might further enhance the theoretical framework, and in this section we discuss these possibilities and suggest potential future directions for research.

First, the reviewed studies clearly support the assumption that people look to others to determine how much they can eat, and therefore individuals will both augment and inhibit their eating in accordance with social norms. However, some studies have found that intake in "baseline" conditions (where participants eat alone) more closely resembles food intake in the "high norm" condition than the "low norm" condition (e.g., Feeney et al., 2011; Hermans et al., 2009a, 2009b; Pliner & Mann, 2004; Robinson & Higgs, 2013; Roth et al., 2001; Vartanian et al., 2013). Some researchers (e.g. McFerran et al., 2010a; Vartanian et al., 2013) have interpreted this as evidence that modeling primarily inhibits, rather than augments intake. Their reasoning is that people have an inherent tendency to eat as much as they can within the bounds of what is



normatively considered appropriate (i.e., avoid eating “excessively”). However, it is possible that this reasoning overlooks a confound in many experimental designs that might augment eating in the so-called “baseline” conditions. That is, experimental designs can communicate norms and provide a point of comparison for participants, even if not intentionally. If modeling is such a strong drive, then participants will *look* for information about appropriate consumption, especially in control conditions where this information is not provided explicitly by a confederate. Therefore, experimental designs that provide large portion sizes and instruct participants that it is exclusively for their consumption (and in some cases, explicitly encourage high consumption, e.g., “Help yourself, we will have to throw the rest away anyway”; De Luca & Spigelman, 1979; Robinson et al., 2013a, 2014b; Vartanian et al., 2013) provide normative information that encourages high intake, over and above any experimental manipulation. Given this potential confound, it is not possible to conclude on the basis of the current literature whether inhibition or augmentation effects are more common in the modeling paradigm. One way to reduce this experimental demand in future studies might be to design studies where participants can choose their own portion sizes; or use foods where participants do not infer that all the offered food is for them personally (e.g. cake, which is typically shared, or wrapped sweets).

Second, there is an ongoing debate about the motives for people’s adherence to social norms. At the time that the normative model was first outlined in 2003, both affiliation (the need to be liked) and uncertainty-reduction (the need to be right; Deutsch & Gerard, 1955) were put forward as potential reasons for modeling. Later, however, Herman and Polivy (2005) questioned the role of affiliation as a motive for modeling, arguing that this is inconsistent with the persistence of modeling in the absence of others. What, at this time, can we say about the role of affiliation versus uncertainty-reduction as motives for modeling, in light of the studies that have been published in the intervening period?

A growing body of evidence has borne out the finding that modeling persists in situations where it is implausible that individuals are strategically seeking to ingratiate themselves with others. For example, the finding by Roth et al. (2001) that modeling effects persist even when participants are alone and believe their eating is unobserved has been corroborated by several other research teams (Burger et al., 2010; Yamasaki et al., 2007). In a related finding, researchers have found that social norms for a wide range of behaviors function when others are not physically present (Cialdini, Reno, & Kallgren, 1990; Kallgren, Reno, & Cialdini, 2000; Larimer, Turner, Mallett, & Geisner, 2004; Stok et al., 2014). These studies are consistent with the view that modeling is underpinned by an uncertainty-reduction motive. In other words, we can conclude that individuals look to others to provide meaningful information about what is appropriate to eat, how much, when and how.

On the other hand, recent evidence has also corroborated the idea that affiliation goals do play a role in shaping modeling behavior. In particular, modeling is enhanced for those with high empathy or low self-esteem (Bevelander et al., 2013a; Robinson et al., 2011) or when people seek a stronger social bond (Exline et al., 2012; Hermans et al., 2009a). These findings suggest that affiliation motives (people’s need to be liked, accepted, and to belong) cannot be ruled out as a motive for modeling. That is, even if uncertainty-reduction is the primary motive underlying modeling, it still remains possible that affiliation goals are a secondary motive under certain circumstances (or even a primary motive in some contexts).

In a nutshell, it is not always clear which motive prevails and under what circumstances. One difficulty inherent in this question is that these two motives could be interrelated, which makes it difficult to examine their independent influence on modeling effects on food intake. A hypothesis that one can derive from the social identity approach (Tajfel & Turner, 1979; Turner, Hogg, Oakes, Reicher, &

Wetherell, 1987) is thus: people model to reduce uncertainty, but modeling will be associated with affiliation (and related variables) because affiliation (*either* perceived or sought) is a precondition for modeling to occur. This is because modeling can only reduce uncertainty to the extent that shared group membership already exists – out-group members do not offer a valid guide to appropriate or correct behavior. To take this a step further, it follows that when we seek to affiliate with others – whether because of empathy, sociotropy, low self-esteem, or contextual factors – we also believe that those others provide a valid reference point for our own behavior (Turner, 1999; Turner & Oakes, 1989). That is, when we perceive a shared *psychological* group membership, the eating norm provided by in-group members becomes *self-relevant* and these in-group norms tell us what thoughts, feelings, and behaviors are appropriate in an often unfamiliar context (Berger & Heath, 2008; Cruwys et al., 2012; McFerran, Dahl, Fitzsimons & Morales, 2010b; Stok et al., 2012).

This theoretical framing is consistent with the normative model, but allows us to understand the different motives that have been identified for modeling not as contradictory, but rather as reflecting different aspects of the same social influence process. On the basis of this theorizing we can say that models and the norms that they communicate will be considered *valid* reference points only to the degree that shared group membership already exists (at least subjectively; Turner, 1991). Furthermore, this implies that the “default” for participants is perceived shared group membership, at least in studies where participants typically share sex, age, weight status, educational background, ethnicity, university student identity, etc. with confederates, any one of which might form a basis for psychological affiliation in the moment.

Third, more research is needed on modeling of food choice to examine whether the normative account is applicable and whether contextual uncertainty might be a critical moderator here. Although there have been theoretical reasons proposed for why food choice might be less affected by social influence than food intake, highly-powered experimental studies are needed to address this empirically. To date, the majority of studies have focused primarily on modeling of snack foods or modeling to encourage (novel) low-energy-dense food consumption among young people (Hendy, 2002; Hendy & Raudenbush, 2000; Reverdy et al., 2008). These are one-sided approaches, because much of a person’s eating is determined by choices made in the grocery store or from restaurant menus, rather than simply free-eating from a single type of food. To be truly confident that modeling effects have a powerful influence on eating-related decisions in peoples’ day-to-day lives and whether the mechanisms underlying modeling of food choice and intake are the same, it would be useful to expand this research area.

## Practical implications

### *Social influence is a primary determinant of eating*

An important finding of this review is that individual factors do not appear to be critical in explaining modeling effects. Several studies investigating factors such as weight and personality have found that even when significant moderators have been identified, they had a small effect relative to the robustness of modeling. This makes the consistent and substantial effect of social influence on eating behavior all the more marked and important to consider in public health policy. Although questions of mechanism and boundary conditions of social influence effects on eating are of academic interest, the simple fact that social influence is a primary predictor of eating behavior has perhaps not been given enough emphasis and more must be done to *translate* this research, that is, make it relevant and accessible to health practitioners and policymakers. This is crucial in an environment where the majority of research is concerned with the genetic, metabolic and

personality-based predictors of eating behavior (particularly for pathological eating behavior; Hill & Melanson, 1999).

The public health problems of obesity and unhealthy dieting, as well as the clinical problems of eating disorders, are partially determined by the same basic social influence process that underpins modeling of food intake and choice. For instance, research has demonstrated that subclinical indicators of disordered eating (such as dieting, bingeing and purging) are also subject to social influence, particularly from peers and family (Crandall, 1988; Hutchinson & Rapee, 2007; Paxton, Eisenberg, & Neumark-Sztainer, 2006; Paxton, Schutz, Wertheim, & Muir, 1999; Salvy, de la Haye, Bowker, & Hermans, 2012). Modeling also extends to food purchasing decisions (Bevelander et al., 2011), and is therefore likely to affect long-term consumption patterns. There are also numerous studies suggesting that people's weight can be predicted (at least partially) from that of their friends, and that obesity clusters in social networks (Badaly, 2013; Christakis & Fowler, 2007). These applied studies of social influence and eating suggest that modeling has very real consequences for physical and mental health at a population level.

Furthermore, what has been overlooked by those who would aim to “inoculate” people against the evils of social influence (e.g. Badaly, 2013; Vartanian, 2009) is that this powerful determinant of eating behavior might be harnessed “for good” (Rosenberg, 2011), for example, to encourage healthy eating. It has been demonstrated that children model the healthy eating habits of their peers and/or parents, leading to an increased vegetable intake and reduced fat intake (Bevelander et al., 2012b; Tibbs et al., 2001) and that students who reside in colleges with healthy eating norms are more likely to eat healthily and exercise (Gruber, 2008). In part because of the focus on harmful social influence, efforts to design and implement interventions that utilize positive social influence are in their infancy.

At this stage, it is also important to realize that when comparing the modeling literature with eating behavior in real-life contexts, the food choices and amounts consumed by people in the direct social environment are not likely to be as uniform as a confederate's behavior in an experimental setting. For example, confederates mostly chose *either* healthy or unhealthy foods, or are instructed to eat a small or large portion. A study on young adults in which several confederates ate different amounts of palatable food suggested that when norms are ambiguous, people are less likely to model the amount of food consumed by others (Leone et al., 2007). This has clear relevance beyond the laboratory, where eating norms are rarely overt or uncontested. Therefore, it may be that not all findings can directly be translated to real-world eating behavior, and more research in applied settings is critical to establishing the relevance of laboratory studies of eating. Nevertheless, based on our current knowledge on modeling of food choice and intake, we propose several steps to inform health-promotion interventions.

#### *Designing effective healthy-eating interventions using modeling*

One approach to modify the social environment with regard to food and eating might be the community reinforcement approach. According to this approach, different reinforcers are used to assist individuals in the adoption and maintenance of a healthier lifestyle, within the context of a supportive social network (Meyers, Villanueva, & Smith, 2005). As noted above, the social network has the potential to positively influence one's energy balance and diet composition in numerous ways – particularly among children. Parents, for instance, may influence the family environment by exposing the family members to certain foods and actively or passively allow them to eat certain foods (Clark, Goyder, Bissel, Blank, & Peters, 2007; Golan & Crow, 2004). By doing so, parents set social norms

regarding food and eating, and these norms are likely to influence initiation and maintenance of children's regular eating habits. Thus, it is conceivable that by modifying the behavior of a “model” (e.g. parent, sibling, peer), there are flow-on benefits to others in the social network.

A similar approach could be applied to nutritional interventions (again, the existing evidence base is strongest among children). Most notably, the ‘Food Dudes’, a program featuring heroic peers that model a preference for fruit and vegetables, has been trialed with thousands of schoolchildren and has been shown to influence actual consumption patterns in the short and medium term (Horne et al., 2004, 2009; Lowe, Horne, Tapper, Bowdery, & Egerton, 2004). Although current studies do not provide robust evidence that peers can reduce preferences for high-energy-dense foods, studies that investigated peer *rejection* of foods show that it is possible for children (Greenhalgh et al., 2009; Horne et al., 2004) as well as young female adults (Robinson & Higgs, 2012) to take over a peer's food aversion. In these studies, the aversion against certain foods was provided by an outspoken peer, which might have had a stronger influence than merely modeling consumption. For example, children were unwilling to eat novel foods after negative comments by their peers (Greenhalgh et al., 2009). Instead of focusing on encouragement of low energy-dense foods alone, it may be useful to expand the research area and investigate whether the impact of a peer could also be used to reject high-energy-dense foods – at least novel ones.

Modeling research is also powerful in its capacity to explain the effectiveness of public health interventions in the domain of eating. For example, we know that interventions such as increasing the availability of fruit and vegetables are effective in improving nutritional status (Hearn et al., 1998). However, rather than attributing this to automatic behavior (or stealthy “nudge” tactics, Hanks, Just, Smith, & Wansink, 2012; Thaler & Sunstein, 2008), modeling research suggests that individuals infer important information about group norms from the availability of particular foods (as well as, for example, portion size, Hermans et al., 2012a) that is then used to inform individual food choices. Therefore, modeling provides a powerful and experimentally tested framework for making causal inferences about the relationship between societal norms and population eating behaviors.

#### *Conclusion*

Although social modeling is a complex process (particularly in predicting the degree to which people will model in particular circumstances), the most important conclusion of this review is that people's food intake is determined in large part by social influence, and by modeling in particular. We found that across 69 modeling studies, there were three key conclusions that we can draw from this review. First, there was near universal support for the finding that people's food intake and choices are shaped by the norms provided by others. Furthermore, we found that many attempts to identify moderators of the modeling effect have been unsuccessful, and when significant moderators have been found they typically account for only a small amount of variance in modeling.

Second, there is evidence that modeling occurs *both* because individuals seek information about appropriate behavior (an uncertainty-reduction motive) and because individuals seek to affiliate with others (an affiliation motive). Rather than treating these as incompatible, this evidence is best understood as supporting a social identity model of social influence, whereby individuals look to similar others (or those with whom they are affiliated) to provide valid information about appropriate eating. Social influence may thus be seen as a fundamental feature of human perception and behavior, which might explain healthy, as well as unhealthy, eating behaviors.



Third, the domain in which modeling has been demonstrated is relatively narrow – most studies focus on the snack food intake of young adult females in a laboratory setting. We conclude that it is now time to move out of the lab and into the realm of intervention – both at the clinical level and at the public health level. One of the great strengths of the literature on modeling has been its experimental focus and strong empirical controls. However, more studies are needed to test the robustness of the modeling effect outside of the laboratory and, even more importantly, to determine how knowledge of this effect might enhance our capacity to support healthy eating and population health. Given the current societal challenges of both obesity and disordered eating, it is timely for us to demonstrate the utility of modeling research for intervention and health promotion.

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