

BEGGARS CANNOT BE CHOOSERS

The Influence of Food Deprivation on Food Related Disgust

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General Introduction and Thesis Outline

The need for food is one of the most basic human needs. Given that food intake is essential for survival it comes as no surprise that humans possess biological and psychological systems which evolved to ensure the detection and ingestion of food (Pittman & Zeigler, 2007). For example, when being in a state of food deprivation need-relevant cues were found to bind more attentional resources (e.g., Channon & Hayward, 1990; Mogg, Bradley, Hyare, & Lee, 1998; Stockburger, Schmaelzle & Schupp, 2005), and to be perceived more readily (Bruner, 1957; Wispe & Dramberean, 1953).

Moreover, need-relevant cues were evaluated more positively in self-report measures (Brendl, Markman, & Messner, 2003; Cabanac, 1971; Drobles, Miller, Hillman, Bradley, Cuthbert, & Lang, 2001; Lavy & van den Hout, 1993) and implicit measures by subjects who were deprived of food (Hoeftling & Strack, 2008; Seibt, Häfner, & Deutsch, 2007). Perceiving food while hungry also reduces the magnitude of the startle eye blink (Hawk, Baschnagel, Ashare & Epstein, 2004), indicating that when hungry, food has the potency to reduce aversive reflexes (but see Drobles et al., 2001; Mauler, Hamm, Weike & Tuschen-Caffier, 2006 for diverging results).

Deprivation may not only influence attention and the evaluation of food cues, but also motivational responses towards food. Particularly, eating relevant cues may activate an immediate approach motivation in those who are deprived (Seibt et al., 2007), and this may even be the case under frustrating conditions (Bulik & Brinded, 1994; Epstein, Truesdale, Wojcik, Paluch, & Raynor, 2003; Lappalainen & Epstein, 1990; Raynor & Epstein, 2003).

Food Deprivation and Food Intake

Common sense also implies that there exists an evolutionary need to lower the threshold of acceptance and consumption of foods under conditions of starvation (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972; Pliner, Herman & Polivy, 1990). Anecdotal evidence suggests, for example, that people under conditions of extreme starvation may even

eat dead human beings in order to stay alive (Berton, 1988; Gilbert, 1986; Hanson, 1999; Keys, Brozek, Henschel, Mickelsen, Taylor, 1950; Read, 1974; Simpson, 1984).

In line with the above reasoning some studies revealed that even moderate levels of food deprivation (< 24 hrs) do increase consumption of good tasting (preferred) and bad tasting (unpreferred) foods in the same manner (Bellisle, Lucas, Amrani, Le Magnen, 1984; Desor, Maller, & Green, 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968).¹ Existing explanations for this phenomenon focus on metabolic factors (e.g., the deprived organisms need to ingest calories) and on the role of taste responsiveness under acute food deprivation (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972).

Food Deprivation and Food Related Disgust

However, there is still another explanation for food deprived subjects' greater intake of unpalatable foods that remained untested to the present day. This alternative explanation does focus on the role of disgust in the realm of eating behavior. Classical theories of disgust, for example, argue that the emotion of disgust is tightly linked to eating behavior (Rozin & Fallon, 1987; see also Darwin, 1965) and can be defined as "revulsion at the prospect of (oral) incorporation of an offensive object" (Rozin & Fallon, 1987, p. 23). Common sense does further suggest that the magnitude of disgust towards a certain food should be negatively related to the intake thereof (see also Kubberod, Ueland, Risvik, & Henjesand, 2006). Hence, it would seem plausible that hungry subjects' greater intake of unpalatable foods might also be accompanied by a reduction of disgust towards these foods. Albeit immanent in several theories at least implicitly (e.g., Jacobs & Sharma, 1969; Nisbett, 1972; Pliner et al., 1990), this assumption has never been tested directly before.

¹ Other studies however revealed an increase in finickiness due to food deprivation, that is, consumption of good tasting foods increased but consumption of bad tasting (bitter) foods decreased amongst food deprived subjects (Jacobs & Sharma, 1969; Herman, Polivy & Werry, 1989; Kauffman, Herman & Polivy, 1995; Nisbett, Hanson, Harris & Stair, 1973). But noteworthy, several boundary conditions other than food deprivation (e.g., the prospect of consuming more palatable food immediately after the experiment, dieting status, bitterness as an evolutionary rooted warning signal) were also considered as critical factors in causing the effect of hunger induced finickiness (see Kauffman et al., 1995 and Pliner et al., 1990 for a detailed discussion).

Consequently, the main goal of the present thesis was to bridge this gap and to examine if the emotion of disgust is an important factor in the relationship between deprivation and food consumption as well. More precisely, it was assumed in the present thesis that food related disgust should vary as a function of homeostatic dysregulation, and that the greater acceptance and consumption of unpalatable foods might also be explained by a reduction of food related disgust amongst hungry subjects. This basic assumption is in line with the notion that food deprived organisms are specifically prepared for food ingestion (Seibt et al., 2007).

However, it contradicts classical theories of disgust (e.g., Rozin & Fallon, 1987) which argue that disgust towards certain foods is based on stable associations and may only change gradually as a result of slow, associative learning processes (e.g., extinction, adaptation; Rozin & Fallon, 1987). At best, the individual's willingness to overcome disgust (but not disgust itself) may vary contingent upon the situation (e.g., surviving in situations of extreme starvation, maintaining politeness in a foreign culture, see Rozin & Fallon, 1987).² So, based on the assumption that disgust is evoked by stable associations both, food related disgust itself and the rejection of unpalatable foods are considered invariant to fluctuations in homeostatic dysregulation unless an individual does not consciously intend to counteract them (Rozin & Fallon, 1987).

This line of reasoning was called into question within the scope of the present thesis. First, it was assumed that food deprivation does very well attenuate food related disgust, and that it does so automatically. That is, food deprived subjects should experience less food related disgust even on an early stage of information processing and they should also consume greater amounts of disgusting foods without overcoming themselves. Second (and also contrary to classic theories of disgust), it was assumed that automatic reductions of food related disgust can be explained by a flexibility of automatic associations and immediate

² Opponent process theory (Solomon, 1980) and the concept of benign masochism (Rozin & Schiller, 1980; Rozin, 1990) have also been suggested as possible explanations for hedonic shifts of initial food aversions. However, both accounts focus on irritating sensory experiences (e.g., indulging hot spices) rather than on disgust and imply slow changes as well (see Rozin, 1999 for a more detailed discussion).

motivational tendencies towards disgusting foods. This latter assumption is based on a contemporary dual process model of social behavior (Strack & Deutsch, 2004), and on recent findings yielding that automatic associations and immediate approach motivational tendencies towards need relevant cues (palatable foods in this case) are by no means stable, but do indeed vary as a function of food deprivation (Seibt et al., 2007). These latter findings imply that disgusting (but edible) foods should also evoke more positive automatic associations and stronger approach motivational tendencies in food deprived subjects because, after all, they are need relevant, too.

Dissertation Goals and Thesis Outline

To the present day no study exists that tests the influence of food deprivation on food related disgust, or on automatic associations and immediate approach motivational tendencies towards disgusting foods. Thus, the first goal of the present thesis was to bridge this gap and to supplement classical theories of disgust by testing if a reduction of food related disgust might occur even automatically under moderate levels of food deprivation.

Second, it was intended to clarify if attenuations of food related disgust would really provide a convincing explanation for hungry subjects' greater intake of unpalatable foods that was observed in prior studies (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968). For this purpose, hungry and satiated participants' intake of disgusting foods was experimentally investigated in greater detail.

The third objective of the present work was to identify several mental mechanisms that may underlie alterations of food related disgust and the intake of disgusting foods. As argued already, there is reason to believe that both, automatic associations and immediate approach motivational tendencies towards disgusting foods might be changed by food deprivation and so it seemed promising to investigate them more extensively.

Over and above, food deprivation might also affect food related disgust and eating behavior on a more elaborated level of processing. Particularly, when given the choice between several food alternatives the deprived organism may also engage in more rational cost-benefit-calculations when deciding which food to select and consume, and which food to reject. In the course of such cost-benefit considerations, positive and negative features of several food options are typically charged against each other in a compensatory manner resulting in a rather elaborated decision about which food to consume and which food to reject.

In the present thesis the assumption was tested that food deprivation changes the relative importance (or weighting) of certain food features during this computational process. Particularly, food deprived subjects should put greater emphasis than satiated subjects to those food features that are functional in ending their state of deprivation (e.g., availability of a given food in terms of amount and time) and neglect those food features that are purely hedonic and “non-nutritional” in nature (e.g. preferred flavor, palatable visual appearance). As a result of this computational process, food deprived participants should be more willing than satiated participants to choose and to consume foods that do not meet their hedonic demands (as long as these foods are functional for ending their state of food deprivation). This assumption was tested in a food choice task that was developed specially for the question at hand. In the following, the goals and research questions of the present thesis will be described in greater detail.

Automatic Reduction of Food Related Disgust

As mentioned above, the first objective of the present work was to illustrate that hunger reduces food related disgust. It was assumed in the present thesis that facial disgust expressions would mirror the magnitude of subjectively experienced disgust, and therefore the experimental focus was put on the influence of food deprivation on facial disgust reactions in

the first two studies.³ According to several researchers, disgust is strongly related to movements around the mouth (Ekman & Friesen, 1975; Darwin, 1965; Izard, 1971; Rozin & Fallon, 1987) and particularly, the prototypical *disgust face* can be characterized by a retraction of the upper lip and a nose wrinkle (Rozin et al., 1993). The M. Levator labii is responsible for raising the upper lip, and its activity therefore captures a central component of the disgust face. Not surprisingly, the activity of the levator muscle was specifically related to processing of disgust relevant stimuli (Vrana, 1993, 1994; Yartz & Hawk, 2002) and to repulsive tastes (Hu, Player, Mcchesney, Dalistan, Tyner & Scozzafava, 1999) in several EMG studies. Given that food deprivation reduces food related disgust, hungry subjects were expected to show weaker levator activity than satiated subjects when being confronted with disgusting food stimuli.

Higher Intake of Disgusting Foods

The second main purpose of the present thesis was to examine if attenuated feelings of food related disgust would also translate into actual eating behavior. If hunger reduces food related disgust, food deprived subjects should also be more willing than satiated subjects to consume disgusting foods when it comes to real food ingestion. As mentioned before, previous studies already yielded greater intake of both, good tasting and bad tasting foods amongst deprived subjects (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968), thus corroborating this assumption. However, to the present day metabolic factors (e.g., the starving organism's need to ingest calories) and the role of taste responsiveness under acute food deprivation were discussed as the most important explanations for this phenomenon (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972).

³ Of course, facial disgust expressions do not only mirror the magnitude of subjectively experienced disgust, but can also influence them via facial feedback loops (see Niedenthal, 2007 for an overview). However, in the scope of the present thesis disgust expressions primarily served as a dependent measure indicating the magnitude of food related disgust amongst hungry and satiated subjects.

In fact, alterations in food related disgust would provide a very compelling alternative explanation for these results, too. Therefore, the actual intake of disgusting foods was measured for food deprived and satiated subjects in two studies. In order to highlight the role of food related disgust in the relationship between food deprivation and the consumption of unpalatable foods (and to render previous explanations implausible) two aspects were kept in mind in these studies. First, hungry subjects were exposed only to moderate levels of food deprivation, thus reducing metabolic pressures to ingest calories immediately. Second, experimental foods were related to the emotion of disgust, but were not bad-tasting. Consequently, differences in taste or taste responsiveness should not provide compelling explanations for any observed results. Based on the assumption that food deprived participants experience less disgust towards disgusting foods, hungry participants were expected to consume more of a disgusting food than satiated participants.

Mental Mechanisms Underlying the Reduction of Food Related Disgust

The third main goal of the present thesis was to investigate mental mechanisms that may underlie a reduction of food related disgust. From the perspective of dual processing accounts (see Strack & Deutsch, 2004 for an overview) food deprivation might alter food related disgust via two systems of information processing that were labeled *Impulsive System* and *Reflective System* (Strack & Deutsch, 2004; see also Bechara, 2005).

On an impulsive (or associative) level of information processing, food deprivation may alter automatic associations and immediate approach motivational tendencies towards disgusting foods. In addition, food deprivation may also exert an influence on a reflective (or rule based) level of processing. That is, food deprivation may influence cost-benefit-calculations of individuals who have to decide whether to select and consume a certain food, or not. Both routes of influence will be described in greater detail below.⁴

⁴ It was argued already that disgust expressions themselves may also represent a mechanism by which food deprivation changes food related disgust (i.e., via facial feedback loops; Niedenthal, 2007; Strack, Martin, & Stepper, 1988). This possibility however was not investigated extensively in the present thesis.

Reduction of food related disgust via the Impulsive System. To begin with, the idea that food related disgust can be reduced by food deprivation automatically is fairly in line with a contemporary model of social behavior, and might be related to a processing system that was labeled *Impulsive System* (Strack & Deutsch, 2004; see also Bechara, 2005). More precisely, information processing in the Impulsive System is characterized by an automatic spread of activation between nodes of a multimodal memory store (associative processing; Anderson, 1976, 1983) that does not depend on processing capacity or intention (see also Fazio, 1990). Reactions in the Impulsive System include the activation of immediate evaluations (or automatic attitudes, respectively), cognitive concepts, behavioral schemas (e.g., immediate execution of approach and avoidance behaviors), and physiological states (see Strack & Deutsch, 2004). It is assumed in the Reflective Impulsive Model (*RIM*; Strack & Deutsch, 2004), that food deprived organisms should be prone to approach need relevant stimuli even on an impulsive level of information processing (see also Hoefling, Strack, & Deutsch, 2006), and recent evidence indeed shows that hungry subjects exhibit stronger immediate approach motivational tendencies towards food cues than satiated participants (Seibt et al., 2007). As already mentioned, automatic attitudes towards eating relevant stimuli were shown to be sensitive for dynamic shifts in homeostatic regulation, too (Hoefling & Strack, 2008; Seibt et al., 2007), and hence might also provide a basis for the automatic reduction of food related disgust.

Reduction of food related disgust and automatic attitudes. Given these latter findings (Hoefling & Strack, 2008; Seibt et al., 2007), it seems plausible to assume that food deprived subjects' weaker disgust reactions towards disgusting foods might also go together with more positive automatic attitudes towards such foods. To test this assumption, two studies were conducted that measured hungry and satiated subjects' immediate evaluations of disgusting foods with newly developed indirect measures of attitudes; the single target IAT (*st-IAT*;

Wigboldus 2005; cf. Steinman & Karpinski, 2006), and the Affect Misattribution Procedure (*AMP*; Payne, Cheng, Govorun, & Stewart, 2005).

To give a brief overview, the st-IAT is a variant of the classical Implicit Association Test (*IAT*; Greenwald, McGhee, and Schwartz, 1998) that uses only one target category rather than two target categories (Steinman & Karpinski, 2006; Wigboldus et al., 2005). In the st-IAT, subjects are asked to press either a left-hand key or a right-hand key depending on which stimulus is presented on a computer screen. Importantly, subjects are asked to press the correct button as quickly as possible and response latencies serve as a main dependent measure. Ultimately, reaction time indices are computed that inform about the extent to which a target category (e.g., disgusting food stimuli) is associated with positive or negative valence. If hungry participants' automatic reduction of food related disgust is really based on a shift in immediate evaluations of disgusting foods, they should exhibit more favorable automatic attitudes towards disgusting foods than satiated participants in the st-IAT.

In the *AMP* no reaction times are measured. Instead, subjects are asked to evaluate several ambiguous stimuli (Chinese pictographs) as "rather positive" or "rather negative" by pressing one of two response keys. Each Chinese pictograph is preceded by a critical stimulus that serves as a prime (e.g., positive pictures vs. disgust related pictures). Importantly, the valence of primes is assumed to influence the individual's evaluation of the ambiguous Chinese pictograph by a kind of affective transfer (e.g., Murphy & Zajonc, 1993). That is, after positive primes, a greater proportion of Chinese pictograph should be categorized as "rather positive" than after negative or disgust related primes. Noteworthy, this effect was observed even after participants were warned not to let the prime images influence their evaluations of the pictographs (Payne et al., 2005). Moreover, a recent study by Payne, McClernon, and Dobbins (2007) shows that nicotine deprivation renders smoking relevant cues more positive for smokers in the *AMP* thereby suggesting that the *AMP* might be sensitive for state fluctuations in homeostatic regulation. Analogously, if food deprivation

renders disgusting foods more positive, this should be reflected in a higher proportion of “positive” responses amongst hungry subjects (compared to satiated subjects) after disgusting food primes.

Reduction of food related disgust and immediate approach motivational tendencies. As already mentioned, the assumption that food deprived organism should approach need relevant stimuli immediately (Strack & Deutsch, 2004) was corroborated at least for palatable food cues (Seibt et al., 2007). However, it seems reasonable to assume that immediate motivational tendencies towards disgusting (but edible) foods should be modulated in the same way. After all, these foods are need relevant, too. Moreover, there is also reason to believe that the specific emotion of disgust is linked to general motivational tendencies of approach and avoidance (Rozin, Haidt & McCauley, 1993). Consequently, a reduction of disgust towards a disgusting stimulus should be accompanied by a change in approach motivational tendencies towards this stimulus. Provided that there is a link between food related disgust and immediate motivational tendencies of approach and avoidance, hungry subjects should exhibit a stronger motivation to approach disgusting foods than satiated subjects.

To test this hypothesis, two studies were conducted that implemented a modified version of the Approach Avoidance Task (*AAT*; Rinck & Becker, 2007; see also Chen & Bargh, 1999). In this task, subjects are presented photographs on a computer screen that have to be symbolically approached by pulling them “towards oneself” with a joystick, or symbolically avoided by pushing them “away from oneself” with a joystick depending on a reaction signal that is not related to the content of the photographs. It is assumed that low response latencies for pulling a given stimulus towards oneself (compared to high response latencies for pushing it away from oneself) are indicative of an automatic approach motivational tendency towards this stimulus. Consequently, it was assumed in the present thesis that food deprived subjects

(compared to satiated subjects) should be faster in pulling disgusting food stimuli “towards themselves” than pushing them “away from themselves”.

Reduction of food related disgust via the Reflective System. It was argued before that food deprivation may also exert an influence on peoples’ disgust reactions and their eating behavior via a more elaborated route of information processing. It might for example be that food deprivation simply changes subjects’ conscious evaluations of disgusting foods (for the case of palatable food stimuli see for example Brendl et al., 2003; Cabanac, 1971; Drobles et al., 2001; Lavy & van den Hout, 1993) that may in turn be responsible for the attenuation of food related disgust and the greater intake of disgusting foods amongst hungry subjects.

This effect however would be trivial and it was assumed in the present thesis that food deprivation may exert an influence on food related disgust and eating behavior via the Reflective System even in the absence of altered conscious evaluations. Particularly, it was hypothesized that food deprivation should exert an influence when the organism is faced with a choice between several food options. In the context of such food choices, the organism might engage in cost-benefit-computations that are helpful in deciding whether to select or to reject a given food option. Importantly, cost-benefit-computations are characterized by weighting and charging positive aspects (benefits) and negative aspects (costs) of a given option against each other, and arriving at a total utility score at the end of this process.

In the present thesis it was tested whether food deprivation shifts the relative importance (or weighting) that is assigned to critical food features within this computational process. Importantly, a distinction was made between *hedonic food attributes* (e.g., palatable visual appearance, preferred flavor) that are not relevant from a nutritional point of view and *functional food attributes* (e.g., availability of food in terms of amount and time, nutritional value) that play a decisive role in ending a state of food deprivation. It was hypothesized, that the utility derived from hedonic food attributes decreases for the starving organism, whereas the utility derived from functional food aspects increases. Ultimately, food deprived

organisms might experience less disgust towards disgusting (but edible) foods, because they do not care about the feature of palatability anymore, but value mainly a food's potential to end the aversive state of deprivation instead.

This hypothesis is in line with the commonsensical assumption that the eating behavior of hungry organisms should be controlled by physiological demands rather than by psychological influences (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972), and is very well reflected in the proverb "Beggars cannot be Choosers". However, the coarse grained distinction between physiological and psychological influences does not equal the distinction between functional and hedonic food features that is put forward in the present thesis. Most important, the present thesis goes beyond prior studies in that it exactly specifies one underlying psychological mechanism and tests it experimentally. To resume, unlike satiated subjects the deprived organism should attach greater importance (or weighting) to functional food attributes than to hedonic food attributes (that are not functional in ending a need state) within a process of cost-benefit-calculations.

A food choice paradigm for assessing the relative importance of food attributes. Prior studies pertaining to this issue merely focused on the intake of palatable vs. unpalatable foods under conditions of restricted access to only one type of food (Bellisle et al., 1984; Desor et al., 1977; Herman et al., 1989; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968; Kauffman et al., 1995; Nisbett et al., 1973). Therefore, it can only be concluded from these studies that food deprived subjects do not hesitate to consume even unpalatable foods in order to satisfy their hunger under the precondition that nothing else is available. To the author's knowledge, no study exists that presents food deprived (vs. satiated) subjects with several food options simultaneously and systematically varies the hedonic and functional attributes of those food options. In contrast to earlier studies, such an experimental design one would allow for a direct quantification of the relative importance of these attributes for hungry and satiated subjects.

For this purpose, a computerized food choice task was developed that presented subjects with a number of choices between several food options. Importantly, food options systematically differed in respect to three critical food-attributes that are relevant for the question at hand. More precisely, different snack options (two at a time) were presented on a computer screen that varied systematically in respect to subjects' idiosyncratic hedonic preferences (preferred snack vs. unpreferred snack), portion size (very small portion vs. large portion), and availability in terms of time (immediately available vs. available only after a delay of 90 min). Combining these three features resulted in a total number of 8 different snack options that served as objects in a complete block design of 28 paired comparisons (Thurstone, 1927). Subjects were instructed to choose their preferred snack option in each of the 28 trials and their choices were analyzed with a de-compositional variant of the Conjoint Analysis (Backhaus, Erichson, Plinke, & Weber, 2003) that allows for an estimation of the relative importance of all three food features, the trade-offs between these features, and the total satisfaction or utility that hungry vs. satiated participants derive from them. To increase the relevance of the task, all subjects were told that they would receive one specific snack option that was randomly determined out of their choices.

Importantly, this food choice task constitutes a situation in which several critical food attributes (and motivations for choosing a particular food, respectively) are pitted against each other and one has to decide which attribute is more important. For example, when given the choice between a highly preferred snack (that is very small and available only after a substantial time delay though), and a large portion of an unpreferred (but acceptable) snack that is available immediately, people face a situation in which their hedonic preferences have to be weighted against their need to satisfy their hunger. Hence, it seems very plausible to assume that hungry subjects should be more likely to choose the unpreferred (but immediately filling) snack over the preferred (but un-filling) snack. Satiated subjects, in contrast should be more likely to insist on their hedonic preferences and go for the preferred snack. After all,

they do not have any motivation to end a negative state of food deprivation, and so portion size or immediate availability of food should be less important to them than their hedonic preferences.

To summarize, it was hypothesized that it is more important for food deprived participants than for satiated participants to get a large portion and to get something to eat immediately in the context of the described food choice task. In contrast, it should be less important for hungry subjects than for satiated subjects to get a highly preferred snack.

Summary of Core Assumptions and Overview of Sections

In the following, a short reminder will be given about the core assumptions of the present thesis. Each core assumption will be examined in a separate section that provides a more specific rationale of the reported studies, all relevant methodological details and results, and an interim conclusion. Any additional hypotheses (which are not central to the topic of food deprivation and food related disgust) will be addressed within the specific section they pertain to.

Section 1: Automatic Reduction of Food Related Disgust

To summarize, it was assumed in the present thesis that even moderate levels of food deprivation (< 24 h) will lead to an automatic reduction of disgust towards disgusting foods. This hypothesis was tested in Section 1 by examining facial disgust expressions (levator muscle activation) of hungry vs. satiated subjects who were confronted with disgusting food stimuli. It was hypothesized that food deprived participants would exhibit weaker levator activity than satiated participants when being confronted with disgusting foods.

Section 2: Greater Consumption of Disgusting Foods

Based on the initial assumption that food deprivation would reduce food related disgust, it was also predicted that food deprived subjects will actually consume greater amounts of disgusting foods than satiated subjects. This hypothesis was tested in Section 2, by presenting

subjects with disgusting foods in an ostensible taste test. As already described, an attempt was made to rule out taste and taste reactivity as compelling alternative explanations for any observed result by using foods that were disgusting, but not bad-tasting.

Section 3: More Positive Automatic Attitudes towards Disgusting Foods

The studies reported in Section 3 were designed to test if an automatic reduction of food related disgust amongst hungry subjects is related to a shift in their automatic attitudes towards disgusting foods. Drawing on prior studies (Hoefling & Strack, 2008; Seibt et al., 2007) and on core assumptions of the Reflective Impulsive Model (RIM; Strack & Deutsch, 2004) it was hypothesized that food deprived subjects might also hold more favorable automatic attitudes towards disgusting foods than satiated subjects. As already described, two recently developed indirect attitude measures, the single target – IAT (*st-IAT*; Wigboldus 2005; cf. Steinman & Karpinski, 2006), and the Affect Misattribution Procedure (*AMP*; Payne et al., 2005) were implemented to test this hypothesis.

Section 4: Stronger Approach Motivational Tendencies towards Disgusting Foods

The assumption that immediate motivational tendencies of approach and avoidance may underlie an automatic reduction of food related disgust is also based on the aforementioned study by Seibt et al. (2007), and the RIM (Strack & Deutsch, 2004). This hypothesis was tested in Section 4, by implementing a modified version of Rinck and Becker's (2007) Approach Avoidance Task (AAT; see also Chen & Bargh, 1999). In short, food deprived subjects were expected to show stronger immediate approach motivational tendencies towards disgusting foods than satiated subjects. This is because the deprived organism should be tuned towards approaching need relevant stimuli (including disgusting, but edible foods), and because a reduction of experienced disgust should be accompanied by a reduction of immediate avoidance motivation (Rozin et. al., 1993).

Section 5: Alteration in the Relative Importance of Functional and Hedonic Food Attributes

Finally, a computerized food choice task will be reported in Section 5 that was designed to test if food deprivation alters the relative importance of critical food attributes in the context of more elaborated cost-benefit-computations. In short, it was assumed in the present thesis that certain attributes of food are mainly hedonic in nature (e.g., preferred flavor, palatable visual appearance) while others are rather functional for ending a state of homeostatic dysregulation quickly (e.g., availability of food in terms of time and amount). It is further assumed that the importance of these features (or the utility that is derived from them) varies as a function of the organism's need state. More precisely, the importance of hedonic food attributes should decrease for the deprived organism, and the importance of functional food attributes should increase.

In the following, the core assumptions will be tested and reported separately in the 5 sections that were described above. At the beginning of each section, a short overview of the studies and a specific rationale will be provided. Then, the methods, results and implications of each study will be described separately before giving an interim conclusion at the end of each section.

Section 1: Does Food Deprivation Reduce Food Related Disgust?

Overview and Rationale of Study 1 and Study 2

As already mentioned, Study 1 and Study 2 were designed to test if food deprivation automatically attenuates disgust reactions towards disgusting foods. In order to measure disgust directly, the focus was put on its expressive component (facial reactions). To recapitulate, it is suggested that the activity of certain facial muscles is related to specific affective states (e.g., Darwin, 1965; Ekman, 1982, 1992; Izard, 1971) with disgust being related to movements around the mouth (Ekman & Friesen, 1975; Darwin, 1965; Izard, 1971; Rozin & Fallon, 1987), particularly to the activity of the *M. Levator labii* (Rozin et al., 1993; Vrana, 1993, 1994; Yartz & Hawk, 2002).

To determine the specific influence of homeostatic dysregulation on food related disgust in Study 1 and Study 2, food deprived and satiated subjects' activity of the *M. Levator labii* was quantified while they were watching photographs of palatable and disgusting foods (as well as positive and disgusting photographs unrelated to food). For control purposes, the activity of the *M. Zygomaticus major* (the muscle involved in smiling), and the *M. Corrugator supercilii* (the muscle responsible for frowning) was also assessed in both studies. This is because there seems to be a more general connection between zygomatic muscle activation and processing positive information, whereas corrugator activation is related to processing negative information (see Dimberg, 1990, and Fridlund & Izard, 1983 for reviews).

In Study 1, hungry and satiated participants were filmed and videotaped surreptitiously while watching the above mentioned photographs on a TV screen. With their agreement, their videotaped facial activity was quantified by two independent raters using the Facial Action Coding System (*FACS*; Ekman & Friesen 1975; Ekman, Friesen, & Hager 2002) afterwards.

In Study 2, facial activity was recorded via EMG in order to detect even small changes in muscular activity that would not manifest as visible muscle contractions.

Hypotheses of Study 1 and Study 2

To summarize, the main purpose of Study 1 and Study 2 was to investigate if disgust reactions towards disgusting foods are modulated by food deprivation automatically. It was hypothesized that hungry participants (compared to satiated participants) would exhibit weaker disgust reactions when watching pictures of unpalatable foods. This should become manifest in a decreased activity of the levator labii muscle. Correspondingly, albeit not central to the present thesis, it was expected that food deprived subjects' activity in the zygomaticus muscle region to be stronger when watching pictures of palatable foods compared to satiated participants. This prediction is in line with prior findings yielding that food deprivation renders eating relevant cues more positive in self-report measures (Brendl et al., 2003; Cabanac, 1971; Drobles et al., 2001; Lavy & van den Hout, 1993) and implicit measures (Hoefling & Strack, 2008; Seibt et al., 2007).

There was no specific hypothesis regarding the activity of the corrugator. But given its involvement in expressing anger and effort (Smith, 1989; Strack & Neumann, 2000), it was assessed to explore potential effects of deprivation.

Study 1: Food Deprivation and Food Related Disgust Measured with the FACS

Methods

Participants and Design

Fifty-two undergraduate psychology students (33 female) at the University of Würzburg participated in an experiment ostensibly designed to measure effects of blood glucose and visual information processing on concentration. Subjects were either food deprived or satiated and were instructed to “watch a series of photographs on a TV screen”. Photos depicted stimuli that were either related to food or not related to food. Within each picture category, half of the pictures were positive and the other half was disgust related, resulting in a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust

related) mixed factorial design with need state being manipulated between subjects. Subjects received course credit for participation. Two days before the experiment, participants were contacted by the experimenter. This was done to convey first instructions and to exclude vegetarians or persons who reported being on a diet or having certain food-relevant allergies before scheduling any participants. Eight subjects had to be excluded from the analyses either because of missing data files ($n = 2$), a Body Mass Index (BMI) below 17.5 ($n = 1$), or above 25 ($n = 2$), or because they classified themselves as vegetarians in the experiment ($n = 3$). The resulting sample consisted of 17 men and 27 women, aged between 19 and 42 years ($M = 21.70$, $SD = 3.86$). Experimental groups did not differ in the percentage of women (hungry: 57.7 % vs. satiated: 66.7%), $\chi^2(1; N = 44) < 1$, and BMI ($M_{hungry} = 20.95$, $SD = 1.84$ vs. $M_{satiated} = 21.20$, $SD = 1.63$), $t(42) < 1$.

Procedure and Materials

Procedure. Participants were either asked to refrain from eating for 15 hours (which was said to lower their blood glucose level), or to have lunch immediately before the experiment (which was said to heighten their blood glucose level). Experimental sessions started at noon or 1:30 p.m., and participants were tested individually. After being welcomed by the experimenter, participants were seated at a table where they signed a consent form and reported their current mood on a paper and pencil questionnaire. Then participants were asked to measure their level of blood glucose on a standard digital blood sugar meter with the aid of the experimenter. Blood glucose concentration (mmol/l) served as an objective manipulation check. Next, subjects were given 90 s to complete an ostensible baseline measure of concentration (Brickenkamp, 1962; Oswald, Hagen, & Brickenkamp, 1997), before watching a sequence of pictures on a TV screen.⁵ In order to disguise the presentation of the pictures, participants were told that they would have to complete another concentration test at the end of the session and that the picture viewing task was designed to examine the impact of

⁵ In fact, the concentration test only served as a means of establishing the cover story and was not analyzed.

processing emotional stimuli on their performance in the second concentration test. While watching the photographs, participants were filmed without their knowledge. After picture presentation all subjects completed a second concentration test, a measure of disgust sensitivity (Schienle, Walter, Stark & Vaitl, 2002), another mood questionnaire, and a set of demographic questions. Amongst them, one question was pertaining to their subjective feeling of hunger and served as a second manipulation check. Finally, subjects completed a funneled debriefing procedure to check for suspicion. All questionnaires were administered as paper and pencil versions.

Mood assessment. To examine the potential influence of mood, self reports of mood were taken at the beginning and at the end of the session by asking subjects how they feel on a scale ranging from 1 (*bad mood*) to 5 (*good mood*).

Concentration test. As an ostensible measure of concentration, the D2-concentration test (Brickenkamp, 1962; Oswald et al., 1997) was used. Subjects were instructed to mark as many targets as possible within 90 s and to be as accurate as possible. Since this task only served to maintain the cover story it will not be reported in greater detail.

Picture presentation. To check if food deprivation would have a specific influence on facial reactions towards need relevant cues, 12 food pictures and 12 control pictures were presented that were unrelated to food (see Appendix A2). Within each category, one half of the pictures were positive and the other half was disgust related. More precisely, positive food pictures depicted palatable looking dishes that were arranged in an aesthetic way (i.e., pizza). In contrast, disgusting food pictures depicted unpalatable looking dishes (i.e., spinach pulp) that were arranged in an unaesthetic way and bore a certain visual resemblance to excrements and vomit due to their color and texture. This manipulation was chosen because disgust towards (and rejection of) certain foods is also evoked by mere visual similarity between a food stimulus and a disgusting object (Rozin, Millman & Nemeroff, 1986). Control pictures depicted either positive objects (i.e., flowers) or disgusting objects unrelated to food (i.e.,

waste). Food pictures and control pictures were matched for valence and arousal amongst both, positive and negative pictures.⁶

Due to technical reasons, pictures were presented in one of three random sequences that had been recorded on DVD in advance. Each trial started with a fixation cross that was presented for 1000ms at the center of a 28" color TV screen. Afterwards, a picture was presented for 6 s in full screen size, followed by an inter-trial-interval of 3 s. The TV screen was placed in eye level 2.5 m in front of the participants.

Recording of facial activity. Subjects were placed in front of a standardized background (blue wall) under standardized lighting conditions and their facial activity was recorded with a standard Camcorder through a one-way mirror. In order to relate the videotaped facial expressions to the presented stimuli, a standard video mixer (Panasonic WJ-AVE5) was used to generate a picture-in-picture output that depicted the synchronized streaming sequence of videotaped facial expressions (main frame) and the actual picture sequence that was shown to each subject (small frame, see Figure 1).



Fig.1: Illustration of the picture-in-picture output from Study 1

Disgust sensitivity. In order to assure that hungry and satiated subjects would not systematically differ in disgust sensitivity, all participants completed the German Questionnaire for the Assessment of Disgust Sensitivity (Fragebogen zur Erfassung der

⁶ In fact, a pretest was conducted to compose the picture sets for Study 1 that will not be reported in greater detail here.

Ekelempfindlichkeit FEE; Schienle et al., 2002) before working through the final part of the session. In short, subjects were asked to judge their level of disgust across 37 different situations on a scale ranging from 1 (*not disgusting*) to 5 (*very disgusting*). Importantly, items can be assigned to five different subscales that refer to the disgust categories death, body secretions, hygiene, spoilage, and oral rejection. The latter two scales are eating relevant subscales that specifically refer to food related disgust (Schienle et al., 2002).

Rating procedure. It was assured that the two raters were not only blind for conditions, but also blind for stimuli by masking the small frame during the rating procedure and presenting acoustic triggers that signaled the onset and offset of each picture. This allowed raters to determine the onset and offset of a (hidden) picture while rating subjects' videotaped facial expressions. Both raters were trained to detect and to rate the activity of the three facial muscles or Action Units (AU; Ekman & Friesen, 1975), respectively. In particular, the activity of the levator (AU 9), zygomaticus (AU 14), and corrugator muscle (AU 4) was determined according to the FACS guidelines established by Ekman and Friesen (1975), and Ekman et al. (2002). More precisely, scale ranging from 0 (*no visible muscle contraction*) to 5 (*maximal muscle contraction*) was used to quantify the degree of facial activity. The maximum magnitude of muscle contraction within the 6 s – interval of picture presentation was determined for each muscle separately and served as a dependent variable.

Results

Manipulation Check

To check for differences between deprived and satiated participants in subjective hunger ratings and blood glucose concentration, two simple T-tests were conducted. As expected, food deprived subjects reported stronger feelings of hunger ($M = 3.73$, $SD = 1.22$) than did satiated participants ($M = .67$, $SD = .84$), $t(42) = 9.24$, $p < .001$, $d = 2.92$, on a scale ranging from 1 (*not hungry at all*) to 5 (*very hungry*). Three satiated subjects refused to measure their blood glucose level. Amongst remaining subjects, food deprived participants

($M = 99.77$ mmol/l, $SD = 24.53$) had only a slightly lower blood glucose concentration than satiated participants ($M = 113.20$ mmol/l, $SD = 28.26$), $t(39) = 1.60$, $p = .12$, indicating that blood glucose level is not a very sensitive indicator of food deprivation after 15 h. Furthermore, several subjects reported that measuring their blood sugar made them feel uncomfortable and anxious in advance. For these reasons, blood sugar was not measured in the following studies anymore.

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2 (need state: deprived vs. satiated) x 5 (subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;38) = .71$, $p = .62$. Furthermore, none of the FEE subscales differed as a function of food deprivation, all $F(1;42) < .91$, $p > .34$. The finding that even the eating relevant subscales of the FEE stayed unaffected by state-level variations of food deprivation supports the notion that the FEE is a trait measure of food-related disgust sensitivity and insensitive to momentary variations in relevant psychological or biological states (Schienle et al., 2002).

Mood. To further rule out any differences between food deprived and satiated participants in self reported mood, a 2 (need state: deprived vs. satiated) x 2 (time of mood assessment: baseline vs. end of the session) mixed model ANOVA was conducted. A main effect of need state emerged, $F(1,42) = 5.29$, $p = .027$, $d = .36$, that was qualified by a significant need state x time of mood assessment interaction, $F(1,42) = 11.68$, $p = .001$, $d = .53$. Follow-up T-tests were conducted to dismantle this interaction. Results indicate that satiated participants were in a better mood than food deprived participants at the beginning of

the experimental session ($M_{satiated} = 3.89, SD = .76$ vs. $M_{deprived} = 2.63, SD = 1.32$), $t(40.83)^7 = 3.98, p < .001, d = 1.17$, but not at the end of the experimental session ($M_{satiated} = 3.44, SD = 1.34$ vs. $M_{deprived} = 3.06, SD = 1.33$), $t(42) < 1$. This is because hungry participants' mood improved significantly towards the end of the session ($M_{baseline} = 2.63, SD = 1.32$ vs. $M_{end} = 3.06, SD = 1.33$), $t(25) = 3.73, p = .001, d = .32$, whereas satiated subjects' mood got slightly worse ($M_{baseline} = 3.89, SD = .76$ vs. $M_{end} = 3.44, SD = 1.34$), $t(17) = 1.72, p = .10, d = .50$.

Inter-rater reliability. To determine inter-rater reliability, correlations between the rating scores of Rater 1 and Rater 2 were computed for each picture and each facial muscle separately. Then, correlation coefficients were Fisher z- transformed, averaged across pictures, and re-transformed to form a mean correlation score that indicates the degree of agreement between both independent raters for each separate muscle. Results indicate high levels of consistency between both raters for the levator, $r(44) = .70$, zygomaticus, $r(44) = .79$, and corrugator muscle, $r(44) = .70$. Therefore, mean rating scores of facial activity were averaged across both raters and used as the major dependent variable in Study 1.

Facial Activity

The activity of the three facial muscles was analyzed with separate 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANOVAS⁸.

Corrugator. A main effect of valence, $F(1,42) = 94.11, p < .001, d = 1.50$, indicates that corrugator activity was higher during presentation of disgust related pictures ($M = .84, SD = .54$) than during presentation of positive pictures ($M = .05, SD = .15$). No other effect reached statistical significance, all $F < 1.84, p > .18$. Taken together, the observed activation pattern suggests that the corrugator muscle captured the general valence of pictures, but was insensitive to a manipulation of need state.

⁷ Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

⁸ In order to control for a priori differences in mood between deprived and satiated subjects, separate Analyses of Covariance (ANCOVA) were also conducted for all muscles. Entering mood as a covariate however did not change results substantially and hence only ANOVAS will be reported in the following.

Zygomaticus. For zygomaticus activity, a main effect of valence emerged, too, $F(1,42) = 29.96$, $p < .001$, $d = .84$. Means indicate that zygomaticus activity was lower during presentation of disgust related pictures than during presentation of positive pictures. More important, the analysis also revealed a two-way interaction between need state and category, $F(1,42) = 10.21$, $p = .003$, $d = .49$, that mirrors the assumptions of the present thesis (see Figure 2). In line with the hypotheses, follow-up T-tests indicate that food deprived participants exhibited greater zygomaticus activity than satiated subjects when watching food pictures, $t(42) = 2.27$, $p = .028$, $d = .71$, but not when watching control pictures, $t < 1$.

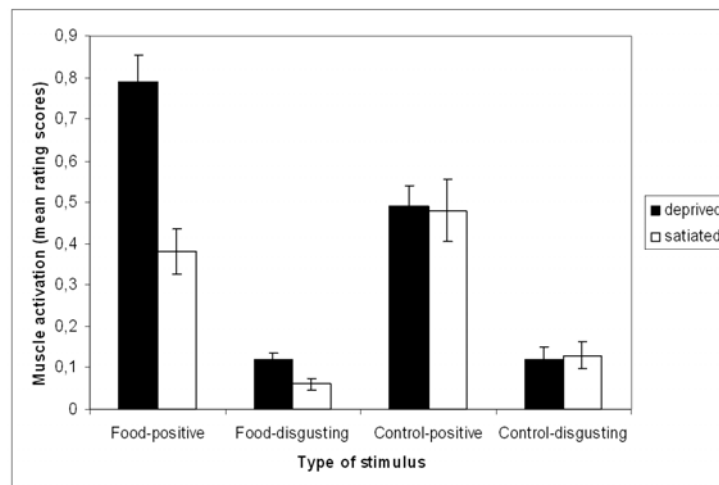


Fig. 2: Zygomaticus activity as a function of need state, category, and valence.

Error bars indicate standard errors of the means.

Furthermore, food deprived subjects showed stronger zygomatic activity towards food pictures than towards control pictures, $t(25) = 3.21$, $p = .004$, $d = .49$, but satiated participants did not, $t(17) = 1.49$, $p = .15$. Importantly, the absence of a significant need state x category x valence interaction, $F(1,42) = 2.95$, $p = .093$, suggests that the effect of food deprivation on zygomaticus reactions was essentially the same for palatable and disgust related foods.⁹ No other effect reached statistical significance, all $F < 1.68$, $p > .20$.

⁹ In fact, the marginal level of significance for this three-way interaction and the data pattern suggest that the effect of food deprivation on zygomaticus activity was somewhat stronger for palatable food pictures than for unpalatable food pictures. However, given that no significant three-way interaction effect was obtained, separate comparisons for palatable vs. unpalatable food pictures were not conducted.

Levator. A main effect of valence, $F(1,42) = 39.13, p < .001, d = .96$, indicates that levator activity was higher during presentation of disgust related pictures ($M = .56, SD = .56$) than during presentation of positive pictures ($M = .01, SD = .04$). Besides a marginally significant main effect of category, $F(1,42) = 3.63, p = .064$, no other effect reached statistical significance, all $F < 2.62, p > .11$. Means indicate that levator activity was slightly lower during presentations of food pictures ($M = .25, SD = .25$) than during presentation of control pictures ($M = .33, SD = .36$) across all participants. However, contrary to the hypotheses need state did not influence levator activity. Neither the main effect of need state, nor the two-way interaction between need state and category or the three-way interaction between need state, category, and valence reached statistical significance, all $F < 1.21, p > .27$.

Discussion

To sum up, Study 1 was designed to investigate if food deprived subjects would exhibit weaker disgust reactions (levator activity) than satiated subjects when confronted with disgusting food stimuli. In addition, it was also examined if food deprived participants would experience more positive affect than satiated subjects (zygomaticus activity) when confronted with palatable food stimuli. For this purpose, facial expressions of hungry and satiated participants were filmed surreptitiously while they were watching a random sequence of photographs on a TV screen. Visible contractions of the levator, zygomaticus, and corrugator muscle served as a dependent variable and were quantified by two independent raters according to the FACS guidelines established by Ekman and Friesen (1975), and Ekman et al. (2002).

To begin with, it was found that all three muscles captured the valence of the presented stimuli. That is, a main effect of valence was observed for all muscles that pointed to the expected direction. In particular, (compared to positive stimuli) disgust related stimuli evoked lower zygomatic activity, but higher corrugator and levator activity. This result nicely fits earlier findings showing that the general valence of stimuli is reflected in the described

pattern of zygomatic and corrugator activation (Dimberg, 1990; Fridlund & Izard, 1983), and a showing connection between levator muscle activation and processing disgust related stimuli (Vrana, 1993, 1994; Yartz & Hawk, 2002).

More important, it was also found that need state influenced subjects' zygomaticus activity in a way that is consistent with the predictions of the present thesis. In particular, food deprived subjects showed stronger zygomaticus activity towards need relevant cues, but not towards control pictures. This finding indicates that all eating relevant stimuli (including disgusting foods) evoked more positive affect in subjects who were deprived of food and is in line with prior studies showing a reduction in the magnitude of the startle eye blink amongst hungry subjects who were confronted with eating relevant cues (Hawk et al. 2004), and more positive evaluations of food cues on an explicit (Brendl et al., 2003; Cabanac, 1971; Drobles et al. 2001; Lavy & van den Hout, 1993) and implicit (Hoefling & Strack, 2008; Seibt et al., 2007) level of information processing amongst hungry subjects.

However, the observed effect of food deprivation did not become manifest in corrugator activity, or in levator activity. That is, contrary to the main hypothesis of Section 1 need state did not influence participants' disgust reactions towards unpalatable foods in this study. Particularly, food deprived participants did not show a weaker levator activity towards disgusting food pictures than satiated participants. This result might be due to the methodology that was used in Study 1. That is, differences between food deprived and satiated subjects in their magnitude of levator muscle contraction might have been too small to be detected by mere sight. To address this issue, facial reactions were assessed via electromyographic measurement (EMG) in Study 2. Thus, it was possible to detect even small changes in muscular activity that would not manifest as visible muscle contractions.

Study 2: Food Deprivation and Food Related Disgust Measured via EMG

Methods

Participants and Design

Fifty non-psychology students (32 female) at the University of Würzburg participated in an experiment ostensibly designed to measure skin conductance during visual information processing at several levels of blood glucose. The experimental design was the same 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed factorial design as in Study 1. Subjects received €8 (approximately \$11 at that time) for compensation. Again, subjects were contacted two days before the experiment to convey first instructions and to exclude vegetarians or persons who reported being on a diet or having certain food-relevant allergies before scheduling any participants. Six subjects had to be excluded from the analyses either because of computer errors ($n = 2$), a BMI below 17.5 ($n = 1$), or above 25 ($n = 3$), resulting in a sample of 15 men and 29 women, aged between 18 and 29 years ($M = 23.34$, $SD = 2.36$). Experimental groups did not differ in the percentage of women (hungry: 62.5 % vs. satiated: 70%), $\chi^2(1; N = 44) < 1$, and BMI ($M_{hungry} = 21.45$, $SD = 1.93$ vs. $M_{satiated} = 21.37$, $SD = 1.73$), $t(42) < 1$.

Procedure and Materials

Procedure. Similar to Study 1, participants were either asked to refrain from eating for 15 hours, or to have lunch immediately before the experiment. Experimental sessions started at noon or 1:30 p.m., and participants were tested individually. After being welcomed by the experimenter, participants were seated at a table with a standard personal computer and a 19 inch monitor. They signed a consent form and reported their current mood. Then EMG electrodes were applied and participants were asked to watch a series of pictures. In order to disguise the recording of muscular activity, participants were told that skin conductance would be measured. Subsequently, all participants rated the pictures in regard to valence and arousal before completing another mood questionnaire and the same set of final questions that

was used in Study 1. Since these question included the same measure of disgust sensitivity (Schienle et al., 2002), the same set of demographic questions (with subjective feeling of hunger serving as a manipulation check), and the same funneled debriefing procedure as in Study 1, they will not be reported in greater detail here.

Mood assessment. To examine the potential influence of mood, self reports of mood were taken at the beginning and at the end of the session by asking subjects how strongly they agree with the statements “I am in a good mood right now”, and “I am in a bad mood right now”, each on a scale ranging from 1 (*totally disagree*) to 7 (*totally agree*). Since both items were negatively correlated at each time of measurement, $r(44)_{baseline} = -.59$, $p < .001$; $r(44)_{end} = -.51$, $p < .001$, the negative mood item was reverse recoded and averaged with the positive mood item to form a single mood index with higher scores indicating better mood.

Picture presentation. In Study 2, 16 food pictures and 16 control pictures were presented that were, to a very large degree, similar to those in Study 1 (see Appendix B2). Again, positive food pictures depicted palatable looking dishes that were arranged in an aesthetic way, and disgust related food pictures depicted unpalatable looking dishes that bore a certain visual resemblance to excrements and vomit. As in Study 1, control pictures depicted either positive objects or disgusting objects unrelated to food. However, since slight changes had been made in respect to the composition and size of the original picture set, explicit picture ratings were also collected in Study 2.

All pictures were presented once in random order. Each trial started with a moderately loud warning pitch tone and a fixation cross that was presented for 1000ms at the center of the screen. Afterwards, a picture (12.5 cm x 16 cm in size) was presented in the middle of the screen for 6 s, followed by an inter-trial-interval that was randomly varying between 14 and 16 s. Pictures were presented one meter in front of the participants.

Facial EMG. Activity of the *M. Zygomaticus major*, the *M. Corrugator supercilii* and the *M. Levator labii* was recorded on the left side of the face using bipolar placements of 13/7

mm Ag/AgCl surface-electrodes according to the guidelines established by Fridlund and Cacioppo (1986). The impedancies of all electrodes were reduced to less than 10 kOhm. The EMG raw signal was measured with a V-Amp amplifier (Brain Products Inc.), digitalized by a 24-bit analogue-to-digital converter, and stored on a personal computer with a sampling frequency of 1000 Hz. Raw data were filtered offline with a 30 Hz low cutoff filter, a 500 Hz high cutoff filter, a 50 Hz notch filter, and a 125 ms moving average filter. The EMG scores are expressed as change in activity from the pre-stimulus level, defined as the mean activity during the last second before stimulus onset. Trials with an EMG activity above 8 μ V during the baseline period and above 30 μ V during the stimuli presentation were excluded (less than 5 %). Before statistical analysis, EMG data were collapsed over the 8 trials with the same picture category, and reactions were averaged over the 6 seconds of stimulus exposure.

Explicit picture ratings. After the EMG was recorded, participants were asked to rate all pictures with regard to their valence and arousal. For this purpose, each subject completed two separate blocks in counterbalanced order. Within each block, only one dimension had to be judged each on a scale ranging from 1 (*very negative*) to 9 (*very positive*) or 1 (*not arousing at all*) to 9 (*very arousing*), respectively. All pictures were presented in random order.

Results

Manipulation Check

To check for differences between deprived and satiated participants in subjective hunger ratings, a simple T-test was conducted. As expected food deprived subjects reported stronger feelings of hunger ($M = 6.00$, $SD = 1.59$) than did satiated participants ($M = 2.50$, $SD = 1.54$), $t(42) = 7.38$, $p < .001$, $d = 2.24$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2(need state: deprived vs. satiated) x 5(subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;38) = 1.95$, $p = .11$. Furthermore, none of the FEE subscales differed as a function of food deprivation, all $F(1;42) < 1.67$, $p > .20$. Consequently, this trait variable was discarded.

Mood. To further rule out any differences in self reported mood, a 2 (need state: deprived vs. satiated) x 2 (time of mood assessment: baseline vs. end of the session) mixed model ANOVA was conducted for the mood indices. Results revealed a main effect of time of mood assessment, $F(1,42) = 14.85$, $p < .001$, $d = .59$, indicating that all participants were in a quite positive mood that slightly decreased over the course of the session ($M_{baseline} = 5.78$, $SD = .81$ vs. $M_{end} = 5.20$, $SD = 1.00$). Need state did not affect mood ratings, all $F < 1$.

Explicit picture ratings. To ensure that food pictures and control pictures were comparable in terms of valence and arousal, explicit picture ratings were analyzed with separate 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANOVAS. Valence ratings revealed that positive pictures ($M = 7.03$, $SD = .78$) were indeed evaluated more positively than disgust related pictures ($M = 2.57$, $SD = .92$), $F(1,42) = 682.38$, $p < .001$, $d = 3.96$. However, this strong main effect of picture valence was qualified by an interaction between valence and category which is substantially smaller in size, $F(1,42) = 18.33$, $p < .001$, $d = .65$. Means indicate that amongst positive pictures, control pictures were evaluated slightly more positively than food pictures ($M_{control} = 7.32$, $SD = 1.02$; $M_{food} = 6.74$, $SD = .86$), $t(43) = 3.66$, $p = .001$, $d = .61$, whereas a reverse (though only marginally significant) pattern emerges for disgust related pictures ($M_{control} = 2.4$, $SD = 1.1$; $M_{food} = 2.74$, $SD = 1.1$), $t(43) = 1.94$, $p = .059$, $d = .31$.

Thus, the difference between positive and negative valence seems to be slightly more pronounced for control pictures than for food pictures.

The ANOVA on arousal ratings revealed an interaction between valence and category, $F(1,42) = 6.59$, $p = .014$, $d = .40$, indicating that disgust related control pictures were evaluated as slightly more arousing than disgust related food pictures ($M_{control} = 6.1$, $SD = 1.56$; $M_{food} = 5.59$, $SD = 1.68$), $t(43) = 2.26$, $p = .029$, $d = .32$, whereas no such difference occurred for positive pictures ($M_{control} = 5.39$, $SD = 1.29$; $M_{food} = 5.66$, $SD = 1.24$), $t(43) = 1.13$, $p = .27$, $d = .21$. More interesting, an interaction between need state and category emerged, $F(1,42) = 8.28$, $p = .006$, $d = 0.45$, indicating that food deprived subjects judged food pictures as more arousing than satiated subjects ($M_{deprived} = 5.89$, $SD = 1.09$ vs. $M_{satiated} = 5.31$, $SD = 1.05$), $t(42) = 1.78$, $p = .04$ (one tailed), $d = .54$. No difference between hungry and satiated participants emerged for control pictures, $t < 1$. Moreover, food pictures evoked less arousal than control pictures in satiated subjects ($M_{food} = 5.31$, $SD = 1.05$ vs. $M_{control} = 5.97$, $SD = .66$), $t(19) = 3.45$, $p = .003$, $d = .75$, but slightly more arousal than control pictures in deprived subjects ($M_{food} = 5.89$, $SD = 1.09$ vs. $M_{control} = 5.56$, $SD = 1.08$). This tendency however does not reach statistical significance, $t(23) = 1.22$, $p = .24$, $d = .30$.

Overall, explicit picture ratings indicate that the presented stimuli were matched for valence and arousal satisfactorily. Furthermore, food deprived participants did not evaluate food pictures more positively than satiated subjects, but they considered them somewhat more arousing. However, there is no reason to believe that this difference casts into doubt the validity of the experiment.

Facial EMG

Corrugator. Corrugator activity was analyzed with a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANOVA. A main effect of valence, $F(1,42) = 15.82$, $p < .001$, $d = .54$, indicates that corrugator activity was higher during presentation of disgust related pictures ($M = .463$, $SD =$

1.03) than during presentation of positive pictures ($M = -.296$, $SD = .50$). In addition, a main effect of category, $F(1,42) = 11.54$, $p = .002$, $d = .53$ occurred, indicating that activation of the corrugator muscle was also higher during presentation of food pictures ($M = .240$, $SD = .59$) as compared to control pictures ($M = -.072$, $SD = .62$). No other effect reached statistical significance, all $F < 1$, $p > .41$. Similar to Study 1, the observed activation pattern indicates that the corrugator muscle reliably captures the general valence of pictures, but is insensitive to a manipulation of need state.

Crosstalk between Zygomaticus and Levator. A serious problem in surface EMG recordings is a phenomenon referred to as *crosstalk* (Fridlund & Izard, 1983; Vrana, 1993; Lundqvist, 1995; Yartz & Hawk, 2002). Surface electrodes do not selectively detect muscle activities occurring in only one particular muscle but also strong activities in neighboring regions. Replicating previous studies (e.g. Vrana, 1993), EMG recordings of the levator labii muscle in this study were affected by strong zygomaticus activity due to spatial proximity of both muscles (et vice versa). More precisely, positive correlations between levator and zygomaticus activity were observed with positive pictures, $r(44) = .297$, $p = .05$, and disgust related pictures, $r(44) = .359$, $p = .017$. The meaningfulness of this positive relationship is cast into doubt and crosstalk appears as the most plausible explanation for the correlation of these muscles (see also Vrana, 1993 for a detailed analysis of the crosstalk phenomenon between levator and zygomaticus).

Influence of food deprivation on zygomaticus and levator activity. To eliminate crosstalk, a focused test of the hypotheses was conducted by excluding valence-inconsistent EMG activity from the analysis. More precisely, zygomaticus activity towards disgust related pictures and levator activity towards positive pictures were omitted from the analysis. As a result, only the activity to emotionally congruent food pictures and to emotionally congruent control pictures was examined for each muscle, resulting in a 2 (need state: deprived vs.

satiated) x 2 (muscle: zygomaticus vs. levator) x 2 (category: food vs. non-food) mixed model ANOVA.¹⁰

The ANOVA revealed a three-way interaction between need state, muscle, and category, $F(1,42) = 4.26$, $p = .045$, $d = .32$. To dismantle this interaction, separate 2 (need state: deprived vs. satiated) x 2 (muscle: zygomaticus vs. levator) ANOVAS were conducted for food pictures and for control pictures. As can be seen from Figure 3, a two-way interaction between need state and muscle emerged only for food pictures, $F(1,42) = 7.19$, $p = .01$, $d = .42$, but not for control pictures. In fact, no effect emerged for control pictures at all, all $F < 1$.

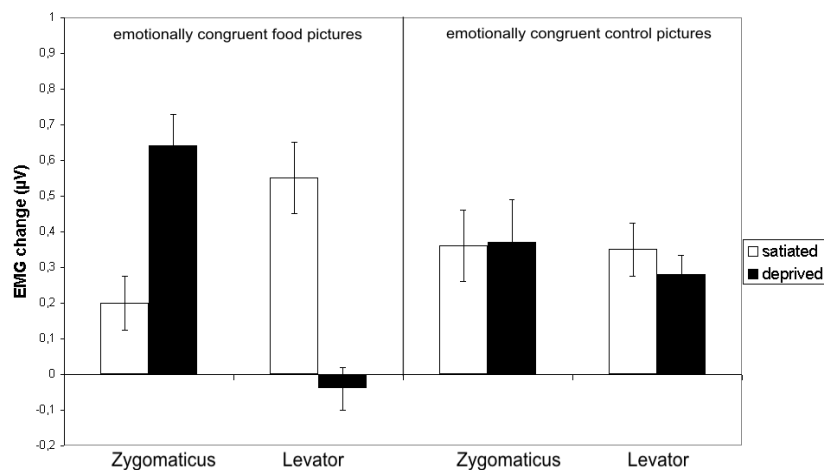


Fig. 3: EMG change (μV) as a function of need state, muscle, and picture category.

Error bars indicate standard errors of the means

To further dismantle the significant two-way interaction for food pictures, follow-up T-tests were conducted. First, these tests confirmed the central prediction that food deprived

¹⁰ EMG data for the zygomaticus and levator muscle were also analyzed with separate 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANOVAS. Without eliminating crosstalk, a main effect of valence emerges for zygomaticus activity, $F(1,42) = 5.23$, $p = .027$, $d = .35$. This effect indicates that zygomatic activity was higher during presentation of positive pictures ($M = .402$, $SD = .80$) than during presentation of disgust related pictures ($M = .108$, $SD = .38$) for all participants. However, neither the two-way interaction between need state and category, $F(1,42) = 2.34$, $p = .13$, nor the three-way interaction between need state, category, and valence, $F < 1$, reached statistical significance. The analysis of levator muscle activation revealed a main effect of need state, $F(1,42) = 4.45$, $p = .041$, $d = .33$, that was qualified by a three-way interaction between need state, picture category, and picture valence, $F(1,42) = 6.56$, $p = .014$, $d = .40$. As expected, levator activity was reduced amongst food deprived subjects as compared to satiated subjects during presentation of disgusting food pictures, $t(42) = 2.62$, $p = .012$, $d = .78$, but not for any other picture category, $t(42) < 1$ for palatable food pictures and disgust related control pictures, and $t(29.4) = 1.61$, $p = .118$ for positive control pictures, respectively.

participants would exhibit weaker disgust reactions than satiated participants when confronted with disgusting food cues. As expected, food deprived participants (compared to satiated participants) showed a decreased activity of the levator muscle when confronted with unpalatable food pictures, $t(42) = -2.62, p = .012, d = .77$. Second, Study 2 corroborates the prediction that food deprived participants would exhibit stronger zygomaticus activity when confronted with palatable food stimuli, $t(42) = 2.16, p = .034$ (one tailed), $d = .56$, (Figure 3).

Discussion

Similar to Study 1, the main purpose of Study 2 was to investigate if food deprivation modulates disgust reactions towards disgusting foods. However, a more sensitive measure for assessing facial activity (EMG) was used in Study 2. Results of Study 2 were compatible with the core assumptions of the present thesis in several ways. First, it was found that hungry participants exhibit greater activity of the zygomaticus muscle than satiated participants during presentation of palatable food pictures, but not during presentation of positive control pictures. In this respect, results of Study 2 two equal the results of Study 1 and corroborate the assumption that palatable foods evoke more positive affect in food deprived participants.

Second (and more important), food deprived subjects also exhibited lower activity of the levator muscle than satiated subjects when confronted with disgusting food cues, but not when confronted with disgusting control stimuli. Thus, by measuring spontaneous disgust reactions via EMG, Study 2 demonstrates that food related disgust is modulated automatically even by moderate levels of food deprivation.

Noteworthy, this is the first study ever to systematically show an alteration of specific emotional states (disgust) by homeostatic dysregulation. Albeit being linked to oral ingestion and eating behavior in classical theories (see Rozin & Fallon, 1987 for an overview) the expressive component of disgust has never been examined systematically in the context of food deprivation before. Contrary to earlier assumptions (Rozin & Fallon, 1987; Rozin, 1999) Study 2 indicates that disgust reactions towards disgusting (but edible) foods are attenuated

automatically even in a state of moderate food deprivation. That is, not only the individual's willingness to overcome disgust may change as a result of food deprivation, but disgust itself may change as well.

Regarding the issue of automaticity, Study 2 also provides new insights into the dynamics of disgust under food deprivation. Noteworthy, neither participants' explicit ratings of the valence of the photographs nor their food-specific disgust sensitivity showed a similar pattern as the EMG data. In particular, hungry subjects did not evaluate palatable or disgusting food pictures more positively than satiated subjects on a reflective level of processing. Furthermore, (compared to satiated participants) hungry participants did not show decreased disgust sensitivity towards eating relevant items in the FEE even though the EMG data clearly indicate that they experienced less disgust when watching pictures of disgusting foods. This observed dissociation between facial expressions, conscious evaluations, and self-reports of food related disgust sensitivity is striking and demonstrates that food deprivation reduces immediate disgust reactions towards unpalatable foods even if people are not subjectively aware of this process.

General Discussion of Section 1

Taken together, Study 1 and Study 2 demonstrate that food related cues induce more positive affect in food deprived participants than in satiated subjects. More precisely, zygomaticus activity towards both, palatable (Study 1 & 2), and even disgusting foods (Study 1) was higher amongst food deprived participants than amongst satiated participants. In this respect the results obtained in Section 1 are compatible with a growing body of evidence suggesting that immediate evaluations of eating relevant cues are sensitive to food deprivation (Hoefling & Strack, 2008; Seibt et. al., 2007). As mentioned before, Study 2 goes beyond these insights by revealing a moderation of specific emotions (disgust) by homeostatic dysregulation that was not shown before.

Noteworthy, the modulation of facial reactions in both studies occurred under conditions of moderate food deprivation and despite the fact that the evaluation of stimuli was never a focal task during the measurement of facial expressions, as for example in the IAT (Greenwald et al., 1993) or in other indirect measures of attitudes, for example the Extrinsic Affective Simon Task (*EAST*; De Houwer, 2003). Participants were instructed to “sit still and just watch a series of pictures” under the pretext of measuring subsequent cognitive abilities (Study 1), or recording skin conductance (Study 2), respectively. These instructions do not reliably prevent subjects from evaluating the stimuli, of course. But participants were neither requested to express their evaluations, nor were they aware that they could do so by contracting certain facial muscles. Moreover, facial reactions are presumably less dependent on intentional mental processes (e.g., categorizing stimuli into predefined categories, initiating predefined responses) as, for example indirect measures like the *EAST* or the IAT. In this sense, the effect of food deprivation on spontaneous facial reactions appears to be automatic to an even greater extent than its effect on immediate evaluative reactions in other indirect attitude measures.

One puzzling result is that food deprivation moderates positive affect (as measured by zygomaticus activity in Study 1 and Study 2) and specific disgust reactions (as measured by levator activity in Study 2), but leaves corrugator activity unaffected in both studies. Given that corrugator activity usually correlates with the general negativity of stimuli (see Dimberg, 1990, and Fridlund & Izard, 1983 for reviews) the question arises if food deprivation alters specific disgust reactions towards disgusting foods without changing their general immediate evaluations per se. In this case disgusting foods (compared to palatable foods) would still evoke immediate negative associations in hungry subjects that do not differ from those of satiated subjects. Thus, only specific disgust reactions towards disgusting foods (but not immediate associations or evaluations) would be affected by food deprivation. In order to clarify if this is really the case, hungry and satiated subjects’ immediate evaluations of

disgusting foods were measured in Section 3. However, in view of the zygomaticus activation pattern (that is assumed to be related to the general positivity of stimuli; see Dimberg, 1990, and Fridlund & Izard, 1983) there is reason to believe that facial reactions do indeed capture differences in immediate evaluations between hungry and satiated participants (at least for palatable food pictures), thus rendering this assumption somewhat implausible.

Alternatively it would be conceivable that corrugator activity also resulted from several influences other than the general valence of stimuli as well (e.g., *cognitive effort*, Smith, 1989; Strack & Neumann, 2000; *unexpectedness, goal obstruction*, Scherer & Ellgring, 2007). Given that identifying disgusting foods requires some effort due to their color and texture, it would come as no surprise that the corrugator activity of food deprived subjects stays unaffected although their immediate evaluations have changed.

Another (admittedly speculative) explanation for the corrugator activation pattern that was observed in both studies focuses on the specific connection between the emotion of disgust, the motivational system of hunger, and “movements around the mouth” (Rozin, Lowery, & Ebert, 1994) that was proposed elsewhere (see for example Darwin, 1965; Ekman, 1982, 1992; Izard, 1971; Rozin et al., 1993, Tomkins, 1982). Missing this specific link to the motivational system of hunger and eating, the corrugator muscle might have been too insensitive for reflecting a manipulation of food deprivation.

Finally, the finding that disgust towards unattractive, but need relevant cues is attenuated amongst hungry subjects in Study 2 is in line with previous studies focusing on food intake as a dependent variable and showing greater intake of both, palatable and unpalatable foods amongst deprived subjects (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968). Importantly, Study 2 may help to understand previously observed effects of food deprivation on food intake. Drawing on the observed findings, it is argued that the higher intake of unpalatable foods amongst food deprived subjects might result from a reduction of disgust towards these foods. Albeit

immanent in several theories at least implicitly (e.g., Jacobs & Sharma, 1969; Nisbett, 1972; Pliner et al., 1990), this assumption has never been tested directly before. To anticipate, the influence of food deprivation on the intake of disgusting foods will be investigated in more detail in the next section.

Importantly, results of Study 2 suggest that the emotion of disgust might influence food intake in a very direct manner. That is, decreased disgust expressions towards unpalatable foods, even in the absence of altered conscious evaluations or changes in food related disgust sensitivity, could lead to increased intake of such foods. This reasoning is in line with earlier findings demonstrating that facial expressions might influence peoples' affective responses towards certain stimuli without influencing subjects' cognitive evaluations thereof (Strack et al., 1988). Albeit Study 2 did not include self reports of consciously experienced disgust towards the experimental stimuli, it seems plausible to assume that disgust expressions do both, mirror and influence the magnitude of subjectively experienced disgust via facial feedback loops (see also Niedenthal, 2007 for an overview). Consequently, it is argued that alterations in experienced disgust might be responsible for lowering the threshold for food intake and that this link between disgust and eating behavior does not depend on conscious evaluations of foods, or on food related disgust sensitivity.

In addition, disgust might influence eating behavior through nonverbal communication based on facial expressions. Nonverbal communication plays an important role in efficiently spreading information throughout the group, thereby coordinating the group's behavior (e.g. Darwin, 1965). Prior research yielded that emotional expressions of others are mimicked even unintentionally and evoke congruent affective reactions in oneself (see Neumann & Strack, 2000 for a more detailed discussion). As a consequence, hungry individuals who mimic group members that exhibit facial expressions of disgust while eating might get "emotionally contagioned" and hence be less prone to indulge unknown or unattractive foods. Alternatively, individuals might be encouraged to indulge such foods in the absence of disgust

expressions in their group members' faces. In the following, the relationship between food deprivation and the intake of disgusting foods will be examined in more detail.

Section 2: Does Food Deprivation Increase Consumption of Disgusting Foods?

Overview and Rationale of Study 3 and Study 4

It was argued in the last section, that there might be a direct link between food related disgust and food intake that is independent from conscious evaluations of foods, or from subjective awareness. The main purpose of the present section was to test this assumption and to clarify if reduced feelings of food related disgust amongst hungry subjects might also be responsible for their greater intake of bad tasting foods that was reported elsewhere (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968). As already mentioned, this hypothesis was actually never tested before and metabolic pressures (e.g., the starving organisms need to ingest calories immediately) and the role of taste responsiveness under acute food deprivation were discussed as the most important explanations for this phenomenon instead (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972).

Hence, one main goal of Study 3 and Study 4 was to highlight the role of food related disgust as another possible explanation by examining food deprived versus satiated subjects' intake of disgusting foods in greater detail.¹¹ In order to stress the role of food related disgust in the relationship between food deprivation and the consumption of unpalatable foods (and to render previous explanations implausible) two aspects were kept in mind in Study 3 and Study 4. First, hungry subjects were exposed only to moderate levels of food deprivation, thus reducing metabolic pressures to ingest calories immediately. Second, experimental foods were

¹¹ For the sake of completeness it has to be mentioned that implicit and explicit attitudes towards the consumed foods were also assessed prior to measuring food intake in both studies. However, these dependent measures will not be reported in this section. This is because the main goal of this section is to report food deprived and satiated subjects' intake of disgust related foods. Apart from this, the influence of food deprivation on automatic attitudes towards disgusting foods will be considered extensively in the next section of the present thesis.

related to the emotion of disgust, but were not bad-tasting.¹² Consequently, differences in taste or taste responsiveness should not provide compelling explanations for any observed results, leaving reductions in food related disgust as the most obvious underlying mechanism. Particularly, experimental foods in the present section were assumed to evoke disgust because of ideational aspects and health concerns, or because of their unpalatable visual appearance. These aspects are understood to play an important role in the realm of food related disgust and food rejection, too (see Fallon & Rozin, 1983; Rozin & Fallon, 1987, and following paragraphs).

Taxonomy of Food Rejections

Albeit being one of the most important reasons for food rejection (Pliner et al., 1990), bad flavor is only one of many negative sensory properties foods can be rejected for. That is, people reject foods because they do not like their taste, their smell, their textural properties (Martins & Pliner, 2006), or their visual appearance (Rozin et al., 1986). In addition, foods are also rejected because they are expected to cause harm to the body when being consumed, or because of more abstract and ideational reasons (Fallon & Rozin, 1983; Rozin & Fallon, 1987). Meat, to give a prominent example is often rejected because of moral reasons (Cooper, Wise, & Mann, 1985; Fallon & Rozin, 1983; Fessler, Arguello, Mekdara, Macias, 2003; Fox 2007; Kenyon & Barker, 1998; Martin, 1976; Rozin & Fallon, 1987, Rozin, Markwith, & Stoess, 1997).

A more systematic distinction between several types of food rejection has also been offered (Fallon & Rozin, 1983; Rozin & Fallon, 1987). Depending on which motivation predominates, it is distinguished between *Distaste* (rejection primarily based on sensory properties), *Danger* (rejection primarily based on anticipated harmful consequences), and *Inappropriate* (rejection primarily based on ideational factors). According to the groundbreaking framework by Rozin and Fallon (1987), *Disgust* is conceptualized as another

¹² In fact, all foods were exactly of the same sort and of good flavor.

type of food rejection that is characterized by a co-occurrence of all three motivations. Put differently, all three former types of food rejections are (to varying degrees) constituents of food related disgust. Over and above, disgusting foods are understood to be offensive and contaminating (Rozin & Fallon, 1987). That is, when confronted with food items they consider extremely disgusting, people should be motivated to avoid any physical contact with these foods (sometimes even their sight), and they should also refuse to eat other (normally acceptable) foods that have been in contact with the disgusting food items.

The Role of Sensory Features and Ideational Aspects for Food Rejection

Within the scope of the present thesis however these extreme cases were not included. Instead, it was focused on two major aspects of food rejection other than bad flavor that are nevertheless related to the rejection category of disgust. In particular, Study 3 was designed to explore if ideational reasons for food rejection would influence food deprived and satiated subjects' food intake differentially. For this purpose, a real apple was presented in Study 3 that was very fresh, firm, and tasty. However, for half of the participants the apple was labeled "genetically modified food (GMF)" (see also Lähteenmäki, Grunert, Ueland, Åström, Arvola, & Bech-Larsen, 2002; Townsend & Campbell, 2004), and for the other half it was labeled "organically grown food (OGF)". This manipulation was assumed to give subjects abstract information about the manufacturing process that the actual apple had undergone. Compared to sensory features like taste, smell, or visual appearance information about the manufacturing process is assumed to reflect an ideational reason for food rejection in the case of GMF. In particular, knowing that a palatable, good tasting food was produced with the help of genetic engineering might still be a reason for rejecting it.

Prior research, for example, yielded that labeling an originally preferred food as "genetically modified" decreased consumers' intentions to buy it (Lähteenmäki et al., 2002). Moreover, GMF is evaluated negatively (e.g., Bredahl 2000; Gaskell, Allum, Bauer, Durant, Allansdottir, Bonfadelli, et al., 2000; Grunert, Bredahl & Scholderer, 2003; Hoban 1997,

1998; Sparks, Shephard, & Frewer, 1994), and evokes feelings of moral objection in a majority of consumers worldwide (Magnusson & Koivisto Hursti, 2002; Subrahmanyam, & Cheng, 2000; Townsend & Campbell, 2004; Winnaker, 1996). Non-purchasers were even found to evaluate GMF as disgusting (Townsend & Campbell, 2004). Furthermore, GMF is also associated with perceptions of health risks (Bredahl, 1999; Grunert, Lähteenmäki, Nielsen, Poulsen, Ueland, & Åström, 2001; Haukenes, 2004) and feelings of worry and fear (Laros & Steenkamp 2004). Albeit it is unclear, how offensive and contaminant GMF is evaluated, it is clearly rejected because of ideational reasons (capturing the rejection category of inappropriate) and anticipated harmful consequences (capturing the rejection category of danger), thereby possessing two central features that characterize disgusting foods.¹³

In Study 4, the sensory properties of apples (visual appearance) were manipulated as well. For this purpose apples were not only labeled as GMF or OGF, but also looked either palatable or unpalatable. In particular, apples were looking very fresh and firm, or they had several smudges and surface blemishes that were added by the experimenter. Thus, apples in Study 4 could be rejected because of the same ideational reason as in Study 3 (genetic modification), or because of their negative sensory properties (unpalatable visual appearance). This second manipulation was chosen because the visual appearance of food is another determinant of food rejection which is related to the emotion of disgust (Rozin et al., 1986) and was manipulated in Study 1 and Study 2 as well.

Moreover, the additional manipulation of visual appearance is especially interesting from a dual systems perspective of information processing because impulsive processes (i.e., immediate perceptual input) and reflective processes (i.e., abstract, propositional knowledge) are pitted against each other in Study 4. Negative visual appearance for example constitutes a

¹³ Anyway, the question arises if offensiveness and contamination are really unique and qualitatively distinct features of food related disgust, or if they refer to the intensity of this emotional experience instead. It seems for example, that offensiveness is in many cases directly related to the intensity of a food's negative sensory properties (e.g., bad smell), or to the extent to which it is considered inappropriate for consumption (e.g., eating pork vs. dog meat). In addition, many dangerous foods are ascribed contaminant properties as well (Rozin & Fallon, 1987).

basal perceptual input that immediately triggers negative associations in the Impulsive System even if a person does not want this to happen. In contrast, the manipulation of food label does not include any immediate perceptual stimulation, but activates propositional knowledge in a top down fashion. Of course, labeling a food as “GMF” or “OGF” might also evoke immediate associations in the Impulsive System, but simultaneously the label can also be used to generate rational judgments in the Reflective System because of its propositional nature. Interestingly, implications from both “input channels” dissociate in the case of visually attractive GMF-apples and visually unattractive OGF-apples. To the author’s knowledge, Study 4 is the first study ever to distinguish between negative sensory properties and ideational aspects as reasons for food rejection while examining the influence of food deprivation on food intake.

Hypotheses of Study 3 and Study 4

It was predicted that food deprived participants would consume greater amounts of disgusting apples than satiated participants in both studies. Additionally (albeit not central to the present thesis), it would come as no surprise if hungry subjects consume greater amounts of palatable apples than satiated participants, too.

In principle, it should not matter if apples evoke food related disgust because of their unpalatable visual appearance, or because of an alleged genetic modification. However, it is unclear if health concerns (which are related to GMF) might play an important role in the relationship between food deprivation and food intake as well. As mentioned earlier, some studies have also found greater rejection of bitter foods amongst hungry subjects (*hunger induced finickiness*; Jacobs & Sharma, 1969; Herman et al., 1989; Kauffman et al., 1995; Nisbett et al., 1973) and one explanation for this phenomenon does focus on the possibility that bitterness might indicate toxicity and hence serve as an evolutionary rooted warning signal (Kauffman et al., 1995; Nisbett, 1972; Pliner et al., 1990). It is argued that hunger

induced finickiness prevents the deprived organism from ingesting lethal amounts of poisonous foods because the risk of a given amount of poisonous food being lethal is higher on an empty stomach (Kauffman et al., 1995), and a lethal dosage of dangerous food is more likely to be consumed by an organism that is prone to gorge itself (Nisbett, 1972). It has to be noted that a context was established in Study 3 and Study 4 that explicitly referred to the unknown long term consequences and health risks of GMF. To the degree that subjects do indeed consider GMF as dangerous and harmful for their health, well known effects of food deprivation on food intake could disappear (or even reverse) for apples that were labeled “genetically modified”. For this reason, an explorative account was adopted when investigating the effects of food deprivation on the consumption of GMF.

Concerning the interplay between sensory versus ideational reasons for rejection (or impulsive versus reflective input channels for food related disgust, respectively) in Study 4, an explorative account was adopted, too. To give only one example, it might be that the manipulation of food label exerts a main effect and outperforms the manipulation of visual appearance. That is, labeling a food as OGF would compensate for unpalatable visual appearance, and labeling a food as GMF would render it unacceptable, even if it looks very attractive. Alternatively, both manipulations could also exert independent main effects (that cannot be compensated). That is, either a GMF label or unpalatable visual appearance is sufficient to render an apple unattractive. Given this range of plausible outcomes, it seemed appropriate to adopt an explorative account for this question as well.

Study 3: Food Deprivation and Consumption of Genetically Modified Foods

Methods

Participants and Design

Seventy undergraduate psychology students and non-psychology majors (51 female) at the University of Würzburg took part in an experiment that was introduced as consisting of

several studies, including a study on the effects of blood glucose levels on concentration (concentration test), and a consumer study on food and taste perception (taste test). Subjects received course credit (psychology students) or were paid € 8 (approximately \$ 11 at that time) for participation.

Subjects were either food deprived or satiated and were asked to eat from an apple that was either labeled “genetically modified food” (GMF) or “organically grown food” (OGF), resulting in a 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OGF) between subjects design. Similar to Study 1 and Study 2, subjects were contacted two days before the experiment to convey first instructions and to exclude persons who reported being on a diet or having certain food-relevant allergies before scheduling any participants. Vegetarians were included in Study 3, because no stimuli were presented that were related to meat.

Four subjects had to be excluded from the analyses either because of identifying themselves as dieters ($n = 3$), or food allergic subjects ($n = 1$) during the experiment. Another 8 subjects had to be excluded because of a Body Mass Index (*BMI*) above 25 ($n = 4$)¹⁴, because they were suspicious about critical hypotheses in the experiment ($n = 3$), or because they doubted the label of the GMF-apple in the taste test ($n = 1$).

The resulting sample consisted of 15 men and 43 women, aged between 18 and 39 years ($M = 21.76$, $SD = 3.41$). Experimental groups did not differ in the percentage of women (hungry: 74.2 % vs. satiated: 74.1%), $\chi^2(1; N = 58) < 1$, and BMI ($M_{hungry} = 21.09$, $SD = 1.78$ vs. $M_{satiated} = 21.28$, $SD = 1.78$), $t(56) < 1$.

Procedure and Materials

Procedure. Similar to Study 1 and Study 2, participants were either asked to refrain from eating for 15 hours, or to have lunch immediately before the experiment. Experimental sessions started at noon or 1:30 p.m., and participants were tested in groups up to three people. After being welcomed by the experimenter, participants were seated at a separate

¹⁴ In fact, one female subject refused to report her weight and was excluded because BMI could not be computed.

table with a standard personal computer on it, signed a consent form and reported their current mood. Subsequently, subjects' automatic attitudes were assessed with a recently developed variant of the Implicit Association Test (*IAT*; Greenwald et al., 1998), that included only a single target category rather than two target categories (Steinman & Karpinski, 2006; Wigboldus et al., 2005). In order to maintain the cover story, the st-IAT was introduced as a measure of concentration that is based on reaction times. In particular, all subjects completed an IAT with pictures of genetically modified foods (GMF) and an IAT with pictures of organically grown foods (OGF) in counterbalanced order. Directly after each st-IAT, subjects' corresponding explicit attitudes were assessed with several Likert scales. As mentioned before, none of these measures will be reported in this section because they are not of theoretical interest. To further disguise a connection between the "apple-IATs" and the taste test, implicit and explicit attitudes towards other stimuli were also assessed under the pretext of measuring subjects' ability to concentrate in an unrelated filler task.

After the concentration tests, the taste test was conducted as part of an ostensible consumer study on food and taste perception. Subsequently, all subjects completed several control questions pertaining to their beliefs and attitudes towards GMF (Richins, 1997; Crites, Fabrigar, and Petty, 1994), another mood questionnaire, and the known set of final questions (including demographic questions, self reported feelings hunger serving as a manipulation check, and a funneled debriefing procedure). Habitual disgust sensitivity was not measured in Study 3 because of two reasons. First, food deprivation did not have any effect on general or even food related disgust sensitivity in Study 1 and Study 2. Second, it was assumed that the various control questions towards GMF would capture inter-individual differences in the rejection of GMF in a much more specific manner than disgust sensitivity per se.

Mood assessment. To examine the potential influence of mood, self reports of mood were taken at the beginning of the session and after the taste test. Subjects were asked to indicate how strongly they agree with the statements "I am in a good mood right now", and "I

am in a bad mood right now”, each on a scale ranging from 0 (*totally disagree*) to 5 (*totally agree*). Since both items were negatively correlated at each time of measurement, $r(58)_{t1} = -.56$, $p < .001$; $r(56)_{t2} = -.54$, $p < .001$, the negative mood item was reverse recoded and averaged with the positive mood item to form a single mood index with higher scores indicating better mood.

Taste Test. As mentioned before, the taste test was presented as a consumer study on food and taste perception. In the taste test, one customary apple of the sort “Granny Smith” was placed on a new serviette in front of each participant. Each apple was either labeled as “genetically modified food (GMF)” or as “organically grown food (OGF)”. More precisely, it was either stated that the apple was genetically modified in order to achieve longer shelf life, or it was stated that the apple was organically grown. In order to bolster this manipulation, a short explanation was given about genetic engineering (vs. organic farming) before the taste test and subjects were reminded about the unknown long-term consequences and health risks of GMF, or about the beneficial effects of OGF for health and environment.¹⁶

Twenty minutes were given to taste the apple and to rate it on several dimensions (e.g., tastiness, naturalness, healthiness, visual appearance). All subjects were encouraged to ask for seconds, but actually none of the subjects asked for a second apple during the taste test. After time had expired, apples were taken out of participants’ reach and food intake (g) was determined by subtracting the amount left from the exact pre-consumption weight ($M = 206$ g, $SD = 25.3$) that did not differ between food deprived ($M = 202$ g, $SD = 27.6$) and satiated subjects ($M = 210$ g, $SD = 22.3$), $t(56) = 1.00$, $p = .32$.

Taste test ratings. During the taste test, subjects were asked to rate how attractive and how palatable they find the visual appearance of the apple that was served, each on a scale ranging from 1 (*not looking attractive / palatable at all*) to 7 (*looking very attractive /*

¹⁵ Due to technical problems, mood ratings from two subjects were not recorded at t2.

¹⁶ In fact, this additional information was given before each st-IAT, and not directly before the taste test. Since participants completed both, a “GMF-IAT” and an “OGF-IAT”, all participants were informed about genetic engineering and organic farming (for the exact German wording of the instructions see Appendix C1).

palatable). Since both ratings were highly correlated across participants, $r(58) = .76, p < .001$, they were combined to form a single index of visual attractiveness.

Furthermore, subjects were asked to rate the healthiness and the naturalness of the apple, each on a scale ranging from 1(*very unhealthy*) to 7(*very healthy*), and 1(*not natural at all*) to 7(*very natural*), respectively. Since GMF is associated with attributes like “artificial“, “unnatural“, and “unhealthy” (Verdurme & Viaene, 2003; Townsend, Clark, & Travis, 2004; Tenbült, De Vries, Dreezens, & Martins, 2005), both questions served as manipulation checks for the independent variable of food label. As mentioned before, all apples were of the same sort (Granny Smith) and should therefore taste similar. However, some participants might like this taste more than others and to make sure that such inter-individual variations would not systematically differ between hungry and satiated participants, subjects were also asked to rate the tastiness of the apple on a scale ranging from 1(*tastes very bad*) to 7(*tastes very good*).

Beliefs about GMF. In order to control for inter-individual differences in pre-existing attitudes towards GMF and beliefs about GMF, three subscales from the Consumption Emotions Set (CES; Richins, 1997) were used. In particular, the emotions of worry, anger, and fear towards GMF were assessed on a scale ranging from 1 (*not worried, angry, etc.*) to 7(*worried, angry, etc.*), including a point of indifference in the middle of the scale. Mean scores for each subscale served as control variables. Furthermore, two subscales from Crites, Fabrigar, and Petty’s (1994) semantic differential were used. Particularly, participants were asked how they evaluate GMF on an evaluative axis (e.g., desirability, liking) and on a cognitive axis (e.g., safety, healthiness) on scales ranging from -3 (*undesirable, unsafe, etc.*) to +3 (*desirable, safe, etc.*), including a point of indifference as a midpoint of the scale. Values from these scales were recoded to match a scale from 1 to 7 before mean scores were calculated. All original items from the five subscales were translated into German with the help of a native English speaker.

Results

Manipulation Checks

Hunger ratings. To check for differences between deprived and satiated participants in subjective hunger ratings, a simple T-test was conducted. As expected, food deprived subjects reported stronger feelings of hunger ($M = 4.84$, $SD = 1.64$) than did satiated participants ($M = 1.78$, $SD = .97$), $t(49.88)^{17} = 8.79$, $p < .001$, $d = 2.71$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Ratings of healthiness and naturalness. To check if labeling an apple as GMF or OGF did influence ratings of healthiness and naturalness in the expected direction, separate 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OMF) ANOVAS were conducted. These analyses revealed a marginally significant main effect of food label for ratings of naturalness, $F(1,54) = 3.11$, $p = .08$, $d = .23$, and a highly significant main effect of food label on ratings of healthiness, $F(1,54) = 21.66$, $p < .001$, $d = .64$. No other effect reached statistical significance, all $F < 1.2$, $p > .28$. As expected, means indicate that GMF-apples were evaluated as more unhealthy ($M = 3.75$, $SD = 1.32$) and more unnatural ($M = 3.18$, $SD = 1.54$) than OGF-apples ($M_{healthiness} = 5.40$, $SD = 1.33$ vs. $M_{naturalness} = 3.90$, $SD = 1.71$) by all participants, indicating that the manipulation of food label was successful. Importantly, food deprived participants evaluated GMF-apples equally unhealthy and unnatural as satiated participants on a reflective level of information processing.

Preliminary Analyses

Ratings of visual attractiveness. To check if the visual appearance of GMF and OGF apples was the same for both, food deprived and satiated participants, a 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OGF) ANOVA was conducted on visual attractiveness ratings in the taste test. A marginally significant main effect of food label, $F(1,54) = 3.36$, $p = .072$, $d = .25$, indicates that the visual appearance of GMF apples was

¹⁷ Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

evaluated slightly more unattractive than the appearance of OGF apples ($M_{GMF} = 4.73$, $SD = 1.79$ vs. $M_{OGF} = 5.45$, $SD = 1.13$) across all subjects. No other effect reached statistical significance, all $F < 1$. Since all apples were of the same sort (and even from the same batch of the same food manufacturer), this marginally significant effect of food label on ratings of visual appearance was not expected. However, when judging the visual attractiveness, participants knew about the label already and hence top down influences might provide a plausible explanation for this effect. (This issue will be re-addressed in the Discussion part.) More important, there were no differences between hungry and satiated subjects in their ratings of visual attractiveness.

Taste of apples. To make sure that taste preferences would not differ systematically between hungry and satiated subjects, ratings of actual tastiness were analyzed with a 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OMF) ANOVA as well. Since only apples of the same sort and manufacturer were used, the tastiness of apples was also expected to be the same across all experimental conditions. However, the analysis revealed a significant main effect of food label, $F(1,54) = 8.89$, $p = .004$, $d = .403$, indicating that all subjects liked the taste of OGF-apples ($M = 5.73$, $SD = 1.05$) more than the taste of GMF-apples ($M = 4.64$, $SD = 1.85$). Neither the main effect of need state, $F < 1$, nor the interaction between need state and food label, $F(1,54) = 2.56$, $p = .12$, reached a level of statistical significance. Again, top down influences and negative expectations appear as the most plausible explanation for the effect of food label on tastiness ratings. Noteworthy, food deprivation did not have any systematic effect on this variable either.

Beliefs about GMF. Mean rating scores from the five subscales were analyzed with separate T-Tests and did not differ between hungry and satiated participants. In particular, food deprived and satiated participants associated GMF to feelings of worry ($M_{deprived} = 3.98$, $SD = 1.41$ vs. $M_{satiated} = 4.19$, $SD = 1.42$), $t < 1$, fear ($M_{deprived} = 3.98$, $SD = 1.43$ vs. $M_{satiated} = 3.91$, $SD = 1.36$), $t < 1$, and anger ($M_{deprived} = 3.46$, $SD = 1.36$ vs. $M_{satiated} = 3.48$, $SD = 1.51$), t

< 1 , to the same degree. Furthermore, food deprived participants and satiated participants did not differ in their ratings on the cognitive axis, ($M_{deprived} = 3.48$, $SD = 1.15$ vs. $M_{satiated} = 3.28$, $SD = 1.09$), $t < 1$, or on the evaluative axis ($M_{deprived} = 3.34$, $SD = 1.15$ vs. $M_{satiated} = 3.33$, $SD = 1.05$), $t < 1$. Consequently these variables will be discarded.

Mood. To further rule out any differences in self reported mood, a 2 (need state: deprived vs. satiated) x 2 (time of mood assessment: t1 vs. t2) mixed model ANOVA was conducted for the mood indices. Neither the main effects of need state, $F(1,54) = 2.30$, $p = .14$, and time of mood assessment, $F(1,54) = 1.14$, $p = .29$, nor the two way interaction between need state and time of mood assessment, $F < 1$, reached statistical significant. Means indicate that all subjects were in a neutral mood at the beginning of the session ($M = 4.15$, $SD = 1.00$) and after the taste test ($M = 4.04$, $SD = .91$).

Food Intake

Food intake was analyzed with a 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OGF) ANOVA that yielded a significant two-way interaction between need state and food label, $F(1,54) = 4.01$, $p = .05$, $d = .27$, which is compatible with the core assumptions of the present thesis (see Figure 4).¹⁸

To further dismantle this interaction, follow-up T-tests were conducted. As expected, food deprived subjects consumed greater amounts of a GMF-apple than satiated participants, $t(26) = 2.70$, $p = .012$, $d = 1.06$. This finding indicates that (compared to satiated participants) hungry participants consume more of a food that was genetically modified, and hence should evoke feelings of food related disgust and rejection because of abstract reasons. Noteworthy, this effect of food deprivation on food intake emerges even though hungry subjects evaluated their GMF-apples equally unnatural and unhealthy as satiated subjects. The rejection of GMF is clearly reflected in the food intake of satiated subjects who consumed significantly smaller

¹⁸ Neither the main effect of need state, $F(1,54) = 2.48$, $p = .12$, nor the main effect of food label, $F < 1$, reached levels of statistical significance.

amounts of the GMF-apple than of the OGF-apple, $t(23.93)^{19} = 2.13$, $p = .044$, $d = .81$. In contrast, food deprived participants consumed the same amount of GMF-apples and OGF-apples, $t < 1$, indicating that they do in fact not reject GMF-apples despite evaluating them more negatively than OGF-apples on several dimensions (e.g., healthiness, visual attractiveness, tastiness). This finding is striking and corroborates the assumption that there might be a direct link between food related disgust and eating behavior that is not depending on conscious evaluations of foods.

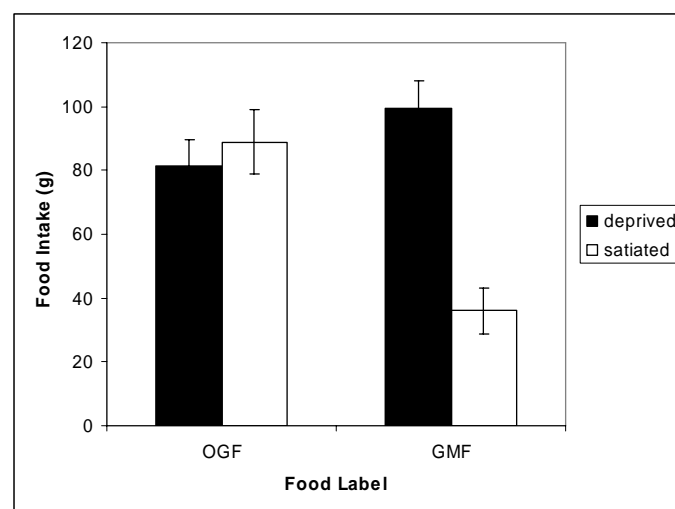


Fig. 4: Food intake as a function of need state and food label.

Error bars indicate standard errors of the mean.

However, contrary to the hypotheses, the intake of OGF-apples did not differ between food deprived and satiated participants, $t < 1$. That is, albeit being deprived of food, hungry participants did not consume more of an OGF apple than did satiated participants. First, this result indicates that organically grown apples seemed to be an attractive snack for satiated participants as well. Furthermore, since the maximum amount to be consumed was limited by the size of an apple and no subject asked for a second one, this result might also reflect a statistical artifact on food intake (*ceiling effect*; Bortz & Döring, 1995). That is, food deprived participants might have consumed greater amounts but were prevented from doing so by

¹⁹ Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

normative concerns (asking for a second apple) and by the absolute size of an apple, respectively.

Discussion

To sum up, Study 3 was designed to explore if food deprived participants would consume greater amounts of disgusting foods than satiated participants. Importantly, experimental foods in Study 3 were related to the rejection category of disgust not because of their bad flavor (Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968), or because of their disgusting visual appearance (Rozin et al., 1986) but because of ideational reasons and health concerns. As already described, disgust towards a certain food is (to a significant degree) based on “the idea of what it is” (Fallon & Rozin, 1983, p. 15), and on negative expectations about the consequences of consumption for ones own health (see Fallon & Rozin, 1983, and Rozin & Fallon, 1987 for overviews).

It was assumed that genetically modified food (GMF) meets both above mentioned criterions and should evoke food related disgust and rejection even in the presence of positive sensory qualities (e.g., palatable visual appearance, good flavor). This assumption is based on prior studies showing that GMF is not only related to general negative evaluations (Bredahl 2000; Gaskell et. al, 2000; Grunert et al., 2003; Hoban 1997, 1998; Sparks et al., 1994), but also to the specific emotion of disgust (Townsend & Campbell, 2004), health concerns (Bredahl, 1999; Grunert et al., 2001; Haukenes, 2004), and feelings of moral objection (Magnusson et al., 2002; Subrahmanyam, & Cheng, 2000; Winnaker, 1996).

In order to test the hypothesis that hungry subjects would consume greater amounts of genetically modified foods than satiated subjects, an ostensible taste test was conducted in Study 3. Food deprived vs. satiated subjects were confronted with a fresh, palatable looking apple that was either labeled “genetically modified food (GMF)” or “organically grown food (OGF)”. Conscious evaluations of the apples and food intake served as dependent measures.

In line with the hypotheses it was found that food deprived participants did indeed consume greater amounts of GMF-apples than satiated subjects. Over and above, food deprived subjects consumed the same amount of both, GMF- and OGF-apples, whereas satiated subjects consumed significantly smaller amounts of GMF apples (compared to OGF-apples). Taken together this data pattern clearly reflects the rejection of GMF amongst satiated subjects and the acceptance of GMF amongst food deprived subjects.

Noteworthy, food deprived subjects consumed greater amounts of GMF despite evaluating them equally negative (i.e., unnatural, unhealthy) as satiated subjects. The observed dissociation between high food intake and negative conscious evaluations is striking and parallels the dissociation between positive facial reactions and negative conscious evaluations of disgusting foods that was observed in Study 2.

Results of Study 3 are also in line with prior studies showing greater intake of bad tasting food amongst food deprived subjects (Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968) and supplement them by focusing on ideational reasons for food rejection instead of bad flavor. In the light of the finding that food deprivation also increases the consumption of foods that are disgusting because of other reasons than bad flavor, prior explanations for the abovementioned effect (i.e., alterations in taste responsiveness under acute food deprivation) appear rather implausible. Instead, Study 3 further corroborates the assumption that food deprivation reduces food related disgust which in turn affects the intake of disgusting foods independent of conscious evaluations of foods or subjective awareness.

Interestingly, the manipulation of food label actually turned out to influence participants' reflective evaluations of taste and visual attractiveness irrespective of their need state. That is, apples labeled "genetically modified" were rated more negatively on the dimensions of taste and visual attractiveness by all participants despite being similar to OGF-apples from an objective point of view. As already mentioned, top down influences and

negative expectations about GMF appear as the most plausible explanations for this phenomenon (see also Lee, Frederick, & Ariely, 2006; Makens, 1965; McClure et al., 2004; Wansink, Park, Sonka, & Morganosky, 2000; Wardle & Solomons, 1994). Noteworthy, food deprived subjects evaluated GMF-apples equally negative as satiated participants on these dimensions, but consumed greater amounts, though.

Another issue pertains to the potential toxicity of GMF and the phenomenon of hunger induced finickiness (Kauffman et al., 1995; Nisbett, 1972; Pliner et al., 1990). In short, results of Study 3 contradict prior findings showing a decreased intake of potentially dangerous or toxic foods amongst food deprived subjects. If food deprivation would really decrease the intake of potentially toxic foods, one would have expected food deprived subjects to consume smaller amounts of GMF than satiated subjects. As already known, this was not the case and therefore, this issue will be re-addressed in more detail in the General Discussion of Section 2.

In contrast to prior studies (Bellisle et al., 1984; Desor et. al, 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968), greater intake of palatable foods (i.e., OGF-apples) amongst food deprived subjects could not be detected in Study 3. That is, satiated participants consumed roughly the same amount of OGF-apples like food deprived subjects. This unexpected finding might be explained by several assumptions. First, a fresh and palatable apple stemming from organic farming (and thus being very attractive on all dimensions) might have triggered consumption behavior even in the absence of homeostatic dysregulation (see also Herman & Polivy, 1984; Lowe & Butryn, 2007; Yeomans, Gray, Mitchell, & True, 1997; Yeomans, Lee, Gray, & French, 2001). Second, the observed pattern may also reflect a methodological artifact (*ceiling effect*; Bortz & Döring, 1995) that is based on the fact that the maximum intake was limited by the absolute size of an apple. In principle, subjects were given ad libitum access to the experimental foods. However, asking for a second or third apple might have cost quite an effort because of normative concerns. Consequently, food deprived subjects' food intake might have been greater if a second or third apple had been

available directly (without asking). And finally, the timeframe in the taste test might have been too long, thus causing satiated participants to consume greater amounts of the attractive OGF-apple simply because they were bored.

However, since the main goal of Study 3 was to examine the effect of food deprivation on the intake of disgust related foods, this issue does not compromise the validity of the results for the question at hand anyway. That is, it was indeed found in Study 3 that the intake of genetically modified foods was indeed influenced by food deprivation into the expected direction.

Study 4: Food Deprivation and Consumption of Genetically Modified Foods II – Ideational vs. Sensory Aspects as Reasons for Food Rejection

Methods

Participants and Design

The design of Study 4 was identical to Study 3, except that visual appearance was introduced as a third factor, resulting in a 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OGF) x 2 (visual appearance: palatable vs. unpalatable) between subjects design. Fifty three undergraduate psychology students (44 female) at the University of Würzburg took part in an experiment that was introduced in the same way as in Study 3. All subjects received course credit for participation and were contacted in a way identical to Study 3. Nine subjects had to be excluded from the analyses either because of identifying themselves as dieters during the experiment ($n = 3$), a Body Mass Index (*BMI*) above 25 ($n = 3$), or because they doubted the label of the GMF-apple in the taste test ($n = 3$). The resulting sample consisted of 8 men and 36 women, aged between 19 and 48 years ($M = 22.66$, $SD = 5.75$). Experimental groups did not differ in the percentage of women (hungry: 81.8 % vs. satiated: 81.8%), and BMI ($M_{hungry} = 20.73$, $SD = 1.81$ vs. $M_{satiated} = 20.64$, $SD = 1.38$), $t(42) < 1$.

Procedure and Materials

Procedure. Since the procedure was almost identical to that in Study 3, only deviations will be reported here. In contrast to Study 3, mood was assessed 3 times throughout the session (right at the beginning, immediately before the taste test, and after the taste test), and a measure of disgust sensitivity (Schienle et al., 2002) was also included in the final part of the session.

Mood assessment. Self reports of mood were assessed with the same items as in Study 3. Again, both items were negatively correlated at each time of measurement, $r(44)_{t1} = -.70$, $p < .001$; $r(44)_{t2} = -.54$, $p < .001$; $r(44)_{t3} = -.59$, $p < .001$, and so the same single mood index was used as in Study 3.

Taste test. In the taste test, one customary apple of another sort (Gala Royal) was placed on a new serviette in front of each participant. Each apple was either labeled as “genetically modified food (GMF)” or as “organically grown food (OGF)” and was either looking palatable or unpalatable. Food label was manipulated in the same way as in Study 3. Visual appearance was manipulated by adding several smudges and surface blemishes to half of the apples that were clearly detectable. Great care was taken to keep as constant as possible the amount and size of smudges and surface blemishes. Fifteen minutes were given to taste the apple and to rate it on the same dimensions that were used in Study 3. Again, food intake (g) was determined by subtracting the amount left from the exact pre-consumption weight ($M = 139$ g, $SD = 22.2$), that did not differ significantly between food deprived ($M = 145$ g, $SD = 25.7$) and satiated subjects ($M = 133$ g, $SD = 16.6$), $t(42) = 1.88$, $p = .07$.

Disgust sensitivity. Analogous to Study 1 and Study 2, the German Questionnaire for the FEE (Schienle et al., 2002) was used to assure that hungry and satiated participants would not systematically differ in general or domain specific disgust sensitivity.

Results

Manipulation Checks

Hunger ratings. To check for differences between deprived and satiated participants in subjective hunger ratings, a simple T-test was conducted. As expected, food deprived subjects reported stronger feelings of hunger ($M = 5.00$, $SD = 1.16$) than did satiated participants ($M = 3.95$, $SD = 1.62$), $t(37.9)^{20} = 2.47$, $p = .018$, $d = .75$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Ratings of visual attractiveness. To check if adding smudges and surface blemishes to customary apples impaired their visual attractiveness for both, food deprived and satiated participants, a 2 (need state: deprived vs. satiated) x 2 (visual appearance: palatable vs. unpalatable) ANOVA was conducted on visual attractiveness ratings.²¹ Need state did not have a significant main effect on ratings of visual attractiveness, $F(1,40) = 3.48$, $p = .07$, $d = .29$. However, a main effect of visual appearance, $F(1,40) = 6.09$, $p = .018$, $d = .38$, emerged that was qualified by a two-way interaction between need state and visual appearance, $F(1,40) = 4.04$, $p = .051$, $d = .31$.

Follow-up T-tests were conducted to specify this interaction. They indicate that only satiated participants clearly differentiated between palatable and unpalatable apples ($M_{\text{palatable}} = 5.50$, $SD = .59$ vs. $M_{\text{unpalatable}} = 3.95$, $SD = 1.71$), $t(12.36)^{22} = 2.83$, $p = .015$, $d = 1.21$, whereas food deprived participants considered both sorts of apples equally attractive ($M_{\text{palatable}} = 5.45$, $SD = .93$ vs. $M_{\text{unpalatable}} = 5.29$, $SD = 1.03$), $t < 1$. This pattern of results indicates that adding smudges and surface blemishes to customary apples rendered them visually unattractive for satiated participants only.

²⁰ Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

²¹ Ratings of visual attractiveness were also analyzed with a 2 (need state: deprived vs. satiated) x 2 (visual appearance: palatable vs. unpalatable) x 2 (food label: GMF vs. OGF) ANOVA. However, entering food label as an additional factor did not change results substantially.

²² Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

Ratings of healthiness and naturalness. To check if labeling an apple as GMF or OGF did influence ratings of healthiness and naturalness, separate 2 (need state: deprived vs. satiated) x 2 (food label: GMF vs. OMF) ANOVAS were conducted.²³ These analyses revealed a marginally significant main effect of food label on ratings of naturalness, $F(1,40) = 3.59$, $p = .065$, $d = 2.13$, and a highly significant main effect of food label on ratings of healthiness, $F(1,40) = 13.14$, $p = .001$, $d = .58$. No other effect reached statistical significance, all $F < 3.4$, $p > .075$. Means indicate that GMF-apples were evaluated as more unhealthy ($M = 5.00$, $SD = 1.21$) and more unnatural ($M = 4.38$, $SD = 1.17$) than OGF-apples ($M_{healthiness} = 6.20$, $SD = 1.06$ vs. $M_{naturalness} = 5.15$, $SD = 1.53$) by all participants irrespective of their need state.

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2(need state: deprived vs. satiated) x 5(subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;38) = 1.54$, $p = .20$. However, food deprived subjects ($M = 3.78$, $SD = .59$) reported lower domain specific disgust sensitivity than satiated participants ($M = 4.17$, $SD = .63$) on the oral rejection subscale of the FEE, $F(1;42) = 4.40$, $p = .042$, $d = .64$, all other $F < 2.33$, $p > .13$. Unlike in Study 1 and Study 2, self reported disgust sensitivity on one of two eating relevant subscales was influenced by food deprivation in this study, indicating that contrary to original assumptions (Schienle et al., 2002), the FEE might possibly be sensitive to momentary variations in relevant psychological or biological states. This issue will be re-addressed in the discussion later.

²³ Ratings of naturalness and healthiness were also analyzed with a 2 (need state: deprived vs. satiated) x 2 (visual appearance: palatable vs. unpalatable) x 2 (food label: GMF vs. OGF) ANOVA. However, entering visual appearance as an additional factor did not change results substantially.

Beliefs about GMF. Mean rating scores from the five subscales were analyzed with separate T-Tests and did not differ between hungry and satiated participants. In particular, food deprived and satiated participants associated GMF to feelings of worry ($M_{deprived} = 3.77$, $SD = 1.43$ vs. $M_{satiated} = 3.94$, $SD = 1.48$), $t < 1$, fear ($M_{deprived} = 3.56$, $SD = 1.34$ vs. $M_{satiated} = 4.08$, $SD = 1.57$), $t(42) = 1.17$, $p = .25$, and anger ($M_{deprived} = 3.11$, $SD = 1.44$ vs. $M_{satiated} = 3.55$, $SD = 1.57$), $t < 1$, to the same degree. Furthermore, food deprived participants and satiated participants did not differ in their ratings on the cognitive axis, ($M_{deprived} = 3.71$, $SD = .82$ vs. $M_{satiated} = 3.44$, $SD = .90$), $t(42) = 1.07$, $p = .29$, or on the evaluative axis ($M_{deprived} = 3.71$, $SD = 1.03$ vs. $M_{satiated} = 3.42$, $SD = .94$), $t(42) = 1.01$, $p = .32$. Consequently these variables will be discarded.

Mood. To rule out any differences in self reported mood, a 2 (need state: deprived vs. satiated) x 3 (time of mood assessment: t1 vs. t2 vs. t3) mixed model ANOVA was conducted for the mood indices. It turned out that need state did not affect mood ratings, $F < 1$ for the main effect and the interaction, respectively. However, an overall effect of time of mood assessment emerged, multivariate $F(2,41) = 6.91$, $p = .003$, $d = .58$. To further specify the overall effect of time of mood assessment, follow-up T-tests for repeated measures were conducted. Results indicate that self reported mood did not differ between t1 and t2 ($M_{t1} = 3.33$, $SD = 1.11$ vs. $M_{t2} = 3.20$, $SD = 1.16$), $t(43) = 1.28$, $p = .21$, but improved towards the end of the session. In particular, mood ratings differed between t2 and t3 ($M_{t2} = 3.20$, $SD = 1.16$ vs. $M_{t3} = 3.53$, $SD = 1.13$), $t(37) = 3.77$, $p < .001$, $d = .29$, and between t1 and t3 ($M_{t1} = 3.33$, $SD = 1.11$ vs. $M_{t3} = 3.53$, $SD = 1.13$), $t(37) = 2.12$, $p = .04$, $d = .21$. However, relating overall means to the scale range from 0 (*bad mood*) to 5 (*good mood*) indicates that all subjects were in a moderately positive mood throughout the whole session.

Taste of apples. To make sure that taste preferences would not differ systematically between hungry and satiated subjects, ratings of actual tastiness were analyzed with a 2 (need state: deprived vs. satiated) x 2 (visual appearance: palatable vs. unpalatable) x 2 (food label:

GMF vs. OMF) ANOVA. Again, only apples of the same sort and even from the same batch of the same food manufacturer were used, and so the tastiness of apples was expected to be the same across all experimental conditions. However, the analysis revealed a significant main effect of need state, $F(1,35) = 12.81, p = .001, d = .61$, indicating that food deprived subjects ($M = 5.27, SD = 1.35$) liked the taste of their apple more than satiated subjects ($M = 3.86, SD = 1.11$), irrespective of visual appearance or food label. No other effect reached statistical significance, all $F(1,35) < 2.45, p > .12$.

Food Intake

In order to control for systematic differences that were detected between food deprived and satiated participants on the oral rejection subscale of the FEE, and in their ratings of tastiness and visual attractiveness food intake was analyzed with a 2 (need state: deprived vs. satiated) x 2 (visual appearance: palatable vs. unpalatable) x 2 (food label: GMF vs. OGF) Analysis of Covariance (ANCOVA), with ratings of tastiness, ratings of visual attractiveness, and the oral rejection subscale of the FEE serving as covariates. The analysis revealed that neither eating relevant disgust sensitivity, $F < 1$, nor ratings of visual attractiveness, $F < 1$, or ratings of tastiness, $F(1,32) = 3.34, p = .077$, significantly influenced food intake. However, the marginally significant effect of tastiness on food intake is reflected in a positive correlation between both variables $r(43) = .54, p < .001$. Not surprisingly, higher ratings of tastiness were associated with greater food intake across all participants.

More important, and fully in line with the hypotheses, a main effect of need state, $F(1,32) = 11.60, p = .002, d = .60$, emerged. This main effect indicates that food deprived participants consumed greater amounts of food than satiated participants across all experimental conditions (Figure 5). In particular, the absence of any two-way or three-way interaction between need state, food label, and visual appearance, all $F(1, 32) < 1.21, p > .27$, indicates that the effect of food deprivation is the same for disgusting and palatable apples. That is, food deprived participants consumed greater amounts of food irrespective of its visual

appearance or its label, and after controlling for inter-individual differences in domain specific disgust sensitivity, visual attractiveness and tastiness.

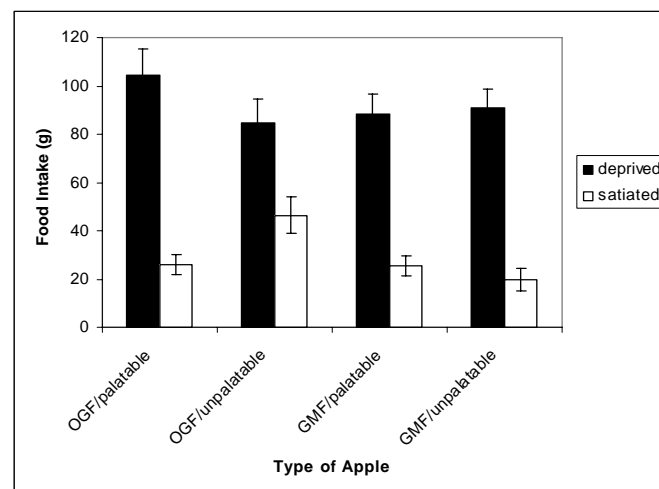


Fig.5: Food intake as a function of need state, food label, and visual appearance.

Error bars indicate standard errors of the means.

However, the absence of any interaction also implies that (compared to a GMF label and unpalatable visual appearance) neither an OGF label, nor palatable visual appearance had a positive effect on satiated participants' food intake. If anything at all, a slight descriptive trend can be seen amongst satiated subjects towards greater consumption of unpalatable looking OGF apples.

Discussion

To sum up, similar to Study 3 the present study was also designed to show that food deprived subjects would consume greater amounts of disgusting foods than satiated participants. Over and above, the interplay between sensory and ideational aspects of food related disgust was also examined in Study 4 (see Fallon & Rozin, 1983; Rozin & Fallon, 1987 for an overview). For this purpose, customary apples were not only labeled "genetically modified food" or "organically grown food", but also looked either palatable or unpalatable. This experimental design allowed for differentiating between negative sensory properties and more abstract, ideational aspects as reasons for food rejection within in a single study. Noteworthy, this distinction is also interesting from a dual systems perspective of information

processing in that it mirrors a distinction between impulsive processes and reflective processes as well. As illustrated before, the visual appearance of food represents an immediate perceptual input that should inevitably trigger positive or negative associations in memory. In contrast, the food label might also be conceptualized as propositional knowledge that might be used for more elaborated judgments about the quality or acceptance of food.

It was examined in an exploratory fashion if both “input channels” would interact with each other. I might for example be that an OGF label (positive propositional knowledge) might compensate for unpalatable visual appearance of food (immediate perceptual input) via more elaborated reasoning. Participants for example might be aware that organically grown foods are normally not looking equally attractive as industrially produced foods (“nature isn’t perfect”) and therefore conclude that unpalatable visual appearance is actually no a disadvantage in the case of OGF, but might be even be a quality feature. As already mentioned, a descriptive trend emerged amongst satiated subjects showing that the consumption of unpalatable looking OGF apples is slightly greater than the consumption of the remaining sorts. Of course, this trend is not taken as reliable evidence for the abovementioned assumption, but nevertheless it is compatible with this idea.

More important, the results of Study 4 show that food deprived participants (compared to satiated participants) consumed greater amounts of both, palatable and disgust related foods. In particular, a main effect of food deprivation on food intake emerged, indicating that the effect of food deprivation was the same across all types of apples. This finding is fully in line with the core assumptions of the present thesis and with prior studies that showed greater food intake amongst hungry subjects for both, good tasting and bad tasting foods (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968).

Importantly, Study 4 replicates the results of Study 3 by showing that food deprived subjects do also consume greater amounts of genetically modified foods thereby corroborating the assumption that food deprived subjects (but not satiated subjects) will overcome their

health concerns (Bredahl, 1999; Grunert, et al., 2001; Haukenes, 2004) and their feelings of rejection and disgust towards GMF (Magnusson et al., 2002; Subrahmanyam, & Cheng, 2000; Townsend & Campbell, 2004; Winnaker, 1996) and consume them readily. Furthermore, food deprived participants also consumed greater amounts of apples that were looking unpalatable. This finding is also in line with the hypotheses and nicely fits the reduction of facial disgust reactions towards disgusting looking foods that was observed in Study 2. Taken together, the observed data pattern even suggests that food can trigger eating behavior in deprived subjects even if it evokes food related disgust on several dimensions at the same time (i.e., unpalatable visual appearance and genetic modification).

Given the finding that neither food label, nor visual attractiveness exerted an influence on food intake one may wonder if these manipulations might have been too weak. Self report data however clearly show that conscious evaluations were very well affected by manipulations food label and visual attractiveness. In particular, albeit evaluating GMF as unnatural and unhealthy to the same extent, food deprived participants consumed significantly greater amounts of GMF-apples than satiated participants. As already pointed out, this dissociation between negative evaluations and high food intake was also observed in Study 3 and parallels the dissociation between positive facial reactions and negative evaluations of disgusting foods in Study 2.

Contrary to evaluations of genetically modified apples food deprived participants did not evaluate the visual appearance of unpalatably looking apples more negatively than the appearance of palatable apples (despite the former having smudges and surface blemishes that were clearly detectable). However, albeit being substantially weaker than the manipulation of visual appearance in Study 1 and Study 2 (visual resemblance to excrements or vomit) this manipulation nevertheless turned out to be effective in evoking food rejection and negative evaluations amongst satiated participants. Thus, it seems not warranted to conclude that the manipulation of visual appearance was not successful per se.

Instead, it seems more likely that food deprivation might have improved explicit evaluations of food in the present study as well (see also Brendl et al., 2003; Cabanac, 1971; Drobles et al., 2001; Lavy & van den Hout, 1993). That is, food deprived subjects evaluated the visual appearance of unattractive apples more positively, liked the taste of their apples better, and also reported lower food related disgust sensitivity on one relevant subscale of the FEE.²⁴ It has to be noted however that food deprived subjects' higher intake of disgust related food can still not be entirely explained by these changes in self report measures. After all, there was still a significant main effect of food deprivation after statistically controlling for food related disgust sensitivity, ratings of tastiness, and ratings of visual attractiveness in the critical analysis. Taken together, Study 4 further corroborates the assumption that there might be a direct link between food related disgust and eating behavior that does not depend on cognitive evaluations or awareness.

General Discussion of Section 2

To sum up, Study 3 and Study 4 demonstrate that the observed reduction of food related disgust from Study 2 does translate into real eating behavior, too. In line with the hypotheses of the present thesis, Study 3 and Study 4 yielded that food deprived participants consumed greater amounts of disgust related foods than satiated participants. More precisely, Study 3 and Study 4 revealed that food deprived subjects consumed greater amounts of genetically modified food (GMF) than satiated participants, and Study 4 also showed that food deprived subjects consumed greater amounts of food that was visually unattractive.

As already mentioned, these findings are compatible with prior studies showing a greater intake of good tasting and bad tasting food amongst food deprived subjects (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968).

²⁴ Interestingly, and contrary to Study 1 and Study 2 this latter finding suggests that the FEE might not be a "pure" trait measure of food related disgust sensitivity (see Schienle et al., 2002), but is also be susceptible to momentary variations of relevant biological and psychological states.

However, the two studies in the present thesis go beyond prior findings by highlighting the role of food related disgust in the relationship between food deprivation and food intake. An attempt was made to render implausible earlier explanations for food deprived subjects' higher intake of bad tasting foods (e.g., metabolic pressures to ingest calories immediately, alterations in taste responsiveness) by subjecting participants only to moderate levels of food deprivation (thereby reducing metabolic pressures) and by using experimental foods that were disgusting, but not bad-tasting (thereby rendering taste responsiveness irrelevant). By showing that food deprived subjects consumed greater amounts of disgusting foods even under these conditions, Section 2 suggests that reductions of food related disgust might be indeed responsible for previously observed results as well.

To recapitulate, foods in both studies were assumed to evoke food related disgust and rejection because they were genetically modified (thus providing a more abstract reason for food rejection; Study 3 and Study 4), or because they were visually unattractive (Study 4). It was argued already that GMF is specifically related to the emotion of disgust (Townsend & Campbell, 2004), feelings of moral objection (Magnusson et al., 2002; Subrahmanyam, & Cheng, 2000; Winnaker, 1996), and health concerns (Bredahl, 1999; Grunert, et al., 2001; Haukenes, 2004) hence possessing several central features that characterize disgusting foods (see Fallon & Rozin, 1983, or Rozin & Fallon, 1987 for overviews).

Given this strong connection between GMF and the emotion of disgust, it appears plausible to relate food deprived participants' greater intake of GMF to their attenuated feelings of disgust towards these foods. In the same fashion, it would make sense to relate deprived participants greater intake of visually unattractive food (Study 4) to their attenuated feelings of disgust. This latter interpretation however should be handled with some caution, because the connection between disgust and unpalatable visual appearance is less obvious for the unpalatable foods in Study 4 (compared to the disgusting food pictures that were used in Study 1 and Study 2).

Noteworthy, food deprived participants consumed quite large amounts of GMF despite evaluating it as unnatural and unhealthy (see also Bredahl, 1999; Grunert, et al., 2001; Haukenes, 2004) in an experimental context that emphasized potential long term health risks. As argued before, this finding is striking and strongly corroborates the assumption that there might be a link between food related disgust and eating behavior that does not depend on conscious evaluations of foods or on awareness.

Furthermore, hungry subjects' greater consumption of GMF has some interesting implications for the phenomenon of hunger induced finickiness that was found for bitter tasting foods (e.g., Kauffman et al., 1995; Nisbett, 1972; Pliner et al., 1990). In short, hungry subjects consumed smaller amounts of bitter tasting foods than satiated subjects in previous studies (see Kauffman et al., 1995 and Pliner et al., 1990 for overviews), and the explanation was put forward that this might be an adaptive mechanism. More precisely, it was argued that bitter foods were normally toxic and especially harmful for food deprived organisms during evolution, and hunger induced finickiness might have prevented the deprived organism from severe health risks or even death (e.g., Kauffman et al., 1995; Nisbett, 1972; Pliner et al., 1990). The fact that food deprived participants actually consumed greater amounts of GMF than satiated participants in Study 3 and Study 4 (despite considering them unhealthy on an explicit level) however contradicts the assumption that food deprived subjects will avoid potentially dangerous foods even more rigorously than satiated subjects.

One might of course argue that GMF-apples were in fact not considered as potentially dangerous or really toxic. Indeed, it seems very reasonable to assume that most participants would not expect to receive dangerous or toxic foods in the course of a psychological consumer study and hence should be unconcerned about sustaining and significant health problems after consumption. However, this argument holds for the original studies of hunger induced finickiness (Kauffman et al., 1995; Nisbett, 1972; Pliner et al., 1990), too. Furthermore, alleged genetic modification was a good reason for food rejection amongst

satiated participants, and it was related to negative evaluations of healthiness amongst all subjects. Therefore, it seems implausible to doubt the effectiveness of the manipulation of food label in general.

Alternatively, the absence of hunger induced finickiness in the present studies might be explained by the assumption that the phenomenon crucially depends on the sensory experience of bitter taste as a deeply routed evolutionary warning signal. According to this assumption, foods that are potentially dangerous, but good tasting should not evoke food rejection. However, as already mentioned GMF-apples were clearly rejected by satiated participants and the question arises why good taste should compensate for potential health concerns in food deprived subjects, but not in satiated participants. Ultimately, this reasoning would result in the additional assumption that deprived subjects should be more responsive than satiated subjects to the good flavor of food. However, the classic idea that food deprivation increases taste responsiveness (e.g., Nisbett, 1972) has already been challenged by numerous findings showing that the food intake of deprived and satiated organisms is not differentially influenced by flavor (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975). Therefore, it would seem more appropriate to assume that other reasons than health concerns or bitter taste per se (e.g., the prospect of consuming more palatable food directly after the experimental session) might have been more important reasons for the effect of hunger induced finickiness that was observed in prior studies (see Kauffman et al., 1995 for a more detailed discussion).

To give an interim conclusion, Section 1 revealed that even moderate levels of food deprivation do increase immediate positive affect (or zygomaticus activity, respectively) towards palatable (Study 1 and Study 2) and even disgusting foods (Study 1). Furthermore, food deprivation does also attenuate specific disgust reactions (or levator activity, respectively) towards unpalatable foods automatically (Study 2). In Section 2 it was found that this attenuation of food related disgust is accompanied by a greater acceptance of

disgusting foods in the realm of food ingestion. That is, food deprived subjects also consumed greater amounts of disgusting foods than satiated subjects. Interestingly, Study 3 and Study 4 even indicate that food deprivation can override existing health concerns that restrict food intake in the case of genetically modified foods.

As a whole, the results observed so far suggest that food deprivation changes food related disgust and the consumption of disgusting foods without necessarily changing conscious evaluations of disgusting foods. The main purpose of the following sections is to examine the mental mechanisms that may underlie this phenomenon. As mentioned before, it will be tested if the automatic attenuation of disgust might be related to immediate evaluations of unpalatable foods (Section 3), and to immediate approach motivational tendencies towards unpalatable foods (Section 4). In Section 5 it will be investigated if food deprivation might also exert an influence on food related disgust by changing the subjective weighting of hedonic versus functional food attributes in the context of more elaborated cost-benefit-computations.

Section 3: Does Food Deprivation Influence Automatic Attitudes towards Disgusting Foods?

Overview and Rationale of Study 5 and Study 6

Study 5 and Study 6 were designed to test if food deprivation alters automatic attitudes towards disgusting foods. Prior studies using indirect attitude measures like the Implicit Association Test (*IAT*; Greenwald et al., 1998) or the Extrinsic Affective Simon Task (*EAST*; De Houwer, 2003), for example yielded that eating relevant cues evoked more positive immediate evaluations (or automatic attitudes, respectively) in food deprived subjects than in satiated subjects (Hoefling & Strack, 2008; Seibt et al., 2007). Furthermore, Section 1 yielded that palatable food cues (Study 1 & 2), and even disgusting foods (Study 1) evoke stronger activity of the zygomaticus muscle in food deprived subjects than in satiated subjects. Given that zygomatic activity is assumed to be an indicator of positive affect and positive stimulus valence (see Dimberg, 1990, and Fridlund & Izard, 1983 for reviews), it can be concluded from these findings that food deprived subjects have more positive automatic attitudes than satiated subjects towards palatable food cues. However, to the present day no study exists that examines the impact of food deprivation on immediate evaluations of disgusting foods.²⁵

In order to assess automatic attitudes towards unpalatable foods, two recently developed attitude measures were used that were introduced already. To repeat, a variant of Greenwald et al.'s (1998) IAT was used in Study 5 that included only a single target category rather than two target categories (Steinman & Karpinski, 2006; Wigboldus et al., 2005), and the Affect Misattribution Procedure (*AMP*; Payne et al., 2005) was used in Study 6. In the st-IAT, subjects are asked to press either a left-hand key or a right-hand key depending on which

²⁵ The finding that food deprivation also increases zygomaticus activity towards disgusting foods (Study 1) can at least be taken as a first hint that food deprivation renders automatic attitudes towards disgusting foods more positive, too. However, it was discussed before that this effect was rather weak and no studies have been conducted that use other indirect measures of attitudes.

stimulus is presented on a computer screen. Importantly, subjects are asked to press the correct button as quickly as possible and response latencies serve as a main dependent measure. Ultimately, reaction time indices are computed that inform about the extent to which a target concept (e.g., disgusting foods) is associated with positive or negative valence. Usually, higher values indicate a more positive automatic attitude towards a target concept. In contrast, no reaction times are measured in the AMP but subjects are asked to evaluate several ambiguous stimuli (Chinese pictographs) as “rather positive” or “rather negative” by pressing one of two response keys. Importantly, each Chinese pictograph is preceded by a prime whose valence is assumed to influence the individual’s evaluation of the ambiguous Chinese pictograph by a kind of affective transfer (e.g., Murphy & Zajonc, 1993). Consistent with this idea a greater proportion of Chinese pictographs was categorized as “rather positive” after positive primes than after negative primes even if participants were warned not to let the prime images influence their evaluations of the pictographs (Payne et al., 2005).

Both studies in this section were largely similar in respect to the experimental design and the stimuli that were used. In Study 6, the same pictures were used as in Study 1, resulting in a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed factorial design. However, positive and disgust related control pictures were not presented in Study 5, resulting in a 2 (need state: deprived vs. satiated) x 2 (valence: palatable food vs. disgusting food) mixed factorial design in Study 5.²⁶

Hypotheses of Study 5 and Study 6

Drawing on previous studies (Hoefling & Strack, 2008; Seibt et al., 2007) and on the results presented so far, it is assumed that disgusting foods should evoke more positive

²⁶ Using the st-IAT requires to perform a separate IAT for each picture category. In order to avoid an experimental design with 4 repeated st-IAT measures (and possible sequence effects), control pictures were dropped in order to reduce the number of mandatory st-IATs. Over and above, prior research (e.g., Hoefling & Strack, 2008; Seibt et al., 2007) and the results presented so far reliably indicate that food deprivation exerts an influence on need relevant cues only (see also Study 1 and Study 2).

automatic evaluations in food deprived subjects than in satiated subjects. In addition (albeit not central to the present thesis) it would come as no surprise if hungry participants would also have more positive automatic attitudes towards palatable foods.

Hence, (compared to satiated participants) food deprived participants were supposed to exhibit higher IAT indices towards both, palatable and disgusting foods in Study 5. Analogous, (compared to satiated participants) food deprived participants should classify a greater proportion of Chinese pictographs as “rather positive” after both, palatable and disgusting food primes. To repeat, no such difference between food deprived and satiated participants was expected for control stimuli unrelated to food in Study 6. For the sake of completeness it shall also be mentioned that the general valence of pictures should still have a trivial main effect on the proportion of “positive” responses in the AMP. That is (albeit not central to the present thesis) it was expected that a greater proportion of pictographs would be classified as “rather positive” after positive primes than after a disgust related primes in Study 6.

Study 5: Food Deprivation and Automatic Attitudes towards Disgusting Foods Measured with the Single Target – IAT

Methods

Participants and Design

Forty-four undergraduate psychology students (35 female) at the University of Würzburg took part in an experiment that was introduced as a study on the effects of blood glucose levels on concentration. Subjects received course credit for participation.

Subjects were either food deprived or satiated and were presented the same photographs of palatable and disgusting foods that had been used in Study 2, resulting in a 2 (need state: deprived vs. satiated) x 2 (valence: palatable food vs. disgusting food) mixed factorial design with need state as a between-subjects factor. Subjects were contacted two days before the

experiment to convey first instructions and to exclude vegetarians, and persons who reported being on a diet or having certain food-relevant allergies before scheduling any participants.

Three subjects had to be excluded from the analyses because of a Body Mass Index (*BMI*) above 25. The resulting sample consisted of 8 men and 33 women, aged between 19 and 48 years ($M = 22.3$, $SD = 5.83$). Experimental groups did not differ in the percentage of women (hungry: 81.8 % vs. satiated: 78.9%), $\chi^2(1; N = 41) < 1$, and *BMI* ($M_{hungry} = 20.80$, $SD = 1.88$ vs. $M_{satiated} = 20.70$, $SD = 1.44$), $t(39) < 1$.

Procedure and Materials

Procedure. Similar to the studies reported so far, participants were either asked to refrain from eating for 15 hours, or to have lunch immediately before the experiment. Experimental sessions started at noon or 1:30 p.m., and participants were tested in groups up to three persons. After being welcomed by the experimenter, participants were seated at a separate table with a standard personal computer and a 19 inch monitor. They signed a consent form and reported their current mood. Subsequently, subjects' automatic evaluations of palatable vs. disgusting foods were assessed with the aforementioned st-IAT (Steinman & Karpinski, 2006; Wigboldus et al., 2005). Each subject completed two separate st-IATs in counterbalanced order, one for palatable foods ("palatable-IAT"), and one for disgusting foods ("disgusting-IAT"). Explicit attitudes towards palatable and disgusting foods were measured after the second st-IAT by presenting all pictures from both st-IATs again and asking subjects a) how palatable they find the visual appearance of each food depicted on a photograph and b) how strongly they desire to consume each food. Subsequently, all participants completed the known set of final questions that will not be described in greater detail. These included the FEE as a measure of general and domain specific disgust sensitivity (Schienle et al., 2002), another mood questionnaire, a set of demographic questions (with self reported feelings of hunger serving as a manipulation check), and a funneled debriefing procedure to check for suspicion.

Mood assessment. Self reports of mood were assessed with the same items as in Study 3 and Study 4. Again, both items were negatively correlated at each time of measurement, $r(41)_{t1} = -.69$, $p < .001$; $r(41)_{t2} = -.57$, $p < .001$ and so the same single mood index was used as reported before.

Overview of the st-IAT. As already mentioned the st-IAT (Steinman & Karpinski, 2006; Wigboldus et al., 2005) was used to measure subjects' automatic evaluations of palatable and disgusting foods. In this task, pictures of foods as well as positive and negative words were presented in the middle of a computer screen. Participants were asked to respond to positive words with a right-hand key (5 on the number pad), and to negative words with a left-hand key (A), or vice versa. So, the key assignment was counterbalanced across participants and remained constant throughout the session. Participants completed one st-IAT to measure their automatic attitudes towards palatable foods, and another st-IAT to assess their automatic attitudes towards disgusting foods. As mentioned before, the order of these two st-IATs was counterbalanced across subjects, too.

Each st-IAT consisted of two critical blocks. In one critical block, participants were asked to respond with the same key to pictures of food and to positive words, and with the opposite key to negative words. In the other critical block, the key assignment for food pictures was reversed, such that participants were required to respond with the same key to pictures of food and negative words, and with the opposite key to positive words. The order of these blocks was determined randomly in both st-IATs and a permanent reminder with the correct key assignment was presented on the top of the screen.

Stimuli and timing of the st-IAT trials. As target stimuli, the same 16 food pictures were used as in Study 2, half of which depicted palatable looking dishes that were arranged in an aesthetic way (i.e. pasta, pizza) and the other half depicted unpalatable looking dishes (i.e. hot pots, spinach pulp) that were arranged in an unaesthetic way and bore a certain visual resemblance to excrements and vomit due to their color and texture (see also Appendix E2).

Within each st-IAT only palatable or disgusting food pictures were presented. Within each critical block, each picture was presented twice in random order (excluding immediate repetitions of the same picture).

As attribute stimuli, 8 positive words (e.g., paradise, fun), and 8 negative words (e.g., poison, feces) were used (see Appendix E2). The number of stimuli per response category was determined such that the number of right-hand and left-hand responses was the same in each critical block. Each critical block consisted of a total of 64 trials. Throughout all blocks, each trial started with a fixation cross that appeared for 1000 milliseconds, immediately replaced by a stimulus which stayed on the screen until a response was given. When participants made a mistake, a red cross appeared under the stimulus until participants made a correct response.

Indices of automatic attitudes were calculated separately for palatable and unpalatable food pictures, using the D600 measure proposed by Greenwald, Nosek, and Banaji (2003) for standard IAT applications with higher values indicating more positive immediate evaluations.

Explicit picture ratings. After both st-IAT had been completed, participants were also asked to rate all pictures on two dimensions. For this purpose, subjects completed two separate blocks in counterbalanced order and rated a) how palatable they find the visual appearance of each food on a scale ranging from 1 (*very unpalatable*) to 9 (*very palatable*), and b) how strongly they desire to eat each food on a scale ranging from 1 (*do not like to eat at all*) to 9 (*like to eat very much*). Within a single block, all pictures were presented once in random order.

Results

Manipulation Checks

To check for differences between deprived and satiated participants in subjective hunger ratings, a simple T-test was conducted. As expected, food deprived subjects reported stronger feelings of hunger ($M = 5.05$, $SD = 1.17$) than did satiated participants ($M = 4.00$, SD

= 1.68), $t(39) = 2.35$, $p = .024$, $d = .73$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2(need state: deprived vs. satiated) x 5(subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;35) = 1.11$, $p = .37$. Furthermore, none of the FEE subscales differed as a function of food deprivation, all $F(1;39) < 2.73$, $p > .10$. Consequently, this variable was discarded.

Mood. To further rule out any differences in self reported mood, a 2 (need state: deprived vs. satiated) x 2 (time of mood assessment: t1 vs. t2) mixed model ANOVA was conducted for the mood indices. Means indicate that all subjects were in a neutral mood at the beginning ($M = 3.78$, $SD = 1.15$) and at the end of the session ($M = 3.71$, $SD = 1.15$). Neither the main effects of need state, $F < 1$, or time of mood assessment, $F < 1$, nor the two way interaction between need state and time of mood assessment, $F(1,39) = 1.59$, $p = .21$, reached statistical significance.

Explicit evaluations. To check if food deprivation had an influence on ratings of visual appearance and self reported desire to consume the depicted foods, two separate 2 (need state: deprived vs. satiated) x 2 (valence: palatable vs. disgusting) ANOVAS with repeated measures were conducted. Not surprisingly, both analyses revealed a highly significant main effect of valence, indicating that disgust related foods were evaluated more negatively than palatable foods in respect to both, their visual appearance ($M_{palatable} = 6.62$, $SD = 1.16$ vs. $M_{disgusting} = 1.63$, $SD = .62$), $F(1,39) = 689.81$, $p < .001$, $d = 4.36$, and the extent to which participants would like to consume them ($M_{palatable} = 6.23$, $SD = 1.57$ vs. $M_{disgusting} = 1.56$,

$SD = .85$), $F(1,39) = 401.60$, $p < .001$, $d = 3.18$. No other effect reached statistical significance, all $F < 1.29$, $p > .26$.

Automatic Attitudes

Automatic attitudes (or D-Scores, respectively) were analyzed with a 2 (need state: deprived vs. satiated) x 2 (valence: positive vs. disgust related) ANOVA with repeated measures as well.²⁷ As mentioned before, higher values indicate a more positive automatic attitude. The analysis revealed that food deprived and satiated participants do not differ in their automatic evaluations per se, as indicated by the absence of a main effect of need state, $F < 1$. However, a main effect of valence, $F(1,39) = 7.35$, $p = .01$, $d = .44$, suggests that positive food pictures (photographs of palatable food, respectively) evoked more positive immediate evaluations than pictures of disgust related food irrespective of need state (Figure 6).

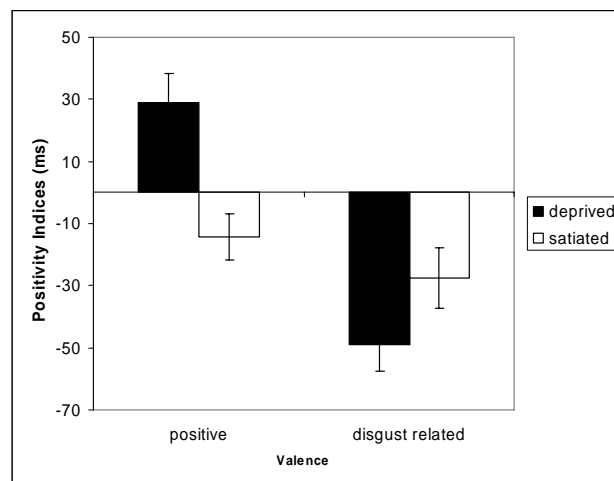


Fig.6: Positivity indices as a function need state and valence.

Error bars indicate standard errors of the means.

Moreover, a marginally significant two-way interaction between need state and valence emerged, $F(1,39) = 3.31$, $p = .077$, $d = .29$, that will not be followed by separate T-tests because it misses conventional levels of statistical significance. There are however two descriptive trends in the data that become also apparent from Figure 6. First, food deprived

²⁷ The order of st-IATs (palatable-IAT first vs. unpalatable-IAT first) was also entered as a factor in another ANOVA, but did not have any effect on automatic evaluations, all relevant $F < 1$. Therefore, automatic evaluations will be reported, that are collapsed across both order-conditions.

subjects differentiated more strongly between palatable and disgusting foods than did satiated subjects, thereby suggesting that the significant main effect of valence might be interpreted with some caution. Second, when focusing on positive food pictures, food deprived participants had slightly more positive automatic attitudes than satiated participants, but when focusing on disgust related food pictures they had slightly more negative automatic attitudes. The former finding is in line with the hypotheses and fits earlier findings concerning the influence of food deprivation on immediate evaluations of food (e.g., Hoefling & Strack, 2008, Seibt et. al., 2007). The latter finding however runs contrary to the hypotheses because it was expected that food deprived participants should exhibit more positive automatic attitudes towards disgusting foods than satiated participants.

Discussion

To summarize, Study 5 was designed to test the assumption that food deprived participants' automatic attitudes towards disgusting foods would be more positive than those of satiated participants. Furthermore (albeit not central to the present thesis), it was also tested if food deprived subjects' automatic attitudes towards palatable food would be more positive, too (see also Hoefling & Strack, 2008; Seibt et al., 2007). For this purpose, two separate s-IATs were conducted that assessed food deprived and satiated participants' immediate evaluations of palatable and disgusting foods.

As already described, a significant main effect of valence was found indicating that disgusting foods evoked more negative immediate evaluations than palatable foods across all subjects. However, the observed data pattern suggests that this effect is more pronounced for food deprived subjects.²⁸ This finding is counterintuitive at first sight, because it indicates that food deprived participants care more about the palatability of food than satiated participants.

²⁸ In fact, focused comparisons would have yielded that only food deprived subjects $t(21) = 3.35, p = .003, d = 1.01$, differentiated between palatable and disgusting foods, but satiated subjects did not $t < 1$. However, it was argued already that the critical need state x valence interaction in the overall ANOVA was only marginally significant. Therefore, no such follow-up t-Tests were reported in the results section and conclusions drawn from these focused comparisons have to be interpreted with reservation.

One admittedly speculative explanation for this finding draws on the assumption that a stronger differentiation between potential foods might be adaptive for food deprived organisms. From this perspective, the valence (or visual palatability) of food stimuli is irrelevant for the satiated organism, whereas the hungry organism is tuned to evaluate potential foods automatically. This “preparedness to evaluate” potential foods might be beneficial in the context of upcoming food selection and food consumption because it enables the hungry organism to make quick and efficient food choices.

The finding that food deprived subjects do not have more positive (but slightly more negative) automatic attitudes towards disgusting foods than satiated participants, disconfirms a central prediction of this section. That is, albeit food deprived subjects showed weaker disgust expressions towards disgusting foods in Section 1, and consumed greater amounts of disgust related foods in Section 2, they do not seem to evaluate them more positively on an automatic level of processing.

It was argued before that food related disgust and food intake might be influenced in a way that does not depend on awareness, or on conscious evaluations of disgusting foods. Consequently, the question arises if food related disgust and food intake might even be independent of automatic evaluations of disgusting foods. However, any conclusion would be premature given the variety of other indirect attitude measures and the number of possible alternative mechanisms underlying responses in an IAT (see Wittenbrink & Schwarz 2007; De Houwer 2006; or Gawronski & Conrey, 2004 for an overview). It might for example be, that the IAT captures automatic semantic associations to a greater extent, than it captures automatic affective reactions, or immediate evaluations (Klauer & Musch, 2002; Spruyt, De Houwer, Hermans, Eelen, 2007). The use of other indirect attitude measures (e.g., affective priming) might hence be more appropriate in order to capture immediate affective reactions towards disgusting foods (see also Fazio 2001). In order to clarify this issue, the recently developed Affect Misattribution Procedure (*AMP*; Payne et al., 2005) was used as an indirect

attitude measure in Study 6. Importantly, it is assumed in the present thesis that the AMP should capture immediate affect to a greater extent than the st-IAT, because responses in the AMP are crucially based on the misattribution of elicited affect, and not on the fast initiation of pre-defined semantic and evaluative categorizations (see also Payne et al., 2005).

Study 6: Food Deprivation and Automatic Attitudes towards Disgusting Foods Measured with the Affect Missattribution Procedure

Methods

As mentioned before, Study 6 was almost identical to Study 5 in respect to design, procedures and materials, and so only deviations from Study 5 will be reported here.

Participants and Design

Sixty two undergraduate psychology students and non-psychology majors (44 female) at the University of Würzburg took part in an experiment that was introduced as a study on the effects of blood glucose levels on visual information processing. Subjects received course credit (psychology students), or were paid € 8 (approximately \$ 11 at that time) for participation. The design of Study 6 was a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed factorial design.

Seven subjects had to be excluded from the analyses because of a Body Mass Index (*BMI*) below 17.5 ($n = 3$) or above 25 ($n = 4$). The resulting sample consisted of 16 men and 39 women, aged between 18 and 41 years ($M = 21.4$, $SD = 3.54$). Experimental groups did not differ in the percentage of women (hungry: 68.0 % vs. satiated: 73.3%), $\chi^2(1; N = 55) < 1$, and BMI ($M_{\text{hungry}} = 21.14$, $SD = 1.93$ vs. $M_{\text{satiated}} = 21.32$, $SD = 1.84$), $t(53) < 1$.

Procedure and Materials

Procedure. The procedure of Study 6 was the same as in Study 5, except that mood was assessed only at the beginning of the session in order to control for possible a priori differences between deprived and satiated subjects. Furthermore, subjects' automatic

evaluations of palatable vs. unpalatable foods were assessed with the Affect Missattribution Procedure (AMP; Payne et al., 2005) that will be described in more detail below.

Mood assessment. Self reports of mood were assessed with the same items as in Study 5. Again, both items were correlated negatively, $r(55) = -.75$, $p < .001$, and so the same single mood index was used as reported before.

Affect Missattribution Procedure (AMP). Stimuli for the AMP were drawn from Study 1. Following the original paradigm from Payne et al. (2005), 12 food pictures were presented and 12 pictures that were unrelated to food. However, within each picture category, half of the pictures were positive, and the other half was disgust related. In addition, 12 neutral pictures of everyday objects that were selected from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) were also presented, resulting in a total number of 36 critical trials (see Appendix F2). Stimuli to be evaluated were 36 Chinese pictographs that had been used in previous AMP studies (Payne et al., 2005).

In each trial, a fixation cross was presented on the center of the screen for 1000 ms, followed by a randomly selected photograph that served as a prime (see Figure 7). Primes were presented for 600 ms. Though being substantially longer than in the original paradigm (75 ms), this prime duration was chosen to assure that all pictures (especially disgust related food pictures) could be properly identified by all participants. This procedure is considered unproblematic because previous studies showed that longer prime durations do not influence the misattribution effect (Payne et al., 2005 – Experiment 3). As can be seen from Figure 7, the prime was followed by a blank screen (125 ms), and then, a Chinese pictograph was presented (300 ms), immediately followed by a black-and-white visual mask that remained on the screen until a response was made. Participants were instructed to judge the probable evaluative meaning of the Chinese pictographs and to pay attention that their judgments would not be influenced by the prime. Particularly, they were asked to decide whether the meaning of each pictograph was “rather positive” or “rather negative” by pressing one of two

response buttons that were labeled “positive” (A) or “negative” (5 on the number pad). This key assignment was reversed for half of the participants. AMP responses were scored by computing the proportion of “*positive*” responses to pictographs for each stimulus category separately.

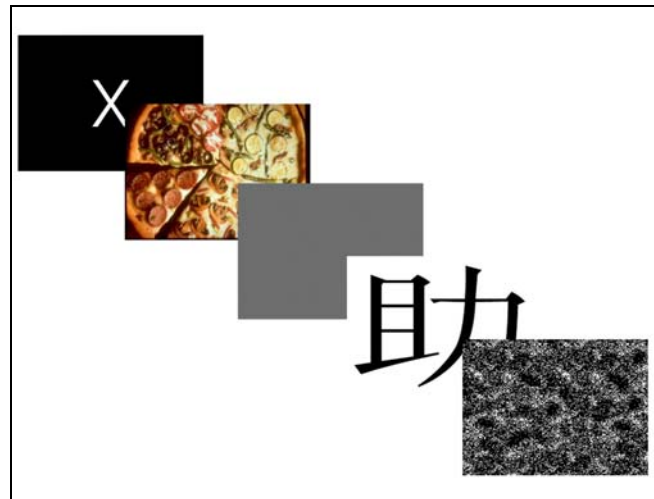


Fig.7: Illustration of the stimulus sequence in a single AMP trial

Results

Manipulation Checks

Hunger ratings of food deprived and satiated subjects were analyzed with a simple T-test. As expected, food deprived participants reported significantly stronger feelings of hunger ($M = 5.60$, $SD = 1.50$) than did satiated participants ($M = 2.73$, $SD = 1.86$), $t(52.96)^{29} = 2.35$, $p = .024$, $d = 1.70$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2 (need state: deprived vs. satiated) x 5 (subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;41) = 1.81$, $p = .13$. Furthermore, none of the FEE subscales

²⁹ Due to inhomogeneity of variances a correction for degrees of freedom (df) was used.

differed as a function of food deprivation, all $F(1;45) < 2.60$, $p > .11$. Consequently, this variable was discarded.

Mood. To further rule out any a priori differences in self reported mood, a simple T-test was conducted for the mood index. No differences emerged between food deprived ($M = 3.93$, $SD = 1.13$) and satiated participants ($M = 3.78$, $SD = 1.15$), $t < 1$.

Automatic Attitudes

AMP scores were analyzed with a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANOVA that did not include neutral pictures of everyday objects.³⁰ Not surprisingly, the analysis yielded a highly significant main effect of valence, $F(1,53) = 46.15$, $p < .001$, $d = .94$, indicating that all participants were more likely to evaluate a Chinese pictograph as “rather positive” after a positive prime than after a disgust related prime (see Figure 8). A main effect of category also emerged, $F(1,53) = 4.58$, $p = .037$, $d = .30$, that was qualified by a significant two-way interaction between category and valence, $F(1,53) = 4.89$, $p = .031$, $d = .30$. Follow-up T-tests were conducted to dismantle this interaction. They revealed that positive control pictures and positive food pictures evoked the same proportion of positive reactions, $t < 1$, but amongst disgust related pictures, food pictures evoked a greater proportion of positive reactions than control pictures, $t(54) = 3.05$, $p = .004$, $d = .49$.

Need state was not found to influence categorizations of Chinese pictographs reliably. In particular, no three-way interaction between need state, category, and valence occurred, $F < 1$, and both, the main effect of need state, $F(1,53) = 2.36$, $p = .13$, $d = .20$, and the two-way

³⁰ A 2 (need state: deprived vs. satiated) x 5 (item type: everyday objects vs. palatable food vs. disgusting food vs. positive control vs. disgust related control) ANOVA including neutral everyday objects was also conducted. This analysis revealed a main effect of item type, multivariate $F(4,50) = 13.85$, $p < .001$, $d = .24$ and was followed by T-tests for repeated measures to specify the main effect. In essence, the greatest proportion of pictographs was classified as “rather positive” after positive primes (65.8% for positive foods and 65.5% for positive control stimuli, respectively), followed by neutral primes (51.5%), and disgust related primes (42.1% for disgusting foods and 31.2% for disgust related control stimuli, respectively), thereby replicating the original priming effect reported by Payne et al. (2005). Follow-up comparisons indicate, that all stimulus categories except positive foods and positive control pictures, $t < 1$, differed significantly from each other, all remaining $t(54) > 2.40$, $p \leq .02$. Within the category of disgusting pictures, a greater proportion of “positive” responses was given after disgusting foods, than after disgusting control pictures, $t(54) = 3.05$, $p = .004$, $d = .49$.

interaction between need state and category, $F(1,53) = 2.39$, $p = .13$, $d = .20$, missed conventional levels of statistical significance.

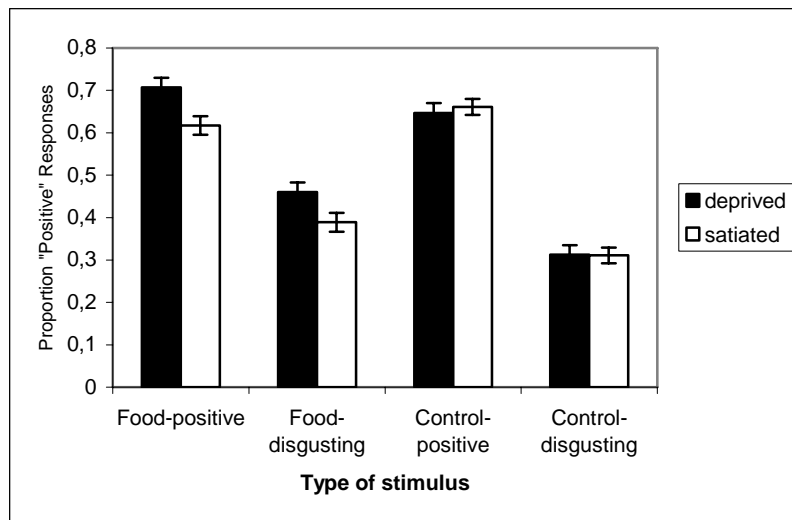


Fig.8: Proportion of “Pleasant” responses as a function of need state, category, and valence.

Error bars indicate standard errors of the means.

Nevertheless, it can be seen from Figure 8 that there is a trend which is in line with the hypotheses of the present thesis. Compared to satiated participants, food deprived participants categorized a greater proportion of Chinese pictographs as positive after food primes but not after control primes. Particularly both, palatable and disgusting foods evoked more positive affective reactions in food deprived participants than in satiated participants, whereas positive and disgust related control stimuli did not. However, since the two-way interaction between need state and category missed statistical significance, no follow-up T-tests will be reported here³¹.

Discussion

To sum up, Study 6 was designed to examine food deprived vs. satiated subjects' automatic attitudes towards disgusting foods with a different experimental paradigm than in Study 5. For this purpose, food deprived and satiated subjects' automatic affective reactions

³¹ In fact, such focused comparisons would have confirmed that food deprived subjects categorized significantly greater proportions of Chinese pictographs as positive than satiated subjects after food related primes, $t(53) = 2.0$, $p = .051$, $d = .53$, but not after control primes, $t < 1$.

towards palatable and disgusting foods were measured with the Affect Misattribution Procedure (*AMP*; Payne et al., 2005).

It was found that the proportion of “positive” responses towards an ambiguous stimulus (Chinese pictograph) was influenced by the valence of the prime thereby replicating the basic misattribution effect that was reported in previous *AMP* studies (e.g., Payne et al., 2005). That is, greater proportions of pictographs were categorized as positive after positive primes than after disgust related primes, irrespective of category. In particular, palatable foods also evoked more positive automatic attitudes than disgusting foods across all participants in Study 6, thus replicating the basic effect from Study 5.

However, albeit food stimuli and control stimuli were matched for valence with a pretest, it turned out that disgusting food pictures evoked a higher proportion of “positive” responses than disgust related control pictures in the *AMP*. This effect was not predicted and maybe explicit evaluations of disgust related foods in Study 6 deviated from explicit evaluations that were assessed in the pretest. That is, disgusting food pictures might have been evaluated more positively than disgusting control pictures on an explicit level, which in turn could be responsible for the observed results in the *AMP*. Explicit picture ratings would have been helpful to clarify this question, but were not conducted in Study 6.

More important, a data pattern became apparent that is consistent with the core assumptions of the present thesis, but missed conventional levels of statistical significance. Compared to satiated participants food deprived participants classified greater proportions of Chinese pictographs as positive after food primes but not after control primes. This trend has to be interpreted with reservation, of course. However, it fits previous findings showing a food deprivation alters automatic attitudes (e.g., Hoefling & Strack, 2008; Seibt et. al, 2007) towards need relevant cues, but not towards need-irrelevant cues. Noteworthy, the present thesis goes beyond previous studies by investigating the effects of homeostatic dysregulation on food related disgust. In particular, food deprived participants also categorized slightly

greater proportions of Chinese ideographs as “rather positive” than satiated participants after disgusting food primes. Of course, this tendency must not be over-interpreted, because it misses conventional levels of statistical significance.³² However, this result is compatible with the core assumptions of the present thesis, the automatic reduction of food related disgust observed in Study 2, and with hungry participants’ greater intake of disgust related foods in Study 3 and Study 4.

General Discussion of Section 3

To summarize, the main purpose of the present section was to investigate if food deprived subjects have more positive automatic attitudes towards disgusting foods than satiated subjects. Given the absence of altered conscious evaluations, it was hypothesized that shifts in the *immediate valence* of disgusting foods might be responsible for hungry subjects’ weaker disgust reactions towards disgusting foods and their greater consumption thereof. In addition (albeit not central to the present thesis), food deprived versus satiated subjects’ automatic attitudes towards palatable foods were assessed as well. It was expected to replicate previously reported findings showing that food deprivation renders automatic attitudes (e.g., Hoefling & Strack, 2008; Seibt et al., 2007) towards palatable foods even more positive. In Study 5, automatic attitudes of food deprived and satiated subjects were measured with the single target-IAT (st-IAT; Wigboldus et al., 2005; cf. Steinman & Karpinski, 2006), and in Study 6 the Affect Misattribution Procedure (AMP, Payne et al., 2005) was used as an indirect attitude measure.

To sum up, Study 5 yielded a main effect of valence indicating that palatable foods evoked more positive automatic attitudes than disgusting foods irrespective of need state. This effect is in line with the very basic finding that positive stimuli elicit more positive automatic

³² Maybe a mere lack of statistical power might be responsible for missing conventional levels of statistical significance. To test this assumption, a conceptual replication of Study 6 could be conducted with a higher number of trials or stimuli in each category (see for example Payne et al., 2007).

evaluations than negative stimuli in indirect attitude measures (e.g., De Houwer 2003; Fazio, Jackson, Dunton, Williams 1995; Greenwald et al., 1998). In addition, there was at least a trend for food deprived participants to evaluate palatable foods even more positive than satiated participants, which is compatible with prior studies using the EAST (Hoeffling & Strack, 2008) or the classic version of the IAT (Seibt et. al, 2007). Over and above, this trend is compatible with hungry subjects' higher zygomaticus activity towards palatable foods that was observed in Study 1 and Study 2 of the present thesis.

However, (compared to satiated subjects) the observed data pattern also suggests a stronger differentiation between palatable and disgusting foods amongst food deprived participants. As already mentioned, this is counterintuitive because common sense implies that food deprived participants should care less about the palatability of food than satiated participants ("Beggars cannot be choosers"). Consequently, hungry participants' immediate evaluations of palatable and disgusting foods should have been more similar (and positive) than evaluations of satiated participants in Study 5. It was discussed already that a stronger differentiation between potential foods might also be adaptive for food deprived organisms. To repeat, a "preparedness to evaluate" potential foods might be beneficial in the context of upcoming food selection and food consumption because it allows the deprived organism to make efficient and quick food choices.

Contrary to the central hypotheses food deprived participant did not evaluate disgusting foods more positively than satiated participants on an automatic level of information processing. Given that food deprivation reduced disgust expressions (i.e., levator activity) towards the very same stimuli (Study 2) and also increased immediate positive affect (i.e., zygomaticus activity) towards disgusting foods (Study 1), as well as consumption thereof (Study 3 & 4), the question arises why these effects are not accompanied by altered automatic evaluations of disgusting foods. However, as already mentioned IAT effects are subject to a number of possible alternative explanations other than the immediate valence of stimuli (for

overviews see De Houwer 2006; Gawronski & Conrey 2004; Kinoshita, Sachiko, & Peek-O'Leary, 2006; or Wittenbrink & Schwarz 2007).

Thus, another indirect attitude measure was implemented in Study 6 that presumably captures immediate evaluations to a greater extent than the st-IAT does; the recently developed Affect Misattribution Procedure (*AMP*; Payne et al., 2005). In line with Study 5, the valence of stimuli had an influence on immediate affective reactions in the AMP. In particular both, palatable foods and positive control stimuli evoked more positive reactions than their disgust related counterparts.

More important, food deprived participants also showed a tendency to evaluate both, palatable and disgusting foods more positively than satiated participants in the AMP. However, any conclusion must be made under reserve because this effect did not reach conventional levels of statistical significance (which might be due to a lack of statistical power). More precisely, (compared to satiated participants) food deprived participants classified greater proportions of ambiguous Chinese pictographs as positive after palatable and disgusting food primes, but not after positive or disgust related control primes. As already discussed extensively, this pattern is in line with the core assumptions of the present thesis and with prior studies reporting an alteration of automatic attitudes towards food cues by deprivation (e.g., Hoefling & Strack, 2008; Seibt et al., 2007). Particularly, Study 6 also suggests that disgusting foods might very well evoke more positive immediate evaluations in food deprived subjects than in satiated subjects, thus fitting other findings from the present thesis, for example the attenuation of food related disgust amongst hungry subjects (Study 2) and their greater consumption of disgust related foods (Study 3 & 4). However, albeit the observed effects from Study 6 seem to be substantial when applying a criterion of convergent validity, they nevertheless fail to reach conventional levels of statistical significance. Maybe further studies using a modified AMP paradigm (e.g., with an increased number of trials) might help to allay these concerns.

Taken together, Study 5 and Study 6 yielded equivocal results concerning the role of automatic attitudes in the reduction of food related disgust amongst food deprived subjects. In Study 5, food deprivation did not affect automatic attitudes towards disgusting foods, but in Study 6 at least a tendency was found into the expected direction. Thus, evidence for a crucial role of immediate evaluations in the automatic reduction of food related disgust towards appears rather weak at the moment. For this reason it was focused on another mechanism that might underlie the reduction of food related disgust in the next section. In particular, the role of immediate approach motivational tendencies was investigated in Section 4.

Section 4: Does Food Deprivation Modulate Immediate Approach

Motivational Tendencies towards Disgusting Foods?

Overview and Rationale of Study 7 and Study 8

The studies reported in this section were designed to test if food deprived subjects have stronger approach motivational tendencies towards disgusting foods than satiated subjects. Classic theories of disgust (Rozin et al., 1993), for example, suggest that the specific emotion of disgust is linked to general motivational tendencies of approach and avoidance, but no assumptions are made about the influence of food deprivation on these motivational tendencies towards disgusting foods. However, given that food related disgust amongst hungry subjects was reduced in Study 2, it seems plausible to assume that hungry subjects' immediate avoidance tendencies towards disgusting foods should be attenuated, too.

Moreover, immediate approach motivational tendencies towards palatable food cues were influenced by food deprivation automatically in a study by Seibt et al. (2007). This effect is in line with the assumption that the hungry organism should be prone to approach need relevant cues on an early stage of information processing (see Strack & Deutsch, 2004 for details). Since disgusting (but edible) foods are need relevant, too it seems plausible assume that food deprivation should also influence immediate approach motivational tendencies towards disgusting foods. However, to the present day no study exists that actually tests the validity of this assumption.

For this purpose, two studies were conducted that implemented an earlier version of the Approach Avoidance Task (*AAT*; Rinck & Becker, 2007; see also Chen & Bargh, 1999) without visual feedback. Particularly, participants were asked to respond to pictures of palatable vs. disgusting foods (as well as pictures of positive and disgusting stimuli unrelated to food) with a joystick. Analogous to a study by Seibt et al. (2007, Experiment 3),

participants were instructed to do so by either pulling the stimuli on the screen “towards themselves” as quickly as possible (approach) or by pushing the stimuli “away from themselves” as quickly as possible (avoidance).

Prior work (Markman & Brendl, 2005) suggests that the representation of the self in space determines whether pushing or pulling a joystick is indicative of approach behavior. To overcome these ambiguities, Rinck and Becker (2007) recently developed a modified version of this paradigm in which the visual sensation of approach vs. avoidance is generated by zooming either towards pictures (approach) or away from pictures (avoidance), thus increasing or decreasing their size depending on the arm movement that is executed. However, another method was used to disambiguate the meaning of the arm movements in the present thesis. Following the Seibt et al. (2007) study, participants were instructed to imagine pulling the stimuli presented on the screen towards their body when they pull on the joystick, and to imagine pushing stimuli away from their body when pushing the joystick, thus introducing the self as a fixed reference point.

Importantly, response latencies served as the main dependent variable in Study 7 and Study 8. In particular, median RTs were determined for each participant and for each picture category separately, and an approach index was calculated as the median RT for pushing minus the median RT for pulling (Rinck & Becker, 2007). A positive value on the approach index indicates faster approach than avoidance reactions and is interpreted as a stronger approach motivational tendency. Importantly, approach indices should be interpreted in a relative rather than in an absolute manner, for instance by comparing approach indices of different participant groups to each other instead of interpreting the absolute size of the index (see Rinck & Becker, 2007 for a more detailed discussion). In addition, error rates were also analyzed in both studies (see De Houwer, 2003).

Both studies were very similar in respect to the stimuli and the procedures that were used. In Study 7 participants’ task was to react as quickly as possible to the category of

pictures (food pictures vs. control pictures), and in Study 8 participants had to react as quickly as possible to a stimulus feature that was completely unrelated to the pictures' content (dashed picture frame vs. permanent picture frame). So on one hand, participants were instructed to react as quickly as possible in both studies, thus constraining the time that was available for conscious information processing. On the other hand, both studies differed in the degree of intentional processing that was allocated to the experimental stimuli. Prior work (e.g., De Houwer, 2006; Moors & De Houwer, 2006) for example stressed out the role of both, rapidness and unintentionality in the realm of automaticity and indirect attitude measures. Furthermore, recent studies already yielded that the quick initiation of simple approach and avoidance arm movements is not entirely automatic, but depends also on processing goals and intentions (e.g., Lavender & Hommel, 2007; Rotteveel & Phaf, 2004). Therefore, it was investigated in the present section how much intentional processing would be necessary to find an effect of food deprivation on immediate approach motivational tendencies towards disgusting foods. Following others (e.g. De Houwer, 2003; 2006), approach motivational tendencies should be considered automatic to a greater extent in Study 8 than in Study 7, because both conditions (limited processing time and unintentionality) are present in Study 8. However, it shall be mentioned that approach motivational tendencies in Study 7 are nevertheless considered automatic, too. This is because a) the criterion of limited processing time applies to Study 7 as well, and b) the valence of stimuli was not intentionally processed either. That is, subjects focused on the semantic category of stimuli as a reaction signal, but not on their valence. Hence, to the degree that valence has an effect on approach motivational tendencies in Study 7, the conclusion seems warranted that this effect is automatic, too.

Hypotheses of Study 7 and Study 8

As argued before, the hypotheses for Study 7 and Study 8 can be derived from two lines of research. First, food deprivation should increase immediate approach motivational

tendencies towards need relevant cues (e.g., Seibt et al., 2007; Strack & Deutsch, 2004). Second, the emotion of disgust should be related to immediate approach motivational tendencies (e.g., Rozin et al., 1993). Since disgusting (but edible) foods are need-relevant and also evoked less disgust and greater acceptance in hungry subjects (see Study 2 - 4), it appears very plausible to assume that food deprivation should alter immediate approach motivational tendencies towards disgusting foods as well.

More precisely, it was expected that hungry subjects should exhibit stronger approach motivational tendencies than satiated subjects towards disgusting foods in Study 7 and in Study 8. It was investigated in an exploratory fashion how much intentional processing would be necessary to find an effect of food deprivation on immediate approach motivational tendencies. Given earlier findings (e.g. Lavender & Hommel, 2007; Rotteveel & Phaf, 2004) it would come as no surprise if effects were stronger under conditions of intentional semantic processing in Study 7.

In addition (albeit not central to the present thesis) it would come as no surprise if hungry participants would exhibit stronger approach motivational tendencies towards palatable foods as well. No difference between food deprived and satiated subjects should emerge for positive or disgust related control stimuli that are unrelated to food.

Study 7: Food Deprivation and Immediate Approach Motivational Tendencies I – Category as Reaction Signal

Methods

Participants and Design

Thirty eight undergraduate non-psychology majors (18 female) at the University of Würzburg took part in an experiment that was introduced as consisting of several studies including a taste test and a computer based study on the interplay between visual information processing and the initiation of behavior. Subjects were contacted in the same way as

described before to convey first instructions and to exclude vegetarians and allergic persons before scheduling any participants. Subjects were paid € 8 (approximately \$ 11 at that time) for participation. The design of Study 7 was a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed factorial design.

Ten subjects had to be excluded from the analyses because of a Body Mass Index (*BMI*) below 17.5 ($n = 1$), above 25 ($n = 7$), or because they refused to report their body weight ($n = 2$). The resulting sample consisted of 13 men and 15 women, aged between 20 and 43 years ($M = 24.2$, $SD = 4.48$). Experimental groups did not differ in the percentage of women (hungry: 50.0 % vs. satiated: 58.3%), $\chi^2(1; N = 28) < 1$, and BMI ($M_{hungry} = 21.57$, $SD = 2.12$ vs. $M_{satiated} = 22.15$, $SD = 1.98$), $t(26) < 1$.

Procedure and Materials

Procedure. Unlike in previously reported studies, *all* participants were asked to refrain from eating for 15 hours under the pretext that a taste test and an unrelated computer study would be conducted in the lab. Food deprivation was manipulated by conducting the taste test either before or after the computer part. Experimental sessions started at noon or 1:30 p.m., and participants were tested in groups up to three persons. After being welcomed by the experimenter, one half of the participants remained food deprived and completed the computer part first (including the AAT), and the other half completed the ostensible taste test first. In fact, the taste test served only as a means to manipulate the need state of participants under more standardized conditions and was not analyzed any further.³³ Within a single

³³ The taste test was conducted in a separate room where all participants were seated at a separate table and were given 30 min ad libitum access to water and food. In particular, each participant was served a large portion (350 g) of freshly cooked Spaghetti of the sort "Buitoni" (Nestlé Food Products) with several customary toppings to choose from (e.g., tomato sauce, basil pesto, shaved Parmesan cheese). Participants were free to eat as much as they want from any product and were encouraged to eat to repletion. While eating, they were asked to answer some questions about several sensory properties of the foods (e.g., taste, texture) on a paper and pencil questionnaire in order to maintain the cover story.

session all participants remained either food deprived during the computer part or completed the taste test first.

In the critical computer part of the session participants were seated at a separate table with a standard personal computer and a 19 inch monitor and reported their current mood. Subsequently, subjects' immediate approach motivational tendencies were measured with the aforementioned AAT. Subsequently, all participants completed the known set of final questions. These included the FEE (Schienle et al., 2002) as a measure of general and domain specific disgust sensitivity, a set of demographic questions (self reported feelings of hunger serving as a manipulation check), and a funneled debriefing procedure to check for suspicion.

Mood assessment. In order to control for possible a priori differences between food deprived and satiated subjects in mood, self reports of mood were assessed at the beginning of the computer session by asking subjects how they feel on a scale ranging from 1(*no good mood at all*) to 5(*very good mood*).

AAT. As already mentioned, the AAT was framed as a study investigating the interplay between visual information processing and the initiation of behavior. Participants completed two separate blocks in which they had to react to photographs on the computer screen with a joystick. In one block, participants were instructed to “pull a photograph towards themselves” if it depicted food and to “push a photograph away from themselves” if it depicted objects, persons, or animals.³⁴ In the other block, this assignment was reversed. The order of the two blocks was counterbalanced across participants. The valence of pictures also differed systematically within each category (positive versus disgusting), but this was never mentioned.

³⁴ This formulation was chosen in order decrease the salience of food stimuli and as an attempt to minimize figure ground effects that might arise if participants divide stimuli into “food” vs. “non-food”, thereby facilitating the task (see Rothermund & Wentura, 2001). Of course, this instruction did not reliably prevent subjects from reformulating the task in the described way.

Each block started with 8 practice trials that were not analyzed. Then, a total number of 40 critical trials were conducted. For this purpose, 20 food pictures were presented, and 20 pictures that were unrelated to food. Analogous to previous studies of the present thesis, half of the pictures were positive, and the other half was disgust related within each category (see Appendix G2). All pictures were presented in random order. Each trial started with a fixation cross that was presented for 1000 ms, immediately followed by a photograph which remained on the screen until subjects made a response. When subjects made a mistake, a reminder with the correct assignment appeared on the screen for 3000 ms.

Results

Manipulation Checks

Hunger ratings of food deprived and satiated subjects were analyzed with a simple T-test. As expected, food deprived participants reported significantly stronger feelings of hunger ($M = 5.31$, $SD = 1.54$) than did satiated participants ($M = 2.67$, $SD = 1.83$), $t(26) = 4.16$, $p < .001$, $d = 1.56$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2 (need state: deprived vs. satiated) x 5 (subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;22) < 1$. Furthermore, none of the FEE subscales differed as a function of food deprivation, all $F(1;26) < 1.98$, $p > .17$. Consequently, this variable was discarded.

Mood. Self reports of mood were analyzed with a simple T-test. It was found that satiated subjects ($M = 4.92$, $SD = .79$) were in a better mood than food deprived subjects ($M = 4.13$, $SD = .86$) at the beginning of the computer session, $t(26) = 2.45$, $p = .021$, $d = .96$.

Immediate Approach Motivational Tendencies

Response latencies. In order to control for a priori differences in mood that were observed between food deprived and satiated participants, approach indices were analyzed with a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANCOVA with mood serving as a covariate.³⁵ Results are displayed in Figure 7. To begin with, the analysis revealed a significant main effect of need state, $F(1,25) = 7.42, p = .012, d = .55$, that was qualified by a two-way interaction between need state and valence, $F(1,25) = 6.43, p = .018, d = .50$, and by a three-way interaction between need state, valence, and category, $F(1,25) = 6.06, p = .021, d = .50$. Separate 2 (need state: deprived vs. satiated) x 2 (valence: positive vs. disgust related) mixed model ANCOVAs were conducted for food stimuli and for control stimuli to dismantle the three-way interaction.³⁶

The analysis on control pictures yielded no significant effect at all, all $F < 2.51, p > .12$. Both, the absence of a main effect of need state and the absence of a valence x need state interaction are in line with the assumption that approach motivational reactions towards need-irrelevant stimuli should not be influenced by the need state of the organism. However, unexpectedly and contrary to previous studies (Solarz 1960; Chen & Bargh 1999; Neumann & Strack, 2000) no main effect of valence emerged neither, $F < 1$.

³⁵ This ANCOVA was also conducted for both sequences of blocks separately. It turned out that all effects were substantially weaker when subjects started by pushing food pictures away from themselves in the first block (compared to pulling food pictures towards themselves). However, the data pattern did not change substantially and hence results will be reported that are collapsed over both sequences.

³⁶ For the sake of completeness it shall be also mentioned that the initial 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANCOVA also revealed a two-way interaction between valence and category, $F(1,25) = 5.54, p = .027, d = .47$, that was further qualified by a three-way interaction between valence, category, and mood, $F(1,25) = 5.04, p = .034, d = .45$. To dismantle this three-way interaction, a median split was performed on mood ratings ($MD = 4$), and 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) ANOVAs for dependent measures were performed for each mood group ($\leq MD$ vs. $>MD$). In the $\leq MD$ group, no effect emerged at all, all $F(1,13) < 3.1, p > .10$. In the $> MD$ group a main effect of category emerged, $F(1,13) = 12.80, p = .003, d = .99$, that was qualified only by a marginally significant valence x category interaction, $F(1,13) = 3.45, p = .086, d = .52$. Taken together, this pattern in the $>MD$ group indicates that food pictures evoked stronger approach reactions than control pictures amongst both, positive ($p = .02$) and disgust related pictures ($p = .003$), and that this effect was slightly more pronounced amongst disgusting pictures. However, these effects are not of central interest and do not interact with food deprivation. Hence they will not be considered any further.

More important, the analysis on food pictures yielded a marginally significant main effect of need state, $F(1,25) = 4.11, p = .053, d = .40$, and a main effect of valence, $F(1,25) = 5.61, p = .026, d = .47$, both of which were qualified by a significant two-way interaction between need state and valence, $F(1,25) = 8.71, p = .007, d = .60$. Follow-up T-tests were conducted to further specify the need state x valence interaction that emerged for food pictures.

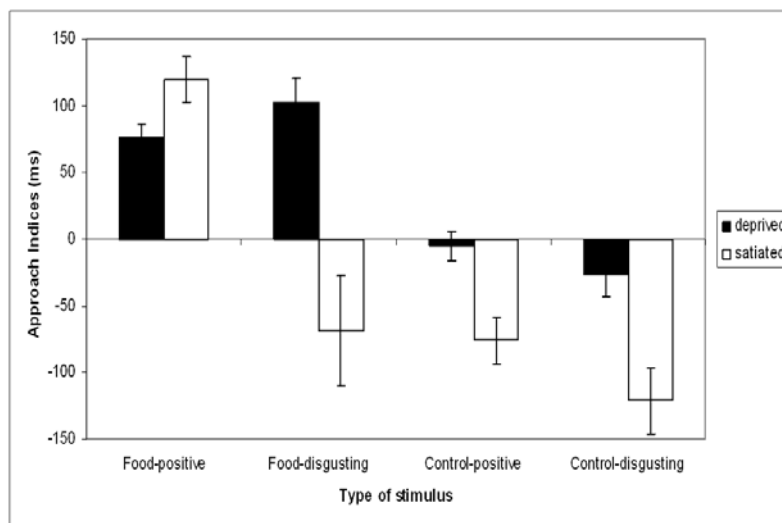


Fig.9: Approach indices as a function of need state, category, and valence.

Error bars indicate standard errors of the means.

Most important and in line with the core assumptions of the present thesis it was found that food deprived participants had a higher approach index towards pictures of disgusting foods than satiated participants, $t(26) = 2.00, p = .028$ (one tailed), $d = .73$, (see Figure 9). This finding indicates that food deprivation alters immediate approach motivational tendencies towards disgusting foods in a way that is compatible with results from Study 2. In particular, food deprived participants experienced less food related disgust than satiated participants in Study 2, and not surprisingly they also exhibited stronger approach motivational tendencies towards disgusting foods in the present study.

It also becomes apparent from Figure 9 that satiated participants exhibited stronger approach motivational tendencies towards palatable foods than towards disgusting foods,

$t(11) = 1.87, p = .045$ (one tailed), $d = .84$. In contrast, food deprived participants' approach motivation was equally strong towards both sorts of food stimuli, $t < 1$.

However, contrary to the predictions approach indices towards palatable foods did not differ between food deprived and satiated participants, $t(26) = 1.15, p = .26$. If anything at all, satiated participants' immediate approach motivation towards palatable foods was even stronger than food deprived subjects' immediate approach motivation. Possible explanations for this finding will be considered in the Discussion part (see below).

Error rates. The overall error rate in Study 7 was 6.43 % ($SD = 2.9$). To check if experimental factors had a systematic influence on error rates, a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANCOVA was conducted with mood serving as a covariate. A main effect of mood was found, $F(1,25) = 4.35, p = .047, d = .42$, indicating that more positive mood ratings were associated with a lower overall error rate in Study 7. This interpretation was corroborated by a correlational analysis that revealed a negative relationship between mood and overall error rate, $r(28) = -.396, p = .037$. Furthermore, a marginally significant main effect of category, $F(1,25) = 3.57, p = .07, d = .39$ emerged, indicating that subjects made slightly fewer errors when reacting to control pictures ($M = 5.4\%, SD = 3.4$) than when reacting to food pictures ($M = 7.5\%, SD = 4.7$). No other effect reached statistical significance.

Discussion

To sum up, Study 7 was designed to test the assumption that food deprived subjects would exhibit stronger approach motivational tendencies towards disgusting foods than satiated subjects. In addition (albeit not central to the present thesis) hungry and satiated subjects' approach motivational tendencies towards palatable foods were also assessed. For this purpose, a prior version of the Approach Avoidance Task (AAT; Rinck & Becker, 2007; see also Chen & Bargh, 1999) was conducted in which food deprived vs. satiated participants were instructed to pull pictures of palatable and unpalatable food "towards themselves" with a

joystick in one block, and to push them “away from themselves” in another block. Analogous to previous studies (Rinck & Becker, 2007) an “Approach Index” was computed from subjects’ response latencies and served as an indicator of immediate approach motivational tendencies. Error rates were also analyzed, but revealed no influence of any of the experimental factors at all.

In line with the central assumption of the present thesis it was found that food deprived participants had stronger immediate approach tendencies towards disgusting foods than satiated subjects. As already mentioned, this finding is also in line with Study 2 of the present thesis that yielded a reduction of food related disgust amongst food deprived participants. Put differently, it seems that the reduction of food related disgust amongst hungry subjects is associated with stronger immediate approach motivational tendencies towards these foods. As mentioned before, this result also fits classic theories of disgust (e.g., Rozin et al., 1993) that relate the emotion of disgust to general motivational tendencies of approach and avoidance. However, Study 7 exceeds classical accounts (Rozin & Fallon, 1987; Rozin et al., 1993) by showing that immediate motivational tendencies towards disgusting foods can be modulated by food deprivation even automatically.

Furthermore, it was found that satiated subjects differentiated between palatable and disgusting foods, but food deprived subjects did not. In other words, satiated subjects appeared picky insofar as they exhibited an approach motivation towards palatable foods only. This finding is in line with prior work showing that palatable foods have a great incentive value and the potential to trigger eating behavior even in the absence of homeostatic dysregulation (e.g., Herman & Polivy, 1984; Berridge & Robinson, 1995). In contrast, food deprived subjects had the same approach motivation towards both, palatable and disgusting foods. Taken together, this pattern of results literally reflects the well known proverb “Beggars cannot be choosers” and is also in line with the core assumptions of the present thesis.

However, contrary to previous studies (Seibt et al., 2007) and to the predictions of the present thesis food deprivation did not increase immediate approach motivational tendencies towards palatable food. In fact, food deprived participants exhibited even slightly weaker approach motivational tendencies towards palatable foods than satiated participants. This pattern might be explained by the assumption that two opponent processes were activated in food deprived subjects while being confronted with palatable food cues in the AAT. In particular, it might be that palatable food cues were not only associated with positive valence and approach motivational tendencies amongst food deprived subjects (Seibt et al., 2007), but also with feelings of craving and frustration (see also Amsel, 1958, 1992; Drobles et al., 2001). From this point of view, palatable food cues trigger immediate consummatory impulses in food deprived subjects that cannot be fulfilled in the experimental situation. Importantly, this can be understood as a frustrating experience (Häcker & Stapf, 1998; Amsel, 1958, 1992).

Recent studies show that frustrating events or stimuli are associated with immediate motivational tendencies of avoidance (Krieglmeyer, Deutsch, & Strack, 2008), and consequently, the “original” effect of food deprivation (i.e., stronger immediate approach tendencies towards palatable foods) could have been weakened considerably by feelings of frustration. Drawing on these post-hoc assumptions, it comes as no surprise that the effect of food deprivation on approach motivational tendencies does not emerge for palatable foods. Noteworthy, this interpretation is further corroborated by the fact that food deprived participants were in a worse mood than satiated participants during the AAT. In fact, several food deprived participants stated after the session even explicitly, that they had expected to perform the taste test upon arrival and not after the computer part, thus being quite frustrated. Albeit mood did not have any general (or tonic) effects in the AAT, it appears plausible that randomly presented photographs of palatable foods might at least have elicited “phasic frustration” during this task.

Finally, results of Study 7 also revealed that valence did not affect subjects' approach indices in an expected manner. That is, valence had an effect on satiated participants approach motivation towards food pictures, but not towards control pictures. Furthermore, one would have expected the valence of control stimuli to influence hungry participants' approach motivational tendencies, too.³⁷ In particular, according to basic findings (e.g., Chen & Bargh 1999; Eder & Rothermund, 2008; Neumann & Strack, 2000) positive control pictures should have evoked stronger approach motivational tendencies than disgust related control pictures amongst all participants. Noteworthy, only a tendency was found into the expected direction, but did not reach statistical significance.

This finding might be due to a lack of intentional processing of stimulus valence that is understood as a prerequisite for compatibility effects between stimulus valence and the initiation of approach- avoidance arm movements (e.g., Lavender & Hommel, 2007; Rotteveel & Phaf, 2004; for further reading see also Klauer & Musch, 2002; Klauer & Musch, 2003; Storbeck & Robinson, 2004). However, the question arises why stimulus valence still had an automatic effect on satiated participants' approach motivational tendencies towards food pictures. One possible (albeit speculative) explanation for this phenomenon focuses on the intentional control of attention and to figure – ground asymmetries that might play a role in the AAT (see Rothermund & Wentura, 2001 for a more detailed discussion of figure ground effects). In short, subjects could have reformulated their task in such a way that they focused their attention predominantly on food stimuli (figure), but not on control stimuli, or “non-food” respectively (ground). As a consequence of this attentional focus towards food pictures, their valence might have been processed even if this was not demanded, whereas control pictures were not processed at all.

³⁷ As already argued, the valence of food stimuli was not supposed to influence hungry participants' approach motivational tendencies. In particular, food deprived participants should associate (and indeed did associate) disgusting foods with immediate motivational tendencies of approach, because even disgusting foods are need relevant.

In order to eliminate the figure ground problem, and to examine if the observed effect of food deprivation amongst food pictures would be replicable under more stringent conditions of automaticity, participants' attention was directed away from the content of the pictures in Study 8. Instead, subjects were asked to react to the frame of pictures (dotted frame versus permanent frame) which represents a surface feature that is truly unrelated to the category of stimuli. On one hand it seems more unlikely that the categories of "food" versus "non-food" will compete for participants' attention in this design (which is positive). On the other hand, affective stimulus response compatibility effects might be substantially weaker if stimuli are processed in an entirely unintentional manner (Lavender & Hommel, 2007; Rotteveel & Phaf, 2004).

Study 8: Food Deprivation and Immediate Approach Motivational Tendencies II – Picture Frame as Reaction Signal

Methods

Participants and Design

The cover story and experimental design of Study 8 was identical to Study 7. Therefore, only deviations will be reported here. Twenty seven subjects had to be excluded from the initial sample of eighty undergraduate non-psychology students (40 female) because of a Body Mass Index (*BMI*) below 17.5 ($n = 1$), above 25 ($n = 19$), or because they refused to report their body weight ($n = 7$). The resulting sample consisted of 26 men and 27 women, aged between 20 and 36 years ($M = 24.49$, $SD = 3.43$). Experimental groups did not differ in the percentage of women (hungry: 50.0 % vs. satiated: 51.0%), $\chi^2(1; N = 53) < 1$, and BMI ($M_{hungry} = 21.22$, $SD = 2.02$ vs. $M_{satiated} = 21.34$, $SD = 1.50$), $t(51) < 1$.

Procedure and Materials

The procedures and materials in Study 8 were the same as in Study 7. Therefore, only deviations will be described in the following.

Mood assessment. In order to control for possible a priori differences between food deprived and satiated subjects in mood, self reports of mood were assessed at the beginning of the computer session by asking subjects how they feel on a scale ranging from 1(*no good mood at all*) to 9(*very good mood*).

AAT. The AAT in Study 8 was also framed as a study on the interplay between visual information processing and the initiation of behavior. However, participants were instructed to “pull a photograph towards themselves” if it was surrounded by a dashed frame and to “push a photograph away from themselves” if it was surrounded by a permanent frame. This assignment was reversed for half of the participants. Thus, the reaction signal in Study 8 was completely unrelated to the critical stimulus dimensions of valence (positive vs. disgusting) and category (food vs. non-food). Similar to Study 7, pictures differed systematically on these two dimensions, but this was never mentioned. Each participant completed one block that started with 8 practice trials and included a short break after half of the trials.

In Study 8, 12 food pictures were presented, and 12 pictures that were unrelated to food. Each picture was presented with two different frames twice (dashed vs. permanent; see Appendix H2), resulting in a total number of 96 critical trials. All pictures were presented in random order (excluding immediate repetitions of the same picture). Each trial started with a fixation cross that was presented for 1000 ms, immediately followed by a photograph which remained on the screen until subjects made a response. When subjects made a mistake, a reminder with the correct assignment appeared on the screen for 3000 ms.

Results

Manipulation Checks

Hunger ratings of food deprived and satiated subjects were analyzed with a simple T-test. As expected, food deprived participants reported significantly stronger feelings of hunger ($M = 5.62$, $SD = 1.17$) than did satiated participants ($M = 2.26$, $SD = 1.75$), $t(51) = 8.19$, $p < .001$, $d = 2.26$, on a scale ranging from 1 (*not hungry at all*) to 7 (*very hungry*).

Preliminary Analyses

Disgust sensitivity. To examine if general disgust sensitivity or domain specific disgust sensitivity were affected by food deprivation, a 2 (need state: deprived vs. satiated) x 5 (subscale: death vs. body secretions vs. hygiene vs. spoilage vs. oral rejection) MANOVA was conducted. It turned out that food deprivation did not have any overall effect on disgust sensitivity, multivariate $F(5;47) < 1$. Furthermore, none of the FEE subscales differed as a function of food deprivation, all $F(1;51) < 1.16, p > .28$. Consequently, this variable was discarded.

Mood. Self reports of mood were analyzed with a simple T-test. It was found that satiated subjects ($M = 7.19, SD = 1.30$) were in a better mood than food deprived subjects ($M = 6.08, SD = 2.02$) at the beginning of the computer session, $t(42.49)^{38} = 2.37, p = .023, d = .65$.

Immediate Approach Motivational Tendencies

Response latencies. In order to control for a priori differences in mood that were observed between food deprived and satiated participants, approach indices were analyzed with a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust related) mixed model ANCOVA with mood serving as a covariate. Surprisingly, this analysis revealed no significant effect at all, all $F < 1.99, p > .17$. As can be seen from Figure 10, all approach indices settled down at a neutral level irrespective of need state, category, or valence.

Error rates. It turned out that the overall error rate in Study 8 ($M = 2.83 \%, SD = 3.63$) was substantially lower than in Study 7, indicating that the experimental task might have been easier for participants in Study 8. Error rates were also analyzed with a 2 (need state: deprived vs. satiated) x 2 (category: food vs. non-food) x 2 (valence: positive vs. disgust

³⁸ Due to inhomogeneity of variances, a correction for degrees of freedom (df) was used.

related) mixed model ANCOVA with mood serving as a covariate. No effects emerged at all, all $F < 1.88, p > .17$.

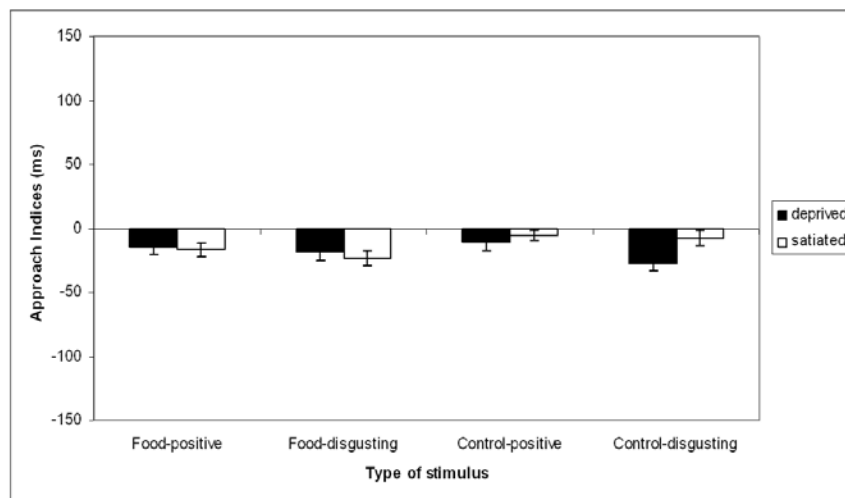


Fig.10: Approach indices as a function of need state, category, and valence.

Error bars indicate standard errors of the means.

Discussion

To sum up, Study 8 was designed to explore if the AAT effects from Study 7 would also emerge when participants focus on a surface feature (picture frame) as a reaction signal instead of focusing on the semantic category of stimuli. As mentioned earlier, the reaction signal in the present study was totally unrelated to the semantic category of the target stimuli, thereby eliminating any intentional processing of the experimental stimuli and figure ground asymmetries that might have resulted from this procedure in Study 7. Thus, Study 8 represents a very stringent test of the hypothesis that food deprivation alters immediate approach motivational tendencies towards disgusting foods automatically.

To summarize, error rates did not reveal any effect in Study 8. Furthermore, the results of Study 7 could not be replicated. In particular, food deprived participants did not show stronger approach motivational tendencies towards disgusting foods than satiated participants in Study 8, and neither valence, nor category did have any effect on immediate motivational tendencies. It almost seems that focusing on a feature unrelated to stimulus content prevented subjects from processing the pictures at all. However, this assumption appears somewhat

implausible given that several other studies using surface features like for example the format of pictures (landscape vs. portrait; e.g., Huijding & De Jong, 2005; Rinck & Becker, 2007; Wiers, Rinck, Kordts, Houben, & Strack, 2008), or their position on the screen (Seibt et al., 2007) did find meaningful AAT effects.

A second explanation considers the possibility that it might not have been the use of a surface feature per se that is responsible for the null effects in Study 8. Instead, manipulating the frame of pictures might represent a special case that is different from manipulating other surface features. It could for example be that visual attention was directed to the periphery of the pictures when subjects tried to focus on the surrounding frame thereby preventing subjects from processing the pictures already on a very basal, perceptual level. In addition, the low overall error rate in Study 8 indicates that the discrimination of frames might have been very easy for participants, thereby protecting task performance against influences of need state, valence, and category. However, this assumption will remain speculative since a more detailed examination of this question would go beyond the scope of the present thesis.

General Discussion of Section 4

Taken together, Section 4 was designed to test the assumption that food deprivation alters immediate approach motivational tendencies towards disgusting foods. Evidence for this hypothesis was found at least under conditions that required subjects to process the semantic content of experimental stimuli intentionally. That is, when subjects focused on the semantic category of pictures as a reaction signal in Study 7, food deprivation rendered subjects' approach motivational tendencies towards disgusting foods more positive. However, when preventing subjects from processing the stimuli intentionally by using picture frames as a reaction signal in Study 8, no effects were found at all.

It was discussed already that the latter finding is not surprising from the perspective of recent studies (e.g., Lavender & Hommel, 2007; Rotteveel & Phaf, 2004) arguing that the

initiation of approach-avoidance movements is not determined by the valence of a stimulus automatically, but depends on processing goals and intentions as well. This interpretation is in line with recent studies showing a certain susceptibility of automatic evaluations to intentional processes (e.g., *figure-ground asymmetries*; Rothermund & Wentura, 2001; *processing goals*; Klauer & Musch, 2002; *salience of semantic properties*; Storbeck & Clore, 2004), but inconsistent with AAT - studies implementing other surface features as reaction signals (e.g., Eder & Rothermund, 2008; Neumann & Strack, 2000; Rinck & Becker, 2007; Seibt et al., 2007; Wiers et al., 2008). Importantly, the picture frames that were used in Study 8 might represent a special case of surface feature that prevented subjects from processing the stimuli already on a very basal and perceptual level thus providing an explanation for the null results of Study 8.

Nevertheless, even the measurement outcomes of Study 7 can be labeled “automatic” to a significant degree. In fact, a detailed discussion of this issue would go beyond the scope of the present thesis, but for automaticity reviews see Moors and De Houwer (2006) or De Houwer, Teige-Mocigemba, Spruyt, and Moors (in press). To repeat only briefly, subjects were instructed to react as quickly as possible, thereby limiting the time available for conscious processing. Second, the valence of food stimuli was processed unintentionally in Study 7 as well, but still it had an effect on satiated participants’ motivational tendencies towards food pictures. That is, satiated participants discriminated between palatable and disgusting foods albeit focusing on category as a reaction signal. Third, an examination of suspicion checks revealed that participants were not aware at all that their need state might alter their ability to initiate quick approach versus avoidance movements towards food pictures. Thus, it appears indeed warranted to conclude that food deprivation altered immediate approach motivational tendencies towards disgusting foods automatically.

Taken together, results of Study 7 confirm the core assumptions of the present thesis and are in line with several studies that were presented so far. Particularly, food deprived

participants' stronger approach motivational tendencies towards disgusting foods are in line with their reduction of food related disgust (Study 2) and their greater consumption of disgust related foods (Study 3 & 4). Thus, when applying a criterion of convergent validity it makes perfect sense that lower feelings of food related disgust amongst hungry participants are accompanied by greater intake of disgusting foods and by stronger approach motivational tendencies towards them.

As mentioned earlier, findings from Study 7 are also compatible with classic theories of disgust (Rozin & Fallon, 1987; Rozin et al., 1993) that relate the emotion of disgust to general motivational tendencies of approach and avoidance. However, the fact that changes in immediate motivational approach tendencies can occur automatically and as a function of the organism's need state was only predicted by the recently developed Reflective Impulsive Model (Strack & Deutsch, 2004) which assumes that the deprived organism should be prepared to approach need relevant cues even on a very early stage of information processing (see also Seibt et al., 2007 for a more detailed discussion).

Contrary to the assumptions of the present thesis and prior studies (Seibt et al., 2007) Study 7 also yielded that food deprived subjects did not show stronger immediate approach tendencies towards palatable foods than satiated subjects. As already discussed extensively, this could be due to the fact that palatable food cues might have been a source of frustration for food deprived participants (Drobes et al., 2001; Mauler et al., 2006) especially because they had to be encountered in an experimental context that prevented deprived subjects from satisfying their hunger immediately (see also Amsel, 1958; Amsel, 1992). Since frustrating events were found to evoke immediate motivational tendencies of avoidance in recent studies (Krieglmeier et al., 2008), it is concluded that food deprived participants' responses towards palatable foods in Study 7 might rather reflect a tug of war between two conflicting motivational tendencies (i.e., homeostatic dysregulation and approach versus frustration and avoidance) than the absence of an effect of need state. This conclusion is corroborated by

prior evidence consistently suggesting that palatable foods elicit more positive facial reactions (see Study 1 & 2), and evoke more positive automatic attitudes (Hoefling & Strack, 2008; Seibt et al., 2007), and stronger approach motivational tendencies (Seibt et al., 2007) amongst food deprived participants in alternative experimental settings. So, taken together the results of Study 7 do not necessarily contradict previous findings yielding that immediate approach motivational tendencies towards palatable foods are increased by food deprivation. But most important, they corroborate the assumption that food deprivation increases immediate approach motivational tendencies towards disgusting foods.

Section 5: Does Food Deprivation Change the Relative Importance of Critical Food Attributes?

Overview and Rationale of Study 9

The last study of the present thesis was designed to examine a third mental mechanism that may underlie the reduction of food related disgust and the greater consumption of disgust related foods amongst hungry subjects. Drawing on the Reflective Impulsive Model (*RIM*; Strack & Deutsch, 2004), it was hypothesized that food deprivation might also change food related disgust on a more elaborated level of information processing. Particularly, it was assumed that food deprivation should exert an influence when the organism is faced with a choice between several food options and engages in cost-benefit-computations that are helpful in deciding whether to select or to reject a given food option. Importantly, cost-benefit-computations are characterized by weighting and charging positive aspects (benefits) and negative aspects (costs) of a given option against each other, and arriving at a total utility score at the end of this process.

In the present thesis it was tested whether food deprivation shifts the relative importance (or weighting) that is assigned to critical food features within this computational process. Importantly, a distinction was made between *hedonic food attributes* (e.g., palatable visual appearance, preferred flavor) that are not relevant from a nutritional point of view and *functional food attributes* (e.g., availability of food in terms of amount and time, nutritional value) that play a decisive role in ending a state of food deprivation. It was hypothesized that the utility derived from hedonic food attributes decreases for the starving organism, whereas the utility derived from functional food aspects increases. To put it in simple terms, immediate saturation should matter more for the food deprived organism than exquisite flavor or gourmet-like presentation. As a consequence, food deprived organisms might experience

less disgust towards disgusting (but edible) foods, because they do not care about the feature of palatability anymore, but value mainly a food's potential to end the aversive state of deprivation instead.

Noteworthy, this hypothesis is in line with the commonsensical assumption that the eating behavior of hungry organisms should be controlled by physiological demands rather than by psychological influences (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972), which is also reflected in the proverb "Beggars cannot be Choosers". However, the present thesis goes beyond prior studies and the coarse grained distinction between "psychological influences" and "physiological influences" by exactly specifying one underlying psychological mechanism and testing it experimentally. To resume, (compared to satiated subjects) food deprived subjects should attach greater importance (or weighting) to functional food attributes than to hedonic food attributes (that are not functional in ending a need state) within a process of cost-benefit-calculations.

As already described, prior studies pertaining to this issue (e.g., Bellisle et al., 1984; Desor et al., 1977; Herman et al., 1989; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968; Kauffman et al., 1995; Nisbett et al., 1973) revealed that food deprived subjects consumed greater amounts of good tasting and bad tasting foods than satiated subjects. However, assessed critically these results merely show that food deprived subjects do not hesitate to consume even bad tasting foods in order to satisfy their hunger, given that nothing else is available. In fact, no statement can be made about the relative importance of hedonic food attributes compared to functional food attributes as long as they are not pitted against each other.

Noteworthy, to the present day no study exists that directly quantifies the importance of hedonic versus functional food features for food deprived and satiated subjects. To bridge this gap, a conjoint analysis was conducted in Study 9 that allows estimation of the relative importance of different food features that are hedonic in nature (i.e., idiosyncratic preference)

or functional in ending a state of food deprivation quickly (i.e., portion size, immediate availability). Furthermore, conducting a conjoint analysis allows estimation of the trade-offs between these features, and the total satisfaction or utility that hungry vs. satiated participants derive from them.

As already outlined, a computerized food choice task was developed that presented subjects with a number of choices between several foods. More precisely, different snack options (two at a time) were presented on a computer screen that varied systematically in respect to subjects' idiosyncratic hedonic preferences (preferred snack vs. unpreferred snack), portion size (very small portion vs. large portion), and availability in terms of time (immediately available vs. available only after a delay of 90 min). Combining these three features resulted in a total number of 8 different snack options that served as objects in a complete block design of 28 paired comparisons (Thurstone, 1927). In particular, subjects were instructed to choose their preferred snack option in each of the 28 trials. To increase the relevance of the food choice task, subjects were told that they would actually receive one snack option that was randomly determined amongst their choices. As a dependent measure, the relative importance of each food feature was computed for each participant separately by using a de-compositional variant of the Conjoint Analysis (Backhaus et al., 2003; see also tutorial for SPSS 14.0).

Hypotheses of Study 9

Common sense suggests that satiated subjects are picky in the context of food consumption (see also Herman & Polivy, 1984). In addition, Section 2 of the present thesis yielded that satiated participants clearly reject foods that are labeled "genetically modified" even though these foods were visually attractive and tasty. In contrast, hungry participants readily accepted and consumed genetically modified foods despite evaluating them equally negative as satiated subjects on several dimensions. This finding suggests that satiated

subjects obviously afford rejecting foods that do not satisfy their demands whereas food deprived subjects do not. Furthermore, Study 7 of the present thesis yielded that satiated subjects are picky even at a very early stage of information processing. As already described, satiated subjects had an approach tendency only towards palatable foods, but an avoidance tendency towards disgusting foods. In contrast, hungry subjects exhibited immediate approach tendencies for both sorts of food, indicating that when in a state of homeostatic dysregulation, palatability is not a major determinant of the organism's motivational responses towards food.

Taken together, it would come as no surprise if satiated participants are also pickier than hungry subjects when actually *choosing* between different foods. In particular, it was hypothesized in the present thesis that satiated participants would exhibit a clear preference for their favored snack when given the opportunity to choose from several food alternatives. Importantly, satiated participants should afford insisting on their hedonic preference even if they would have to wait for their favored snack or receive only a small amount of it. To put it in other terms, the relative importance of hedonic preference should be significantly greater than the relative importance of (large) portion size or (short) waiting time amongst satiated participants in a conjoint analysis.

In contrast, food deprived subjects should value immediate saturation more than getting their preferred snack. Hence, the features of (large) portion size and immediate availability should be more important for hungry participants than their hedonic preference. From a biological perspective one would argue that this is the case because the former features are functional in ending a state of food deprivation, but insisting upon a preferred snack is not.

So far, predictions were made for the utility structure within the group of satiated and deprived subjects separately. In addition, when comparing the utility of each feature between both experimental groups, the relative importance of hedonic preference should be significantly smaller for food deprived participants than for satiated participants, and the

importance of both, (large) portion size and (short) waiting time should be larger for food deprived participants than for satiated participants.

Study 9: Food Deprivation and the Relative Importance of Critical Food Attributes – Beggars Cannot Be Choosers (Even if They Are Allowed to Choose)

Methods

Participants and Design

Fifty-nine undergraduate psychology students (43 female) at the University of Würzburg took part in an experiment that was introduced as consisting of several studies including one experiment on the effects of blood glucose levels on concentration (concentration test) and one experiment on consumer psychology³⁹. Subjects received course credit for participation. Aside from need state, hedonic and functional aspects of experimental foods were manipulated within a food choice task, resulting in a 2 (need state: deprived vs. satiated) x 2 (hedonic preference: preferred snack vs. non-preferred snack) x 2 (portion size: very small portion vs. large portion) x 2 (availability: immediately available vs. available only after 90 min delay) mixed factorial design with need state being manipulated between participants. All subjects were contacted two days before the experiment to convey first instructions and to exclude persons who reported being on a diet or having certain food-relevant allergies before scheduling any participants. Vegetarians were included in Study 9, because no food stimuli were presented that included meat.

Eight subjects had to be excluded from the analyses because of a BMI below 17.5 ($n = 1$), a BMI above 25 ($n = 5$), or because of computer errors ($n = 2$). The resulting sample consisted of 14 men and 37 women, aged between 18 and 41 years ($M = 21.64$, $SD = 3.76$).

³⁹ In fact, a D2 - concentration test (Oswald et al., 1997) was conducted at the beginning of the experimental session that was not analyzed (see also Study 1). The only purpose of this test was to cover the manipulation of need state and hence it will not be reported any further.

Experimental groups did not differ in the percentage of women (hungry: 74.1 % vs. satiated: 70.8 %), $\chi^2(1; N = 51) < 1$, and BMI ($M_{hungry} = 21.46$, $SD = 2.03$ vs. $M_{satiated} = 21.35$, $SD = 1.92$), $t(49) < 1$.

Procedure and Materials

Procedure. Similar to Studies 1-6, participants were either asked to refrain from eating for 15 hours (which was said to lower their blood glucose level), or to have lunch immediately before the experiment (which was said to heighten their blood glucose level). Experimental sessions started at noon or 1:30 p.m., and participants were tested in groups up to three persons. After being welcomed by the experimenter, participants were seated at a table where they signed a consent form and reported their current mood. Then participants were asked to rank order 8 different, customary snacks according to their momentary hedonic preferences (e.g., potato chips, chocolate muffins, M&M's, salty peanuts). Afterwards, subjects completed an ostensible measure of concentration (Oswald et al., 1997). As already mentioned the concentration test only served as a means of establishing the cover story and will not be reported in greater detail. After the concentration test, participants completed the computerized food choice task (paired comparisons) and the known set of demographic questions. Similar to all other studies reported so far, self reported feelings of hunger served as a manipulation check. Finally, subjects completed a funneled debriefing procedure to check for suspicion.

Mood assessment. In order to check for a priori differences between food deprived and satiated participants in mood, subjects were asked how strongly they agree with the statement "I am in a good mood right now" on a scale ranging from 1 (*totally disagree*) to 6 (*totally agree*) at the beginning of the session.

Paired comparisons. Paired comparisons were introduced as a study on consumer choices. For this purpose, a computerized food choice task was developed that presented subjects with a series of food choices on a computer screen. In each trial, subjects were

instructed to choose between two snack options (*Option A* vs. *Option B*) that were depicted on separate photographs. On top of each photograph, written information about the availability of the depicted snack in terms of time was given (*immediately [sofort]* vs. *in 90 min*). Importantly, a snack option is defined as a photograph plus written information (see also Figure 9A-9D for an illustration).

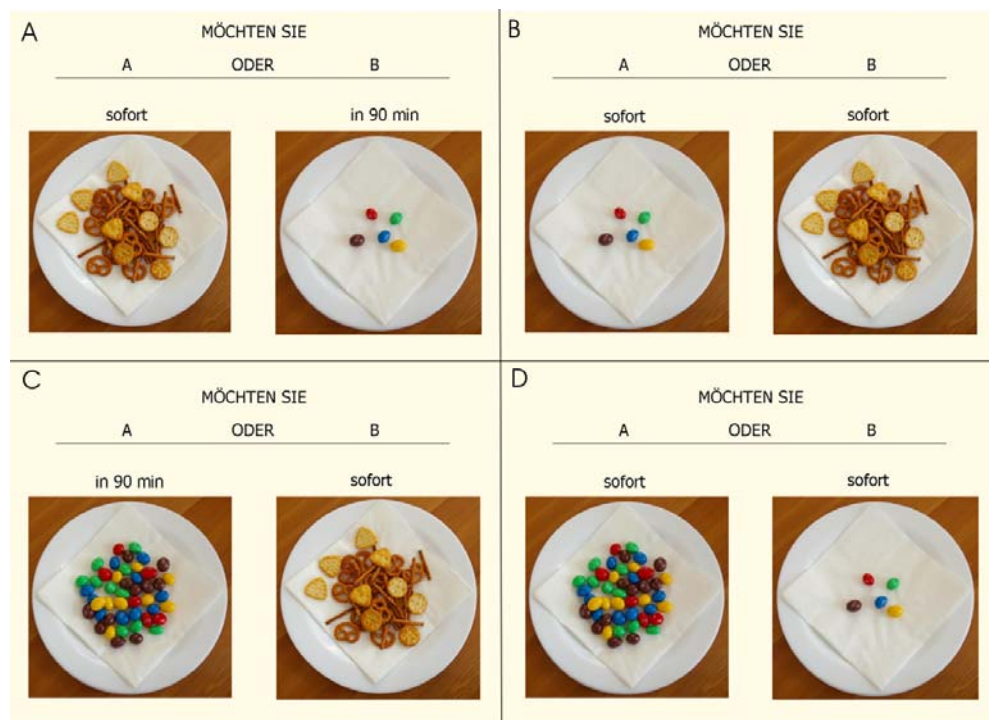


Fig. 9: Illustration of 4 representative choice trials in Study 9

The position of a given snack option on the computer screen (left half vs. right half) was determined randomly in each trial. To increase the relevance of the choice task, participants were told that they would actually receive one of the depicted options that would be randomly determined amongst their choices.

It was already described that snack options systematically varied in respect to subjects' idiosyncratic hedonic preferences (preferred snack vs. unpreferred snack), portion size (very small vs. large), and availability in terms of time (immediately available vs. available only after a delay of 90 min) and that combining these three distinct features of twofold gradation resulted in a total number of 8 different snack options that served as stimuli in a complete

block design of 28 paired comparisons (Thurstone, 1927). In the following, it will be described in greater detail how the independent variables were manipulated.

To vary hedonic preferences on an idiosyncratic level, each participant's initial rank order of snacks was analyzed by the experimenter while participants were completing the concentration test. For the paired comparison procedure, the snack ranked on position 2 was selected as the preferred snack, and the snack ranked on position 6 was selected as the non-preferred snack for each participant.⁴⁰ For each subject, a specific computer file was started by the experimenter that had been generated in advance and included only photographs of the two snacks ranked on position 2 (e.g., M&M's) and 6 (e.g., salty crackers). Subjects however were not told about this but were merely informed that they would be presented with randomly chosen photographs of several snacks in the food choice task. Portion size was manipulated by photographing each snack on a plate under standardized conditions, both, in a small portion size version and in a large portion size version (see Appendix I2). As mentioned before, availability in terms of time was indicated by a short reminder above each picture saying "immediately" vs. "in 90 minutes" (see Figure 9).

The relative importance of each feature was computed for each participant separately by using a de-compositional variant of the Conjoint Analysis (Backhaus et al., 2003; see also tutorial for SPSS 14.0). Importantly, scores of relative importance represent percent-values that can be interpreted in an absolute manner.

Results

Manipulation Check

Hunger ratings were analyzed with a simple T-test. As expected, food deprived participants ($M = 5.56$, $SD = 1.50$) reported stronger feelings of hunger than satiated participants ($M = 2.54$, $SD = 1.82$), $t(49) = 6.77$, $p < .001$, $d = 1.81$.

⁴⁰ Extreme ranks (i.e., rank 1 and rank 8) were not selected in order to ensure that hedonic preference would not act as a "k.o. – criterion" in the conjoint analysis. In fact, it is a central prerequisite for conducting a conjoint analysis that all critical features are related to each other in a compensatory manner (Backhaus et al., 2003). Using extreme ranks might have violated this requirement.

Preliminary Analyses

Self reports of mood were analyzed with a simple T-test that yielded no a priori differences in mood between satiated subjects ($M = 4.00$, $SD = 1.22$) and food deprived subjects ($M = 3.74$, $SD = 1.29$), $t(49) < 1$. Consequently, this variable was discarded.

Conjoint Analysis

Data aggregation. First, a “Plan”- file was generated by assigning each snack option from the food choice task a number from 1-8 that clearly indicates the parameter-values of all features (e.g., 1 = preferred snack & large portion size & immediately available, 2 = preferred snack & large portion size & available after 90 min delay, etc.). Then, a “Data” – file was generated for each subject separately by rank ordering all snack options according to the number of trials in which they were preferred. Finally, a de-compositional variant of the conjoint analysis was conducted using SPSS statistical Software. In short, a benefit function is estimated for the discrete choices in Study 9, which can be specified as

$$\Delta B = \beta_1 \text{Hedonic Preference} + \beta_2 \text{Portion Size} + \beta_3 \text{Availability in Terms of Time}$$

where ΔB is the change in benefit in moving from snack option A to snack option B, and the explanatory variables are the differences between snack option A and B in respect to the three critical features. Coefficients β_1 to β_3 show the relative importance of the different features. The three attributes were coded in such a way that higher scores indicate higher importance of getting the favored snack (hedonic preference), getting a large portion (portion size), and getting a snack immediately (waiting time).

Relative importance of food attributes. The relative importance of food attributes was analyzed with a 2 (need state: deprived vs. satiated) x 3 (food attribute: hedonic preference vs. portion size vs. waiting time) mixed model ANOVA with need state being manipulated between subjects. The analysis revealed a significant main effect of food attribute, multivariate $F(2,48) = 4.41$, $p = .017$, $d = .44$, that was qualified by a significant need state x

food attribute interaction, multivariate $F(2,48) = 6.21, p = .004, d = .52$ (see Figure 12). Follow-up T-tests were conducted to specify this interaction.

In line with the central predictions of the present thesis, it was found that the relative importance of individual hedonic preferences was greater for satiated subjects than for food deprived subjects, $t(39.58)^{41} = 3.26, p = .002, d = .93$. This indicates that it was more important for satiated subjects to get their favored snack than for food deprived subjects. In contrast, the relative importance of waiting time was greater for food deprived subjects than for satiated subjects, $t(49) = 2.52, p = .015, d = .71$. As expected, it was more important for food deprived subjects to get a snack immediately than for satiated participants. It also becomes evident from Figure 12 that it was more important for food deprived subjects to get a large portion than for satiated subjects. This tendency however did not reach statistical significance, $t(49) = 1.27, p = .21$.

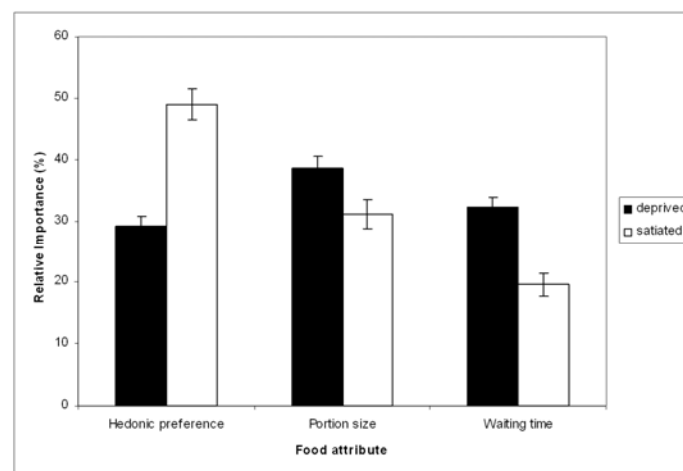


Fig. 12: Relative importance of several food features as a function of need state.

Error bars indicate standard errors of the means.

Taken together, comparisons between hungry and satiated subjects confirm the central assumption that food deprivation moderates the importance of hedonic and functional food attributes. That is, (compared to satiated participants) individual hedonic food preferences are

⁴¹ Due to inhomogeneity of variances, a correction of degrees of freedom (df) was used.

less important for food deprived subjects, but immediate availability of food is more important.

A second issue pertains to the tradeoff between the three attributes within the group of food deprived and satiated subjects. For this purpose, T-tests for dependent measures were conducted for food deprived and satiated subjects separately. To repeat, it was hypothesized that hedonic preferences should be less important for hungry subjects' food choices than portion size or waiting time. Indeed, an inspection of Figure 9 reveals that individual hedonic preferences were the least important selection criterion for food deprived subjects, whereas portion size was the most important selection criterion. However, differences in the relative importance between the three attributes were not very pronounced amongst food deprived subjects. That is, portion size was only slightly more important for food deprived subjects than their individual hedonic preference, $t(23) = 2.02$, $p = .073$ (one tailed), and waiting time did not differ from those two features, both $t < 1$.

Amongst satiated participants however the pattern reverses and becomes more pronounced. It can be seen from Figure 9 that individual hedonic preferences were clearly the most important aspect for satiated participants' food choices, whereas waiting time turned out to be the least important feature. Particularly, T-tests yielded that it was more important for satiated participants to get their favored snack than to get a snack immediately, $t(23) = 3.73$, $p = .001$, $d = 1.32$, or to get a large portion, $t(23) = 2.02$, $p = .028$ (one tailed), $d = .75$. Portion size again was slightly more important than waiting time, $t(23) = 1.70$, $p = .052$ (one tailed), $d = .55$. Taken together, these latter findings corroborate the assumption that satiated subjects insist on their favored snack even at the cost of a very small portion or substantial waiting time, whereas food deprived subjects do not.

Discussion

To sum up, Study 9 was designed to test the assumption that food deprivation alters the relative importance (or weighting) of critical food attributes within more elaborated cost-

benefit-computations that are helpful in choosing between several food options. According to the Reflective Impulsive Model (*RIM*; Strack & Deutsch, 2004) cost-benefit-computations can be allocated in the Reflective System because they are not associative in nature, but represent rather complex arithmetical computations of utility scores.

It was hypothesized that satiated subjects should derive greater utility from hedonic food attributes than food deprived subjects. In contrast food deprived participants were assumed to derive greater utility than satiated participants from functional food attributes that have the potential to end a state of food deprivation quickly (see also Herman & Polivy, 1984). Put differently, food deprivation was assumed to shift the organism's priorities actively and to do so by altering the subjective weighting of hedonic versus functional food attributes in the context of food selection and cost-benefit-computations. Noteworthy, this specific assumption has never been tested before.

For this purpose, food deprived and satiated subjects made several food choices in a complete set of paired comparisons (Thurstone, 1927). Importantly, snack options varied systematically in respect to hedonic food attributes and functional food attributes. More precisely, each snack option consisted either of a favored or un-favored snack that was available immediately, or only after a delay of 90 min. In addition, the portion size of each snack option was either very small or large enough to generate feeling of satiety. By analyzing participants' food choices with a Conjoint Analysis (see Backhaus et al., 2003), it was possible to determine the relative importance of each food attribute for deprived and satiated subjects separately.

Fully in line with the hypotheses of the present thesis it was found that satiated participants attached greater importance to their individual hedonic preferences than food deprived subjects. In fact, the utility structure amongst satiated subjects even indicates that hedonic preferences were the most important selection criterion in this group. That is,

(compared to hungry participants) satiated participants predominantly insisted on getting their favored snack and were willing to accept small portion sizes and long waiting times for it.

In contrast, food deprived participants valued functional food features more than satiated subjects. That is, it was more important for food deprived subjects than for satiated subjects to get something to eat immediately, and to get a large portion. The utility structure within the group of food deprived subjects however does not indicate that hedonic preferences were significantly less important than the two functional food features, but at least a tendency into the expected direction was found.

Taken together, these findings suggests that satiated participants are unwilling to accept foods that do not meet their hedonic preferences, whereas food deprived subjects do readily accept such foods if they are functional in ending their need state quickly. Noteworthy, results of Study 9 are in line with previous studies yielding greater acceptance of unpreferred foods (e.g., Bellisle et al., 1984; Desor et al., 1977; Herman et al., 1989; Hill, 1974; Hill & McCutcheon, 1975; Kauffman et al., 1995; Nisbett, 1968; Nisbett et al., 1973), and disgust related foods (i.e., *genetically modified foods*; see Study 3 and Study 4 of the present thesis) amongst food deprived subjects.

However, Study 9 supplements these findings by showing that food deprivation does not only influence the intake of un-preferred or disgusting foods, but more elaborated food choices as well. More important, Study 9 exceeds prior studies with regard to the conclusions that can be drawn from the observed results. As mentioned before, prior studies (e.g., Bellisle et al., 1984; Desor et al., 1977; Herman et al., 1989; Hill, 1974; Hill & McCutcheon, 1975; Kauffman et al., 1995; Nisbett, 1968; Nisbett et al., 1973) were not very informative about the psychological mechanisms underlying food deprived subjects' greater acceptance of unpreferred (i.e., bad tasting) foods. By pitting hedonic and functional aspects of food against each other in a Conjoint Analysis, it could be tested directly if food deprived participants will

accept unpreferred foods more readily because hedonic aspects are not important for them anymore.

For example, when given the choice between a preferred snack (which is too small to generate feelings of satiety, though) and an unpreferred (but acceptable) snack that is large enough to satisfy ones hunger (availability in terms of time being equal), most food deprived subjects chose the latter option, but most satiated subjects selected the first alternative. Consequently, it can be concluded that hedonic preferences are indeed less important for food deprived subjects than functional food features.

However, the question arises how the results of Study 9 can be related to the topic of food related disgust. This is because foods in the present study were unpreferred, but actually not unpalatable (not to mention disgusting). In fact, all foods were customary snacks and therefore, even un-favored snacks might have been quite acceptable and attractive for subjects in Study 9. Nevertheless, they were still rejected by satiated subjects and it appears implausible why a low overall intensity of food rejection should affect the validity of the relative difference that was found between food deprived and satiated subjects. It appears plausible to argue that the same mechanism should be applicable as long as a certain ratio between homeostatic dysregulation and level of disgust is given. That is, under higher levels of food deprivation even disgusting foods might have been used as alternatives in the food choice task.

Apart from that, the methodological account itself imposed certain restrictions with respect to the degree of disgust that was appropriate for un-preferred foods. Particularly, it is considered as a critical prerequisite for conducting a conjoint analysis that all attributes are related to each other in a compensatory manner (Backhaus et al., 2003). From this perspective, the use of more unpalatable (or even disgusting) foods would have been rather disadvantageous. This is because the conjoint analysis is not an appropriate measure of

analysis anymore if neither (large) portion size, nor immediate availability can compensate for violated food preferences.

Another possible objection is pertaining to the rank ordering procedure that was implemented to assess idiosyncratic snack preferences in Study 9. In particular, ranking stimuli on an ordinal scale level does not assure equidistance of intervals, like for example evaluating stimuli on a Likert scale. Consequently, the absolute difference in actual liking between the preferred snack (rank 2) and the unpreferred snack (rank 6) might not have been the same for each participant. Even if this should be true, it is unlikely that this exerted a systematic bias on food choices of satiated versus food deprived participants in Study 9. In particular, this error should be distributed unsystematically across all participants. Furthermore, it appears rather implausible that there should not be any meaningful differences in liking, when selecting two specific snacks (out of eight) that were ranked on position 2 and 6 by each participant.

Consequently, it is concluded that the results of Study 9 are informative about another possible mental mechanism that is underlying the greater acceptance and consumption of disgusting foods amongst food deprived subjects, namely the change in the relative importance of hedonic versus functional food features within the context of cost-benefit-analyses. As argued right above, relative differences between hungry and satiated subjects are considered informative even if unpreferred foods were probably not rejected to the same extent as disgust related foods, and even if rank ordering snacks in respect to subjective liking might have been a rather coarse grained way of assessing idiosyncratic food preferences amongst participants.

Summary of Results and Final Conclusions

The main goals of the present thesis were a) to investigate if even moderate levels of food deprivation would attenuate food related disgust, b) to test if reductions of food related disgust would translate into real eating behavior and provide a compelling explanation for deprived subjects' greater intake of unpalatable foods that was observed before (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968), and c) to identify mental mechanisms that might underlie alterations in food related disgust and consumption of disgusting foods. Drawing on a contemporary dual systems model of social behavior (Strack & Deutsch, 2004) it was distinguished between impulsive (or associatively based) and reflective (or rule-based) mechanisms of information processing that might contribute to changes in food related disgust and intake of disgusting foods. Particularly, it was investigated if food deprivation alters automatic attitudes and immediate approach motivational tendencies towards disgusting foods in the Impulsive System, and the outcome of more elaborated cost-benefit-calculations in the context of food choices in the Reflective System.

As mentioned initially, the intuitive assumption that food related disgust might be reduced in an acute state of homeostatic dysregulation was never tested directly before. Earlier studies for example showed that food deprived subjects consumed more bad tasting food than satiated subjects (e.g., Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968), but focused on metabolic pressures (e.g., the starving organism's need to ingest calories immediately) and the role of taste reactivity under acute food deprivation as possible explanations for this phenomenon. Moreover, classical theories of disgust (e.g., Rozin & Fallon, 1987), argued that food related disgust is based on stable associations and hence should not vary as a function of the organism's need state. If anything at all, the individual's willingness to overcome disgust should change (e.g., in situations of

extreme starvation), thus representing a conscious attempt to override existing feelings of food related disgust rather than a change in disgust itself.

This line of reasoning was called into question within the present work. In fact, it was hypothesized that food deprivation does very well alter food related disgust and consumption of disgusting foods and that it does so even automatically. That is, food deprivation was expected to influence food related disgust and consumption of disgusting foods independent of explicit evaluations of these foods or subjective awareness. This assumption is pretty in line with the recently developed Reflective Impulsive Model (*RIM*; Strack & Deutsch, 2004) that proposes several automatic effects of food deprivation on the processing of need relevant cues in the Impulsive System. In support of this, recent studies yielded that food deprivation renders immediate evaluations of eating relevant cues more positive (Hoefling & Strack, 2008; Seibt et al., 2007), and increases immediate approach motivational tendencies towards eating relevant stimuli (Seibt et al., 2007). However, these studies used neutral or palatable food stimuli and so no study exists that investigates immediate evaluations and immediate motivational tendencies towards disgusting foods (that are need relevant, too). To bridge this gap and to supplement classic theories of disgust (e.g., Rozin & Fallon, 1987) automatic attitudes and immediate approach motivational tendencies towards disgusting foods were extensively investigated in the present thesis.

Finally, it was also hypothesized that food deprivation might affect food related disgust and eating behavior via the Reflective System, but without changing explicit evaluations of disgusting foods. In short, it was assumed that food deprivation changes the outcome of cost-benefit-calculations that are made in the context of food choices. More precisely, the utility derived from hedonic food features (e.g., preferred flavor, palatable visual appearance) should decrease for the deprived organism because these features are not functional in ending the acute need state. In contrast, the utility derived from functional food features that are helpful in ending a state of food deprivation quickly (e.g., availability of food in terms of amount and

time) should increase under food deprivation. Importantly, hungry versus satiated subjects' food choices should differ as a result of this computational process. That is, food deprived subjects should choose their foods according to functional attributes, and satiated subjects should choose their foods according to hedonic attributes.

To explore the dynamics of food related disgust from different points of view, and to test the specific assumptions that were made in the present thesis, a variety of dependent measures was analyzed, for example biological measures of immediate affect (EMG), real food intake, indirect attitude measures (e.g., *st-IAT*; Wigboldus 2005; cf. Steinman & Karpinski, 2006; *AMP*; Payne et al., 2005), measures of immediate approach-avoidance behavior (AAT; Rinck & Becker, 2007; see also Chen & Bargh, 1999), and real food choices. Taken together, these analyses provide a comprehensive picture of food related disgust and its role in the relationship between food deprivation and eating behavior.

Summary of Results

In the following, the central results of the present thesis will be re-considered in more detail, and their implications for both, the understanding of food related disgust under food deprivation and further research will be discussed. It can be announced in advance that the results greatly confirmed the core assumptions of the present thesis.

Automatic Reduction of Food Related Disgust

To begin with, it was confirmed in Section 1 that even moderate levels of food deprivation (< 24 h) automatically attenuate food related disgust. Particularly, food deprived subjects exhibited weaker spontaneous disgust expressions (i.e., levator activation) than satiated subjects when being confronted with photographs of disgusting foods in Study 2. As discussed before, this provides an extension of classical theories of disgust (Rozin & Fallon, 1987; Rozin, 1993) in two ways. First, the assumption that food deprivation alters food related disgust was actually tested and confirmed empirically for the first time. Second, the original

assumption was even exceeded by showing that an alteration of food related disgust does not necessarily depend on conscious attempts to overcome disgust, or on slow associative learning processes, but can occur automatically and even in the absence of altered conscious evaluations. Noteworthy, dissociations between facial reactions and conscious evaluations of disgusting foods were found, indicating that there might be direct link between food related disgust and eating behavior that does not depend on awareness or on explicit evaluations of disgusting food stimuli.

Furthermore, albeit not central to the present thesis, food deprivation did also affect more general affective reactions towards food cues. In particular, food deprived participants also showed more positive affect (i.e., stronger spontaneous zygomaticus activity) than satiated participants towards disgusting foods (Study 1), and towards palatable foods (Study 1 & 2). Given that zygomatic activity is related to the general valence of stimuli (see Dimberg, 1990, and Fridlund & Izard, 1983 for reviews), this latter finding nicely fits prior studies showing more positive immediate evaluations of food related cues amongst food deprived subjects (Hoefling & Strack, 2008; Seibt et al., 2007).

Greater Consumption of Disgusting Foods

In Section 2, the prediction was confirmed that food deprived participants will also consume greater amounts of disgust related foods than satiated participants. As already discussed extensively, genetically modified foods (GMF) were used as experimental foods in the present thesis because they are rejected on the basis of “the idea of what they are” (Fallon & Rozin, 1983, p. 15), and on the basis of health concerns, thereby possessing central attributes of disgusting foods (for overviews see Fallon & Rozin, 1983; Rozin & Fallon, 1987). Moreover, the visual appearance of food was also manipulated in Study 4 so that foods were looking either palatable or evoked food rejection because of their unpalatable visual appearance (see also Rozin et al., 1986).

Compared to satiated participants, food deprived participants did indeed consume greater amounts of GMF (Study 3 & 4), or foods that were visually unattractive (Study 4). Again, a dissociation was observed between negative explicit evaluations of GMF and actual consumption thereof amongst food deprived subjects. That is, food deprived participants evaluated GMF equally negative (i.e., unhealthy, unnatural) as satiated participants on a reflective level of information processing, but consumed significantly greater amounts thereof. This finding corroborates the assumption of a direct link between food related disgust and eating behavior that does not depend on conscious evaluations of foods.

As discussed before, findings from Section 2 may expand our understanding of prior studies showing greater intake of bad tasting foods amongst food deprived subjects (Bellisle et al., 1984; Desor et al., 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968). By using GMF that were disgusting, but not bad-tasting, it was assured that previous explanations (i.e., changes in taste responsiveness) do not provide compelling explanations for deprived subjects greater food intake in the present studies. The finding that food deprivation does nevertheless alter food intake highlights the role of food related disgust in the relationship between food deprivation and food intake. In fact, it suggests that food deprived participants' greater intake of unpalatable foods in prior studies might not only be related to their taste reactivity or to physiological pressures, but to their reduced feelings of disgust towards these foods, too.

More Positive Automatic Attitudes towards Disgusting Foods

In Section 3, it was investigated if food deprived subjects would have more positive automatic attitudes towards disgusting foods than satiated subjects. This hypothesis did not receive strong and unequivocal support in the present thesis however. In particular, Study 5 implemented a single target IAT (Wigboldus, 2005; cf. Steinman & Karpinski, 2006) and yielded that food deprived participants did not have more positive automatic attitudes towards disgusting foods than satiated subjects. Although palatable foods were evaluated slightly more

positive by food deprived participants than by satiated participants (which is in line with the assumptions of the present thesis), disgusting foods were evaluated slightly more negative.

In fact, the observed data pattern in Study 5 suggests stronger differentiation between positive and disgusting foods amongst food deprived participants than amongst satiated participants. As already discussed, this result may be due to the fact that evaluating foods immediately is adaptive in a state of food deprivation. This is because imminent food consumption requires people to choose between potential foods before consuming them, and evaluating all potential foods in a given situation immediately might be helpful for picking the most attractive foods quickly.

From this perspective, it might have been misleading to conclude from earlier findings (Seibt et al., 2007) that food deprived participants will evaluate all food related cues more positively than satiated participants in an IAT. In fact, findings by Seibt et al. (showing more positive automatic attitudes towards food cues in a standard IAT) might be based on the fact that only palatable foods were used as stimuli, thereby overlooking the fact that differences in the evaluation of palatable versus unpalatable foods will not be attenuated, but pronounced by food deprivation (*hunger induced finickiness*; see also Kauffman et al., 1995 and Pliner et al., 1990).

However, given the previously reported results of Section 1 and Section 2 (indicating more positive affect towards disgusting foods and greater consumption of disgusting foods), this interpretation seems rather implausible. Instead, a growing body of evidence suggests that the specific nature of the IAT (and its variants) might be responsible for the unexpected findings in Study 5. Particularly, the IAT is assumed to capture the activation of semantic associations to a greater extent than the activation of immediate affective reactions (e.g., Payne et al., 2005). From this perspective, palatable and disgusting food pictures could have activated multiple semantic associations that were independent from a subject's personal affective reaction towards the food pictures.

Ultimately, the observed data pattern in Study 5 might be due to the fact that semantic associations towards palatable and disgusting foods were activated more easily and more quickly amongst food deprived participants than amongst satiated participants. Given that food deprivation increases the perceptual readiness for need relevant cues (Bruner, 1957; Wispe & Dramberean, 1953) and the cognitive accessibility of need relevant cues (Aarts, Dijksterhuis, & deVries, 2005), it appears plausible that critical areas of food deprived participants' associative memory store (see Strack & Deutsch, 2004) might have been pre-activated. Consequently, food deprived subjects' IAT responses might indeed have been influenced by semantic associations towards palatable and disgusting foods to a greater degree than satiated participants' reactions, but not so much by their immediate affective reactions towards palatable and unpalatable foods.

This latter assumption is admittedly speculative, but was somewhat corroborated by findings from Study 6. Particularly, an Affect Misattribution Procedure (*AMP*; Payne et al., 2005) was conducted that presumably captures subjects' immediate affective reactions to a greater extent than the IAT. In line with the central assumptions of the present thesis it turned out that both, positive and disgusting foods evoked more positive reactions amongst food deprived subjects than amongst satiated subjects. As mentioned before, this pattern missed conventional levels of statistical significance, and thus no definite conclusion should be drawn from this finding. However, the observed tendency is absolutely compatible with previous studies showing that food deprivation renders automatic attitudes towards food cues more positive in an EAST (Hoefling & Strack, 2008; Seibt et al., 2007), or in an IAT (Seibt et al., 2007), and with the finding that palatable and disgusting foods evoked more positive affect (i.e., stronger zygomaticus activity) amongst food deprived subjects (Study 1). Consequently, it appears plausible to conclude that Study 6 yields at least some support for the assumption that food deprived subjects have more positive automatic attitudes towards both, palatable and disgusting foods.

The discrepancy between findings from Study 5 and Study 6 however suggests that future research should further elaborate the different mental mechanisms that underlie the growing number of indirect attitude measures. This would certainly be helpful for clarifying under which conditions different indirect measures yield rather diverging or rather converging results.

Stronger Approach Motivational Tendencies towards Disgusting Foods

In Section 4, the central prediction was confirmed that food deprived participants would exhibit stronger approach motivational tendencies towards disgusting foods than satiated participants. In particular, a modified version of the Approach Avoidance Task (AAT; Rinck & Becker, 2007; see also Chen & Bargh, 1999) was used in Study 7, and hungry participants exhibited higher approach indices towards disgusting foods than satiated participants. As discussed before, this finding nicely fits previously reported results showing a reduction of food related disgust (Study 2), greater consumption of disgust related foods (Study 3 & 4), and the trend towards more positive immediate evaluations of disgusting foods amongst food deprived subjects (Study 6).

However, contrary to the assumptions and to prior studies (Seibt et al., 2007), food deprived subjects' approach motivational tendencies towards palatable foods were not stronger than those of satiated participants. As already discussed extensively, this phenomenon might be explained by the concept of frustrative nonreward (Amsel, 1958; Berridge & Robinson, 1995).

Noteworthy, Section 4 also yielded that food deprivation had an effect on immediate approach motivational tendencies only when subjects were instructed to react to the category of stimuli in Study 7, but not when participants were instructed to react to a surface feature that was totally unrelated to the experimental stimuli in Study 8 (picture frame). As mentioned earlier, this finding is compatible with studies showing that stimulus-response compatibility effects do crucially depend on processing goals and intentional processing of stimuli (e.g.

Lavender & Hommel, 2007; Rotteveel & Phaf, 2004), but contradict earlier findings by Seibt et al. (2007) that found an effect of food deprivation on immediate approach motivational tendencies towards (palatable) food cues using another surface feature (position of a picture on the screen). It was argued already, that the use of picture frames as surface features might have directed visual attention away from the stimuli, thereby preventing subjects from processing the presented pictures already on a basal perceptual level.

Changes in the Relative Importance of Hedonic versus Functional Food Features

Finally, Study 9 confirmed the prediction that food deprivation may also alter the outcome of more elaborated cost-benefit-considerations in the Reflective System. In particular, it was assumed that food choices (especially when made in a context of pairwise comparisons) would be based on cost-benefit-computations and that food deprivation would change the weighting of hedonic and functional food features within this computational process. As expected, it turned out that hedonic food attributes (e.g., preferred flavor) become less important for food deprived subjects, and functional food attributes (e.g., availability of food in terms of amount time) become more important. In particular, it was less important for food deprived subjects than for satiated subjects to get a preferred snack in Study 9, but more important to get something to eat immediately and to get a large portion size (even if this meant choosing an un-favored snack). This pattern corroborates the intuitive assumption that immediate saturation matters more for food deprived individuals than their hedonic demands (“Beggars cannot be choosers”). Ultimately, food deprived subjects might experience weaker feelings of food related disgust than satiated subjects and consume disgusting foods more readily because they do not care so much about the palatability of food anymore. Noteworthy, this does not necessarily mean that explicit evaluations of disgusting (or un-preferred) foods do change as a result of homeostatic dysregulation. Instead, the weighting (or importance) that is assigned to this explicit evaluation changes as a result of food deprivation.

Final Conclusions

To conclude, the present thesis confirmed that even moderate levels of food deprivation reduce food related disgust and increase consumption of disgusting foods. Strikingly, these effects were found in the absence of awareness and altered conscious evaluations of disgusting foods, indicating that there might be a direct link between food related disgust and eating behavior that can operate unconsciously.

Consistent with a contemporary dual process model of social behavior (Strack & Deutsch, 2004), it turned out that changes in automatic attitudes towards disgusting foods and immediate approach motivational tendencies towards disgusting foods might provide possible explanations for this phenomenon at least under certain experimental circumstances (e.g., depending on which indirect measure and reaction signal is used). The fact that food deprivation exerts an influence on measurement outcomes of indirect measures such as the AMP or the AAT (but not on explicit evaluations) indicates that homeostatic dysregulation has the potential to prepare the organism for food consumption at a very early state of information processing and does not depend on cognitive capacity, awareness, or intention (see also Seibt et al., 2007).

However, the results of the present thesis suggest that food deprivation does also affect more rational processes (e.g., cost-benefit-calculations) that may be responsible for food deprived participants' greater acceptance of disgusting foods and their reduction of food related disgust as well. Particularly, cost-benefit-calculations are characterized by weighting and charging against each other the costs and benefits of various (food) alternatives. In particular, it was found that food deprivation changes the relative importance (or weighting) of hedonic and functional food attributes in the context of such considerations. That is, hedonic aspects of foods (e.g., preferred flavor) seem to be of minor importance for food deprived subjects and are outweighed by aspects that are more functional in ending their state of food deprivation (e.g., immediate availability of food, adequate portion size). From this

perspective, food deprived participants may well be aware that a certain food does not meet their hedonic demands. Nevertheless, they will readily accept even un-preferred foods if they have the potential to end an acute state of food deprivation. Ultimately, reductions in food related disgust might also be explained by the fact that the hedonically negative aspects of disgusting foods (e.g., bad flavor, unpalatable visual appearance, the way they were produced) are compensated by their functional value to generate immediate satiation.

Not to be forgotten is the fact that the automatic modulation of facial disgust expressions themselves might act as an underlying mechanism influencing food related disgust via facial feedback loops (see Niedenthal, 2007 for an overview), or through nonverbal communication based on facial expressions. To repeat, hungry individuals who mimic group members that exhibit facial expressions of disgust while eating might get “emotionally contagioned” (Neumann & Strack, 2000) and hence be less prone to indulge unknown or unattractive foods. Alternatively, individuals might be encouraged to indulge such foods in the absence of disgust expressions in their group members’ faces.

Taken together, the results of the present thesis are highly informative about the interplay of physiological processes, affective information processing, and human eating behavior by providing new and explicit insights into the dynamics of food related disgust under food deprivation. For the first time it was explicitly shown that even moderate states of homeostatic dysregulation do alter specific emotional states (reduction of food related disgust) which in turn foster the intake of otherwise unaccepted foods in a quite direct manner.

Over and above, the findings of the present thesis may also expatiate upon a groundbreaking model for the regulation of human eating behavior (*Boundary Model*; Herman & Polivy, 1984). In principle, it is argued in the Boundary Model (Herman & Polivy, 1984) that “biologically aversive pressures to eat” (p. 143) will predominantly determine human eating behavior when the organism is in an acute state of food deprivation, whereas psychological and social influences exert the strongest influence when the organism is in a

zone of “biological indifference” (p.142). However, the authors primarily focus on food intake and remain relatively vague about the exact mental mechanisms that come into play when organisms transgress the hunger boundary during the course of food abstinence.

Noteworthy, the results of the present thesis give a clearer understanding of exactly this issue. In particular, it can be concluded from the present thesis that the intake of unattractive foods under conditions of deprivation is not due to aversive biological pressures alone, but is related to specific changes in affective and motivational reactions towards these foods as well. In particular, the deprived organism is prepared to consume food by an automatic increase of appetitive affective and motivational reactions towards both, attractive and unattractive foods even outside the zone of biological indifference.

Of course the results of the present thesis capture the effect of food deprivation on normal eaters’ reactions only. Future research could hence investigate if food deprivation has the same automatic effect on restrained eaters who chronically try to restrict their food intake (Herman & Mack, 1975; Herman & Polivy, 1980) or on participants that suffer from eating disorders like Obesity, Anorexia nervosa or Bulimia nervosa. Common sense suggests these subjects might react differently towards food in general, or towards disgusting foods in particular. As a consequence, food deprivation might not have the same impact on their reactions. Another interesting issue for future research pertains to the deprivation of other bodily needs (e.g., sexuality) or higher social needs (e.g., the need to belong; Baumeister & Leary, 1995) on subjects’ affective and motivational responses towards relevant cues.

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APPENDIX

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Study 1

Instructions

Picture Viewing Task:

Liebe(r) Versuchsteilnehmer(in),

Bisherige Forschung hat gezeigt, dass es sich positiv auf Konzentrationsfähigkeit, Lernfähigkeit und Gedächtnisleistung auswirken kann, wenn man sich emotional auf die Reize aus seiner Umwelt einlässt, statt entstehende Gefühle kontrollieren zu wollen. Zahlreiche Studien konnten dies für emotional gehaltvolle Bilder, Texte und auch Filmausschnitte zeigen.

In diesem Abschnitt der Sitzung werden Dir gleich eine Reihe von Bildern am Fernseher präsentiert. Bitte lasse Dich beim Betrachten dieser Bilder auf Ihren emotionalen Gehalt ein. Dies ist für die Bearbeitung der nächsten Konzentrationsaufgabe wichtig!

Bevor die Versuchsleitung die Bilddarbietung startet, noch einige Details:

Bitte betrachte die Bilder aufmerksam und versuche, das weiße Kreuz vor jedem Durchgang zu fixieren. (An dieser Stelle werden die Bilder erscheinen.)

Bitte bleibe entspannt, aber aufrecht auf dem Stuhl sitzen – verrücke den Stuhl nicht, da der Abstand zum Fernseher für alle Personen gleich bleiben soll.

Gib nun der Versuchsleitung ein Handzeichen. Falls Du keine Fragen mehr hast, wird sie die Bilddarbietung jetzt gleich starten.

Stimuli



Study 2

Instructions

Picture Viewing Task:

Liebe(r) Versuchsteilnehmer(in),

vielen Dank dass Sie an dieser Studie teilnehmen. Im Folgenden werden Sie mehrere Aufgaben am Computer bearbeiten, die ihnen jeweils am Bildschirm genauer erklärt werden. Unter anderem geht es darum herauszufinden, ob die Hautleitfähigkeit bei der Verarbeitung von visuellen Reizen vom Blutzuckerspiegel beeinflusst wird. Hierzu müssten Sie bereits am Telefon eine gesonderte Instruktion erhalten haben.

Falls Sie Fragen zur jeweiligen Aufgabenbearbeitung haben sollten, wenden Sie sich bitte an die Versuchsleitung.

Im folgenden Abschnitt werden Ihnen Bilder auf dem Monitor präsentiert. Ihre Aufgabe besteht darin, sich diese Bilder anzusehen. Da währenddessen Ihre Hautleitfähigkeit gemessen wird, möchten wir Sie bitten, möglichst ruhig und entspannt sitzen zu bleiben und den Kopf möglichst nicht mehr zu bewegen.

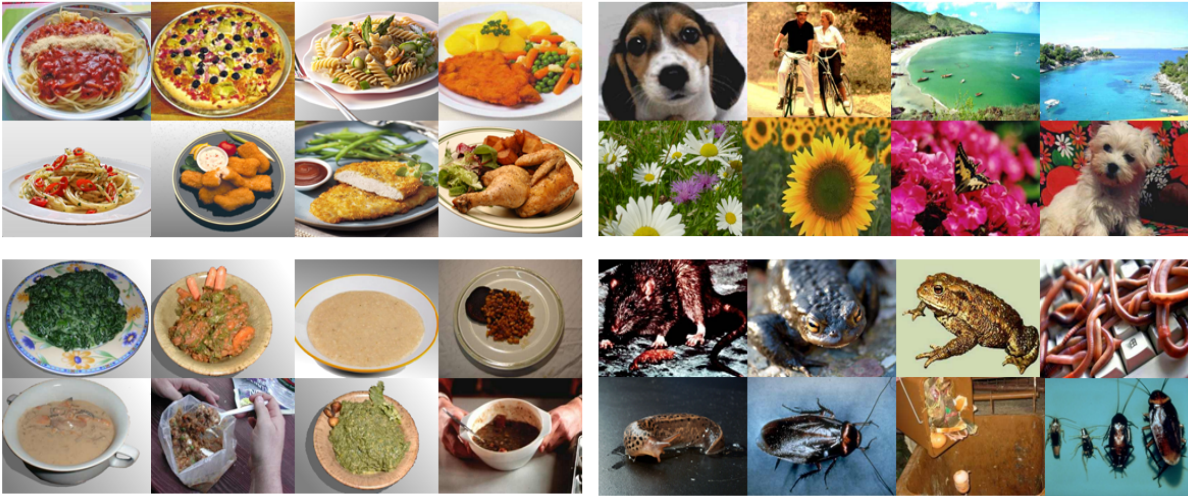
Zwischen den einzelnen Bildern kommt es zu recht langen Pausen. Dies ist normal und notwendig für die Messung Ihrer Hautleitfähigkeit in Reaktion auf die einzelnen Bilder.

Rechtzeitig, bevor ein neues Bild erscheint, werden Sie einen Signalton hören. Fixieren Sie zu diesem Zeitpunkt bitte das Kreuz in der Mitte des Bildschirms.

Falls Sie noch Fragen haben, wenden Sie sich nun bitte an die Versuchsleitung.

Bitte drücken Sie die Leertaste, um zu beginnen.

Stimuli



Study 3

Instructions

Information text about GMF:

Im Folgenden sehen sie Wörter und Bilder von Obst- und Gemüsesorten am Bildschirm. Es handelt sich um Obst und Gemüsesorten, die genetisch manipuliert wurden. Bei gentechnologischen Verfahren werden Gene eines fremden Organismus in das Erbmaterialeiner Nutzpflanze implantiert. Bspw. macht das Anti-Frost Gen eines Fisches eine Kartoffelpflanze kälteresistent. Bislang ist jedoch noch nicht eindeutig geklärt, welche langfristigen Risiken der Anbau und der Verzehr solcher genbehandelten Pflanzen für Mensch und Natur in sich birgt.

Information text about OGF:

Im Folgenden sehen sie Wörter und Bilder von Obst- und Gemüsesorten am Bildschirm. Es handelt sich um Obst und Gemüsesorten aus natürlich-ökologischem Anbau. Der biologische Anbau ist besonders umweltfreundlich, und der Verzehr solcher Produkte wird ernährungswissenschaftlich als äußerst wertvoll eingestuft.

Taste Test:

Im folgenden Abschnitt werden wir einen Geschmackstest mit Ihnen durchführen, bei dem Sie den Ihnen vorliegenden Bio-Apfel [Gen-Apfel] bewerten sollen. Er stammt aus rein ökologischem Anbau. [Durch eine genetische Manipulation ist er wesentlich länger haltbar als herkömmliche Äpfel.] Ein Fragebogen erfasst Ihre Meinung hinsichtlich einiger Kriterien, wie Attraktivität, Aussehen, Süße, Geschmack und Nährwert.

Dieser Versuchsteil wird ca. 20 Minuten in Anspruch nehmen. Es ist Ihnen selbstverständlich freigestellt von dem Bio-Apfel [Gen-Apfel] zu essen. Falls Sie den Bio-Apfel [Gen-Apfel] nicht probieren möchten, bitten wir Sie, den Fragebogen trotzdem möglichst vollständig zu bearbeiten. Füllen Sie dann lediglich die Fragen aus, die sich nicht auf den Überpunkt „Geschmack“ beziehen.

Bitte essen Sie jetzt von dem Bio-Apfel [Gen-Apfel] und füllen Sie den Fragebogen vollständig aus. Sie können soviel von dem Apfel verzehren, wie sie möchten. Wenn Sie die Aufgabe beendet haben, verhalten Sie sich bitte ruhig und warten Sie bis alle anderen Versuchsteilnehmer fertig sind. Die Versuchsleitung wird Ihnen ein Zeichen geben, sobald es weiter gehen kann.

Questions

KP – Studie Datenerhebung Würzburg /April-Mai.07

Vp-Code: _____ Cond.: D+ / D- Exp.: - 02 -

Konsumpräferenz-Studie

Sehr geehrte(r) VersuchsteilnehmerIn,

Die internationale Konsumpräferenz-Studie ist ein von der EU gefördertes Projekt der Universitäten Berlin (FU), Würzburg und Konstanz, welches in enger Zusammenarbeit mit einigen namhaften deutschen Nahrungsmittelherstellern durchgeführt wird. Ziel dieses Projektes ist, sowohl das subjektive Geschmacksempfinden als auch die subjektive Produktwahrnehmung gegenüber verschiedenen Artikeln in unterschiedlichen Altersgruppen und Kulturen zu untersuchen. Einige Lebensmittelhersteller passen bereits seit vielen Jahren die Rezepturen ihrer Produkte (z.B. Cola, Eiskreme, Chips, etc.) den jeweiligen kulturellen Geschmacksvorlieben in verschiedenen Ländern an.

Im folgenden Abschnitt werden wir diesen Geschmacks- und Beurteilungstest mit Ihnen durchführen, bei dem Sie den Ihnen vorliegenden Gen-Apfel bewerten sollen. Durch eine genetische Manipulation ist er wesentlich länger haltbar als herkömmliche Äpfel. Ein Fragebogen erfasst Ihre Meinung hinsichtlich einiger Kriterien, wie Attraktivität, Aussehen, Süße, Geschmack und Nährwert.

Dieser Versuchsteil wird ca. 20 Minuten in Anspruch nehmen. Es ist Ihnen selbstverständlich freigestellt von dem Gen-Apfel zu essen. Falls Sie den Gen-Apfel nicht probieren möchten, bitten wir Sie, den Fragebogen trotzdem möglichst vollständig zu bearbeiten. Füllen Sie dann lediglich die Fragen aus, die sich nicht auf den Überpunkt „Geschmack“ beziehen.

Bitte essen Sie jetzt von dem Gen-Apfel und füllen Sie den Fragebogen vollständig aus. Sie können soviel von dem Apfel verzehren, wie sie möchten. Wenn Sie die Aufgabe beendet haben, verhalten Sie sich bitte ruhig und warten Sie bis alle anderen Versuchsteilnehmer fertig sind. Die Versuchsleitung wird Ihnen ein Zeichen geben, sobald es weiter gehen kann.

weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Beurteilungsbogen

Fragen zum Geschmack des Produktes

1. Wie beurteilen Sie die Konsistenz bzw. Bisshaftigkeit des Produkts?

mehlig hart
genau richtig

2. Wie süß schmeckt Ihnen das Produkt?

nicht süß zu süß
genug genau richtig

3. Wie säuerlich schmeckt Ihnen das Produkt?

nicht säuerlich zu säuerlich
genug genau richtig

4. Wie saftig schmeckt Ihnen das Produkt?

nicht saftig zu saftig
genug genau richtig

5. Wie gehaltvoll/nährreich schmeckt Ihnen das Produkt?

nicht saftig zu saftig
genug genau richtig

6. Wie schmeckt Ihnen das Produkt insgesamt?

sehr schlecht sehr gut

weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Fragen zum visuellen Eindruck des Produktes

1. Wie appetitlich sieht das Produkt auf den ersten Blick für Sie aus?

Gar nicht sehr
appetitlich neutral appetitlich

2. Wie beurteilen Sie die Farbe des Produktes?

Gar nicht sehr
appetitlich neutral appetitlich

3. Wie frisch beurteilen Sie das Produkt?

Gar nicht sehr
frisch neutral frisch

4. Wie natürlich beurteilen Sie das Produkt?

Gar nicht sehr
natürlich neutral natürlich

5. Wie beurteilen Sie die Größe des Produktes?

Zu klein zu groß
genau richtig

6. Wie attraktiv beurteilen Sie das Produkt?

Gar nicht sehr
attraktiv neutral attraktiv

7. Wie sehr glänzt die Oberfläche des Produktes?

Gar nicht sehr
neutral

weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Fragen zum taktilen Eindruck des Produktes

1. Wie fühlt sich das Produkt an der Oberfläche an?

rauh glatt
neutral

2. Wie rund fühlt sich das Produkt insgesamt an?

zu ~~verle~~ zu ideal
genau richtig

3. Wie beurteilen Sie das Gewicht des Produktes insgesamt?

Zu leicht zu schwer
genau richtig

Fragen zum Ernährungsbeitrag

1. Wie „gehaltvoll“ finden Sie das Produkt (im Sinne von Nährwert)?

Gar nicht sehr
gehaltvoll neutral gehaltvoll

2. Wie hoch schätzen Sie den Kaloriengehalt (pro 100g) des Produktes ein?

Sehr wenig sehr viel
Kalorien normal Kalorien

3. Für wie gesund halten Sie dieses Produkt?

Sehr selten sehr häufig
gelegentlich

4. Sollte dieses Produkt auch Bestandteil bzw. Inhaltsstoff für andere Produkte sein, also zur Weiterverarbeitung Verwendung finden?

Nein ja
weiß, nicht

weiter →

Study 4

Instructions

Information text about GMF:

Im Folgenden sehen sie Wörter und Bilder von Äpfeln am Bildschirm. Es handelt sich um Äpfel, die genetisch manipuliert wurden. Bei gentechnologischen Verfahren werden Gene eines fremden Organismus in das Erbmaterialeiner Nutzpflanze implantiert. Bspw. macht das Anti-Frost Gen eines Fisches eine Kartoffelpflanze kälteresistent. Bislang ist jedoch noch nicht eindeutig geklärt, welche langfristigen Risiken der Anbau und der Verzehr solcher genbehandelten Pflanzen für Mensch und Natur in sich birgt.

Information text about OGF:

Im Folgenden sehen sie Wörter und Bilder von Äpfeln am Bildschirm. Es handelt sich um Obst und Gemüsesorten aus natürlich-ökologischem Anbau. Der biologische Anbau ist besonders umweltfreundlich, und der Verzehr solcher Produkte wird ernährungswissenschaftlich als äußerst wertvoll eingestuft.

Taste Test:

Im folgenden Abschnitt werden wir einen Geschmackstest mit Ihnen durchführen, bei dem Sie den Ihnen vorliegenden Bio-Apfel [Gen-Apfel] bewerten sollen. Er stammt aus rein ökologischem Anbau. [Durch eine genetische Manipulation ist er wesentlich länger haltbar als herkömmliche Äpfel.] Ein Fragebogen erfasst Ihre Meinung hinsichtlich einiger Kriterien, wie Attraktivität, Aussehen, Süße, Geschmack und Nährwert.

Dieser Versuchsteil wird ca. 20 Minuten in Anspruch nehmen. Es ist Ihnen selbstverständlich freigestellt von dem Bio-Apfel [Gen-Apfel] zu essen. Falls Sie den Bio-Apfel [Gen-Apfel] nicht probieren möchten, bitten wir Sie, den Fragebogen trotzdem möglichst vollständig zu bearbeiten. Füllen Sie dann lediglich die Fragen aus, die sich nicht auf den Überpunkt „Geschmack“ beziehen.

Bitte essen Sie jetzt von dem Bio-Apfel [Gen-Apfel] und füllen Sie den Fragebogen vollständig aus. Sie können soviel von dem Apfel verzehren, wie sie möchten. Wenn Sie die Aufgabe beendet haben, verhalten Sie sich bitte ruhig und warten Sie bis alle anderen Versuchsteilnehmer fertig sind. Die Versuchsleitung wird Ihnen ein Zeichen geben, sobald es weiter gehen kann.

Questions

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Vp-Code: _____ Cond.: D+ / D- Exp.: - 02 -

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Im folgenden Abschnitt werden wir diesen Geschmacks- und Beurteilungstest mit Ihnen durchführen, bei dem Sie den Ihnen vorliegenden Gen-Äpfel bewerten sollen. Durch eine genetische Manipulation ist er wesentlich länger haltbar als herkömmliche Äpfel. Ein Fragebogen erfasst Ihre Meinung hinsichtlich einiger Kriterien, wie Attraktivität, Aussehen, Süße, Geschmack und Nährwert.

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weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Beurteilungsbogen

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1. Wie beurteilen Sie die Konsistenz bzw. Bissfestigkeit des Produkts?

mehlig hart
genau richtig

2. Wie süß schmeckt Ihnen das Produkt?

nicht süß zu süß
genau richtig

3. Wie säuerlich schmeckt Ihnen das Produkt?

nicht säuerlich zu säuerlich
genau richtig

4. Wie saftig schmeckt Ihnen das Produkt?

nicht saftig zu saftig
genau richtig

5. Wie gehaltvoll/nährreich schmeckt Ihnen das Produkt?

nicht saftig zu saftig
genau richtig

6. Wie schmeckt Ihnen das Produkt insgesamt?

sehr schlecht sehr gut

weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Fragen zum visuellen Eindruck des Produktes

1. Wie appetitlich sieht das Produkt auf den ersten Blick für Sie aus?

Gar nicht sehr
appetitlich neutral appetitlich

2. Wie beurteilen Sie die Farbe des Produktes?

Gar nicht sehr
appetitlich neutral appetitlich

3. Wie frisch beurteilen Sie das Produkt?

Gar nicht sehr
frisch neutral frisch

4. Wie natürlich beurteilen Sie das Produkt?

Gar nicht sehr
natürlich neutral natürlich

5. Wie beurteilen Sie die Größe des Produktes?

Zu klein zu groß
genau richtig

6. Wie attraktiv beurteilen Sie das Produkt?

Gar nicht sehr
attraktiv neutral attraktiv

7. Wie sehr glänzt die Oberfläche des Produktes?

Gar nicht sehr
neutral

weiter →

KP – Studie Datenerhebung Würzburg /April-Mai.07

Fragen zum taktilen Eindruck des Produktes

1. Wie fühlt sich das Produkt an der Oberfläche an?

rauh glatt
neutral

2. Wie rund fühlt sich das Produkt insgesamt an?

zu verformt zu ideal
genau richtig

3. Wie beurteilen Sie das Gewicht des Produktes insgesamt?

Zu leicht zu schwer
genau richtig

Fragen zum Ernährungsbeitrag

1. Wie „gehaltvoll“ finden Sie das Produkt (im Sinne von Nährwert)?

Gar nicht sehr
gehaltvoll neutral gehaltvoll

2. Wie hoch schätzen Sie den Kaloriengehalt (pro 100g) des Produktes ein?

Sehr wenig sehr viel
Kalorien normal Kalorien

3. Für wie gesund halten Sie dieses Produkt?

Sehr selten sehr häufig
gelegentlich

4. Sollte dieses Produkt auch Bestandteil bzw. Inhaltsstoff für andere Produkte sein, also zur Weiterverarbeitung Verwendung finden?

Nein ja
weiss nicht

weiter →

Study 5

Instructions

Single Target IAT: Practice Trial

Im nun folgenden Teil werden sie erneut eine Reaktionszeitaufgabe bearbeiten, die den vorhergehenden Aufgaben sehr ähnlich ist.

Nach einem Übungsdurchgang werden Sie wieder auf verschiedene Wörter und Bilder reagieren, die am Bildschirm präsentiert werden.

Sie beginnen nun mit dem Übungsdurchgang. Drücken Sie die Linke Taste [Rechte Taste], wenn sie Wörter sehen, die Sie nicht mögen und die Rechte Taste [Linke Taste], wenn Sie Wörter sehen, die Sie mögen. Reagieren Sie möglichst schnell ohne zu viele Fehler zu machen.

Bitte klicken Sie auf „continue“.

Single Target IAT: Block 1

Im Folgenden sehen sie Wörter und Bilder von Essen.

Drücken Sie die Linke Taste [Rechte Taste], wenn sie Wörter, die Sie nicht mögen oder Bilder von Essen sehen.

Betätigen Sie die Rechte Taste [Linke Taste], wenn Sie Wörter sehen, die Sie mögen. Reagieren Sie möglichst schnell ohne zu viele Fehler zu machen.

Bitte klicken Sie auf „continue“.

Single Target IAT: Block 2

Im Folgenden sehen sie erneut Wörter und Bilder von Essen. Diesmal ist jedoch die Tastenzuordnung vertauscht!

Drücken Sie die linke Taste nur noch, wenn sie Wörter sehen, die Sie nicht mögen.

Betätigen Sie die rechte Taste, wenn Sie Wörter, die Sie mögen oder Bilder von Essen sehen.

Reagieren Sie möglichst schnell ohne zu viele Fehler zu machen.

Bitte klicken Sie auf „continue“

Stimuli

Food pictures:



Positive words: Liebe, Freude, Paradies, Geschenk, Blume, Spaß, Gut, Lachen [love, joy, paradise, gift, flower, good, laugh]

Negative words: Gift, Krankheit, Unglück, Tod, Ekelig, Schmutz, Erbrechen, Kot [poison, illness, misfortune, death, disgusting, dirt, vomit, feces]

Study 6

Instructions

Affect Misattribution Procedure:

Liebe(r) Versuchsteilnehmer(in),

In dieser Studie geht es um die Frage, wie Menschen einfache, aber schnelle Entscheidungen treffen. Außerdem soll die strittige Frage geklärt werden, ob die Blutzuckerkonzentration einen Einfluss auf solch einfache Entscheidungen haben könnte.

Ihnen werden gleich am Monitor kurz nacheinander verschiedene Bildpaare gezeigt. Beim ersten Bild handelt es sich immer um ein Foto, beim zweiten Bild immer um ein chinesisches Schriftzeichen.

Ihre Aufgabe besteht darin, die chinesischen Schriftzeichen zu beurteilen. Die Fotos dienen lediglich dazu, die Schriftzeichen anzukündigen. Beurteilen Sie in jedem Durchgang **nur** das visuelle Erscheinungsbild des chinesischen Schriftzeichens.

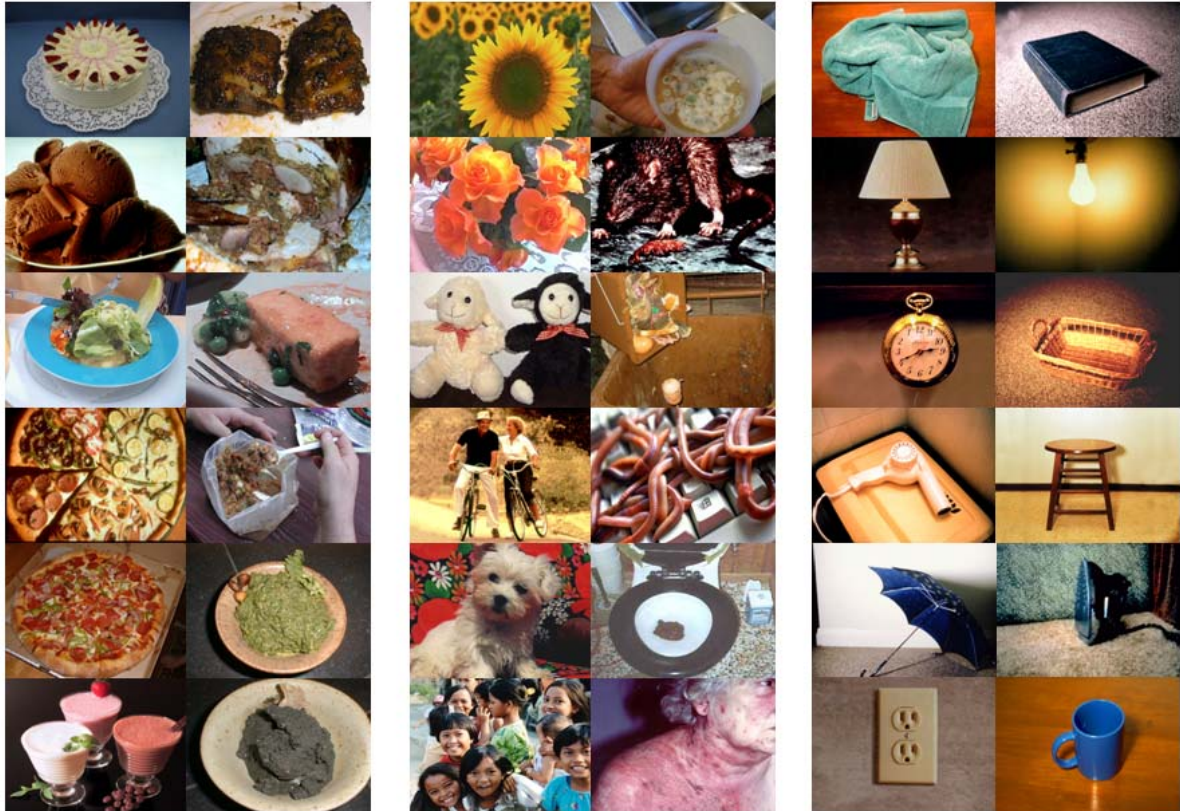
Drücken Sie die RECHTE Taste, wenn ein Schriftzeichen eher angenehm auf Sie wirkt.

Drücken Sie die LINKE Taste, wenn ein Schriftzeichen eher unangenehm auf Sie wirkt.

Es gibt bei dieser Aufgabe keine richtigen oder falschen Antworten. Bitte urteilen Sie möglichst zügig und überlegen Sie nicht zu lange.

Bitte geben Sie nun der Versuchsleitung ein Handzeichen. Sie wird Ihnen die Tasten zeigen und das Experiment starten, falls Sie keine Fragen mehr haben.

Stimuli



虎 块 汉 欣 罪 介 助 刀 曲
 地 荣 昨 毛 彩 词 归 堆 松
 人 姓 注 树 律 制 铁 射 票
 制 键 赶 旁 笔 代 扁 承 雄
 卫 弹 皆 叶 售 施 莫 波 答
 副 皮 百 木 判 释 卖 纪 名
 假 含 退 刻 火 动 往 既 令
 称 数 声 简 量 连 池 成 氏
 普 愿 半 精 昔 文 口 国 感

Study 7

Instructions

Approach Avoidance Task Block 1:

Liebe(r) Versuchsteilnehmer(in),

in der nächsten Aufgabe geht es um die Frage, wie die Kategorisierung von Reizen das Initiieren motorischer Bewegungsprogramme beeinflusst. Der Versuch besteht aus zwei Durchgängen, in denen Sie jeweils einen Joystick zu sich heranziehen bzw. von sich wegdrücken sollen - je nach dem, was für ein Foto Ihnen am Bildschirm gezeigt wird. Im zweiten Durchgang wird sich die anfängliche Zuordnung dann umdrehen! Sie werden jedoch vor Beginn des Durchgangs nochmals an die genaue Zuordnung erinnert werden.

Für den ersten Durchgang gilt:

Wenn auf dem Foto NAHRUNG [GEGENSTÄNDE, PERSONEN ODER TIERE] abgebildet ist [sind], dann ziehen Sie die abgebildete Speise [diese] so schnell wie möglich mit dem Joystick zu sich heran!

Wenn auf dem Foto GEGENSTÄNDE, PERSONEN ODER TIERE [NAHRUNG] abgebildet sind [ist], dann drücken Sie diese [die abgebildete Speise] so schnell wie möglich mit dem Joystick von sich weg!

Reagieren Sie so schnell wie möglich!

Geben Sie der Versuchsleitung jetzt bitte ein Handzeichen, damit der Joystick platziert werden kann.

Approach Avoidance Task Block 2:

Bitte beachten Sie, dass sich die Zuordnung im nun folgenden Durchgang umdreht! In diesem Durchgang gilt:

Wenn auf dem Foto NAHRUNG [GEGENSTÄNDE, PERSONEN ODER TIERE] abgebildet ist [sind], dann drücken Sie die abgebildete Speise [diese] so schnell wie möglich mit dem Joystick von sich weg!

Wenn auf dem Foto GEGENSTÄNDE, PERSONEN ODER TIERE [NAHRUNG] abgebildet sind [ist], dann ziehen Sie diese [die abgebildete Speise] so schnell wie möglich mit dem Joystick zu sich heran!

Reagieren Sie so schnell wie möglich!

Stimuli



Study 8

Instructions

Approach Avoidance Task:

Für die nun folgende Aufgabe benötigst du den Joystick. Es werden dir nun Bilder am Bildschirm präsentiert, die unterschiedlich gerahmt sind (durchgezogene oder gestrichelte Rahmen). Deine Aufgabe ist es, so schnell wie möglich zu entscheiden, um welche Rahmenart es sich handelt.

Ist der Rahmen durchgezogen, dann ziehe das Bild so schnell wie möglich mit dem Joystick zu dir heran. Ist der Rahmen gestrichelt, dann drücke das Bild mit dem Joystick so schnell wie möglich von dir weg.

Also:

DURCHGEZOGEN	–	zu dir heranziehen
GESTRICHELT	–	von dir wegdrücken

Versuche dich so gut es geht zu konzentrieren und bemühe dich, möglichst *schnell* und *fehlerfrei* zu reagieren.

Gib der Versuchsleitung nun unbedingt ein Handzeichen, dass der Joystick richtig für dich platziert werden kann! !

Approach Avoidance Task:

Für die nun folgende Aufgabe benötigst du den Joystick. Es werden dir nun Bilder am Bildschirm präsentiert, die unterschiedlich gerahmt sind (durchgezogene oder gestrichelte Rahmen). Deine Aufgabe ist es, so schnell wie möglich zu entscheiden, um welche Rahmenart es sich handelt.

Ist der Rahmen gestrichelt, dann ziehe das Bild so schnell wie möglich mit dem Joystick zu dir heran. Ist der Rahmen durchgezogen, dann drücke das Bild mit dem Joystick so schnell wie möglich von dir weg.

Also:

GESTRICHELT	–	zu dir heranziehen
DURCHGEZOGEN	–	von dir wegdrücken

Versuche dich so gut es geht zu konzentrieren und bemühe dich, möglichst *schnell* und *fehlerfrei* zu reagieren.

Gib der Versuchsleitung nun unbedingt ein Handzeichen, dass der Joystick richtig für dich platziert werden kann! !

Stimuli





Study9

*Instructions***Liebe Versuchsteilnehmerin, lieber Versuchsteilnehmer,**

in der folgenden Aufgabe geht es um Entscheidungen in mehrdimensionalen, nicht-eindeutigen, konsumatorischen Situationen.

Es werden Ihnen gleich am Bildschirm jeweils zwei Bilder dargeboten, auf denen Sie verschiedene Snacks sehen, die Sie nachher tatsächlich erhalten können. Der Zeitpunkt, zu dem diese Snacks erhältlich sind, ist zu jedem Bild mit angegeben. Sie sollen per Tastendruck diejenige Alternative auswählen, die Sie *momentan* bevorzugen. Dazu wurden auf der Tastatur zwei Tasten mit roten Punkten markiert.

Insgesamt werden Sie 28 Entscheidungen treffen. Der Computer wird *zufällig* aus allen 28 von Ihnen gewählten Alternativen eine ermitteln, die Sie danach als kleines Dankeschön bekommen.

Es gibt bei dieser Aufgabe keine richtigen oder falschen Entscheidungen. Bitte entscheiden Sie sich für die Alternative, die Sie wirklich bevorzugen und nicht für die, von der Sie vielleicht annehmen, dass man sie bevorzugen müsste.

Denken Sie daran, dass es hier keine richtigen oder falschen Entscheidungen gibt.

Es besteht bei dieser Aufgabe kein Zeitdruck. Bitte überlegen Sie dennoch nicht zu lange, sondern urteilen Sie möglichst intuitiv und spontan.

Wenn Sie keine Fragen mehr haben, drücken Sie bitte auf „Continue“, um zunächst ein Beispiel eingeblendet zu bekommen.

Stimuli



Erklärung gemäß §4 Abs. 4 der PromO vom 14.06.2001

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertation selbständig angefertigt und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe.

Würzburg, den 7. Oktober 2008

Atilla Höfling

Curriculum Vitae

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Biographical Data

Date of Birth: November 14, 1976
Place of Birth: Duisburg, Germany
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Current Position

Research Associate at the University of Würzburg, Department of Social Psychology

Education

since 10 2003	Postgraduate study in social psychology under the direction of Prof. Dr. Fritz Strack at the University of Würzburg
09 2003	Graduation "Diplom-Psychologe" (M.A. equivalent). Grade: 1.6 (Grade AB equivalent) German diploma thesis: "Cognitive and procedural influences on social comparison processes"
1998 - 2003	Undergraduate studies in psychology at the University of Würzburg
1992 - 1996	Secondary school in Würzburg, Germany Grade: 1.9 (Grade B equivalent)
1987 - 1992	Secondary school in Lippstadt, Germany

Research and Education Experience

1999 – 2003	Student Assistant at the Department of Social Psychology, University of Würzburg
2000 – 2003	Several tutorials at the Department of Social Psychology, University of Würzburg

Language Skills

German (mother tongue), fluent in English and French

Publications

Hoefling, A., Likowski, K.U., Deutsch, R., Häfner, M., Seibt, B., Mühlberger, A., Weyers, P., & Strack, F. (in press). When hunger finds no fault with moldy corn: Food deprivation moderates facial disgust reactions towards disgusting foods. *Emotion*.

Hoefling, A., & Strack, F. (2008). The tempting effect of forbidden foods: High calorie content evokes conflicting implicit and explicit evaluations in restrained eaters. *Appetite*, 51, 681-689.

Hoefling, A., Strack, F., & Deutsch, R. (2006). Reflektive und impulsive Determinanten sozialen Verhaltens. In: E.H. Witte (Ed.), *Evolutionäre Sozialpsychologie und automatische Prozesse* (pp. 13 – 31). Lengerich: Pabst.

Würzburg, 08.10.2008

Zusammenfassung

In der vorliegenden Arbeit wurde untersucht, wie sich Nahrungsdeprivation auf nahrungsbezogene Ekelreaktionen auswirkt und welche mentalen Prozesse in diesem Zusammenhang eine Rolle spielen. Hierzu wurden in insgesamt 9 Studien unterschiedliche direkte und indirekte Einstellungsmaße, biologische Maße und auch tatsächliches Essverhalten von hungrigen und sattten Probanden analysiert.

Stand der Forschung

Klassische Ekeltheorien (z.B. Rozin & Fallon, 1987) gehen davon aus, dass Ekel (auch Ekel gegenüber bestimmten Speisen) ein robustes Phänomen ist, welches auf stabilen und gut gelernten Assoziationen beruht. Deshalb wurde bisher angenommen, dass sich höchstens die Bereitschaft eines Individuums verändern sollte, seine Ekelreaktionen zu überwinden (z.B. in extremen Notsituationen), nicht aber die Stärke der eigentlichen Ekelempfindung selbst. Physiologische Bedürfniszustände sollten klassischen Theorien zufolge daher keinen Einfluss auf unmittelbare Ekelreaktionen gegenüber unappetitlichen Speisen und deren Ablehnung haben.

Diese klassische These wurde im Rahmen der vorliegenden Arbeit in Frage gestellt. Frühere Studien belegen beispielsweise, dass hungrige Probanden nicht nur größere Mengen wohlschmeckender Speisen konsumieren als satte Probanden, sondern auch größere Mengen schlecht schmeckender (bitterer) Speisen (z.B. Bellisle, Lucas, Amrani, Le Magnen, 1984; Desor, Maller, & Green, 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968). Bisherige Erklärungsansätze fokussierten jedoch hauptsächlich auf die mögliche Rolle von stoffwechselbedingten Faktoren und physiologischen Veränderungen in der Geschmacksempfindlichkeit (Herman & Polivy, 1984; Jacobs & Sharma, 1969; Nisbett, 1972). Die These, dass obige Befunde auch durch eine spezifische Abnahme nahrungsbezogenen Ekels erklärt werden können, fand bisher jedoch keine Beachtung.

Hauptziele und Hypothesen der vorliegenden Arbeit

Um bisherige Theorien weiter zu differenzieren, sollte in einem ersten Schritt nachgewiesen werden, dass Nahrungsdeprivation nahrungsbezogenen Ekel vermindert (Studie 1 & 2). Es wurde angenommen, dass sich die Intensität nahrungsbezogenen Ekels an den unmittelbaren fazialen Reaktionen von Probanden erkennen lässt und dass hungrige Probanden schwächere Ekelreaktionen gegenüber ekligen Speisen zeigen sollten als satte Probanden.

In einem zweiten Schritt sollte sodann gezeigt werden, dass eine Abnahme nahrungsbezogener Ekelreaktionen auch eine plausible Erklärung für die größere Aufnahme von schlecht schmeckenden Nahrungsmitteln unter hungrigen Probanden darstellt, die in früheren Studien gefunden wurde. Hierzu wurde untersucht, welche Menge an appetitlichen und ekligen Nahrungsmitteln hungrige und satte Probanden tatsächlich konsumieren (Studie 3 & 4).

In einem dritten Schritt sollten verschiedene mentale Mechanismen untersucht werden, die als Erklärung für eine Abnahme nahrungsbezogenen Ekels dienen könnten. In Anlehnung an das Reflektive Impulsive Modell (*RIM*; Strack & Deutsch, 2004) wurde hierbei zwischen impulsiven (bzw. assoziativ vermittelten) und reflektiven (bzw. regelbasierten) Mechanismen unterschieden.

Zum einen wurde überprüft, ob Nahrungsdeprivation automatische Einstellungen (Studie 5 & 6), und unmittelbare Verhaltensbereitschaften (Studie 7 & 8) gegenüber ekligen Speisen verändert (für einen Überblick siehe Hoefling, Strack, & Deutsch, 2006; Strack & Deutsch, 2004). Beide Mechanismen basieren auf der ungerichteten und unwillkürlichen Aktivierungsausbreitung in assoziativen Netzwerken (siehe Anderson, 1976; 1983), die als grundlegender Informationsverarbeitungsmechanismus im Impulsiven System angesehen wird (Strack & Deutsch, 2004).

Zum anderen wurde die These geprüft, dass Nahrungsdeprivation auch über komplexere mentale Prozesse im Reflektiven System (z.B. Kosten-Nutzen-Analysen) eine Auswirkung auf nahrungsbezogene Ekelreaktionen und das menschliche Essverhalten haben kann. Genauer gesagt wurde angenommen, dass Individuen im Rahmen der Nahrungsauswahl die Vor- und Nachteile von bestimmten Speisen auch bewusst gewichten und gegeneinander abwägen. In diesem Zusammenhang wurde zwischen hedonischen Aspekten von Nahrung (z.B. individuelle geschmackliche Vorlieben) und funktionalen Aspekten (z.B. Portionsgröße, unmittelbare Verfügbarkeit) unterschieden. Mittels eines Dominanzpaarvergleichs (Thurstone, 1928) wurde geprüft, ob Nahrungsdeprivation die Gewichtung von hedonischen und funktionalen Nahrungsattributen verändert. Es wurde vermutet, dass hungrige Probanden ihre Nahrungsauswahl stärker an funktionalen Aspekten ausrichten als satte Probanden und nicht von hedonischen Aspekten einer Speise abhängig machen („In der Not frisst der Teufel Fliegen“). Im Folgenden sollen die wichtigsten Ergebnisse der vorliegenden Arbeit im Überblick dargestellt werden.

Kernbefunde der vorliegenden Arbeit

Modulation unmittelbarer Ekelreaktionen. Die These, dass Nahrungsdeprivation unmittelbare Ekelreaktionen gegenüber ekelerregenden Speisen moduliert, konnte in der vorliegenden Arbeit bestätigt werden. In Studie 2 wurden mittels elektromyographischer Ableitung (EMG), die Muskelaktivität des M. Levator Labii erfasst, die als Indikator für die Stärke von unmittelbaren Ekelreaktionen diene. Der Levator ist für ein Anheben der Oberlippe und das ekel-typische „Nase rümpfen“ verantwortlich (z.B. Darwin, 1965; Ekman & Friesen, 1975; Rozin, Lowery, & Ebert, 1994). Frühere Studien belegen zudem, dass die Aktivität des Levators spezifisch mit der Verarbeitung ekelauslösender Reize (z.B. Vrana, 1993, 1994; Yartz & Hawk, 2002) und ekligem Geschmack (Hu, Player, Mcchesney, Dalistan, Tyner & Scozzafava, 1999) in Verbindung steht.

Es wurde herausgefunden, dass hungrige Probanden eine schwächere Levatoraktivierung als satte Probanden zeigten, während sie mit Fotos von ekelerregenden Speisen konfrontiert wurden. Interessanterweise trat dieser Effekt auf, obwohl hungrige Probanden solche Speisen auf reflektiver Ebene genau so negativ beurteilten wie satte Probanden. Dies bestätigt die Annahme, dass Nahrungsdeprivation unmittelbar zu einer Abnahme nahrungsbezogener Ekelreaktionen führt, die sogar unabhängig von bewussten Bewertungen sein kann.

Größere Aufnahme ekelauslösender Speisen. Die Hypothese, dass hungrige Probanden größere Mengen ekelauslösender Speisen konsumieren als satte Probanden wurde ebenfalls bestätigt. Außerdem lieferte die vorliegende Arbeit Hinweise darauf, dass auch die Ergebnisse früherer Studien (z.B. Bellisle, Lucas, Amrani, Le Magnen, 1984; Desor, Maller, & Green, 1977; Hill, 1974; Hill & McCutcheon, 1975; Nisbett, 1968) durch eine Abnahme nahrungsbedingter Ekelreaktionen erklärt werden könnten und nicht ausschließlich durch Veränderungen der Geschmacksempfindlichkeit unter Nahrungsdeprivation bedingt sind. In der vorliegenden Arbeit waren eklige Speisen nämlich nicht bitter, sondern schmeckten genau so gut wie appetitliche Speisen. Vielmehr wurden geschmacklich identische Speisen verwendet, von denen die Hälfte gezielt mit der Emotion Ekel in Verbindung gebracht wurde, indem sie als „Genfood“ gekennzeichnet wurden (vgl. hierzu auch Bredahl, 1999; Grunert, Lähtenmäki, Nielsen, Poulsen, Ueland, & Åström, 2001; Haukenes, 2004; Lähtenmäki, Grunert, Ueland, Åström, Arvola, & Bech-Larsen, 2002; Magnusson & Koivisto Hursti, 2002; Townsend & Campbell, 2004; Subrahmanyam, & Cheng, 2000; Townsend & Campbell, 2004; Winnaker, 1996).

In Studie 3 und 4 wurde gefunden, dass satte Probanden Speisen ablehnten, die als „Genfood“ deklariert waren, während hungrige Probanden diese in uneingeschränktem Ausmaß konsumierten. Dieser Befund kann nicht durch Unterschiede in der Geschmacksempfindlichkeit erklärt werden und legt nahe, dass eine Reduktion

nahrungsbezogener Ekelreaktionen für das Essverhalten von hungrigen Probanden verantwortlich ist. Interessanterweise beurteilten hungrige Probanden genetisch veränderte Lebensmittel genau so negativ wie satte Probanden, konsumierten jedoch größere Mengen davon. Diese Dissoziation zwischen reflektiven Bewertungen und tatsächlichem Verhalten ähnelt der bereits im ersten Abschnitt gefundenen Dissoziation zwischen reflektiven Bewertungen und fazialen Reaktionen und erhärtet somit die Annahme, dass Veränderungen nahrungsbezogenen Ekels unmittelbar auf das Essverhalten wirken können und von bewussten Bewertungen unabhängig sind.

Positivere automatische Einstellungen gegenüber ekligen Speisen. Die Hypothese, dass nahrungsdeprivierte Probanden positivere automatische Einstellungen gegenüber ekligen Speisen haben als satte Probanden, beruht auf früheren Studien, die eine solche Positivierung zumindest für appetitliche oder neutrale Nahrungsreize fanden (z.B. Hoefling & Strack, 2008; Seibt, Häfner, & Deutsch, 2007). Diese Hypothese wurde allerdings nur bedingt bestätigt. In Studie 6 hatten hungrige Probanden zwar sowohl gegenüber appetitlichen, als auch gegenüber ekligen Speisen positivere automatische Bewertungen als satte Probanden, dieser Unterschied verfehlte jedoch knapp statistische Signifikanz. Die beobachtete Tendenz stimmt somit zwar mit den bisher berichteten Kernbefunden und den Hypothesen der vorliegenden Arbeit überein, sollte jedoch nur unter Vorbehalt interpretiert werden.

Stärkere unmittelbare Annäherungstendenzen an eklige Speisen. Die Annahme, dass hungrige Probanden sich auch auf impulsiver Ebene stärker an eklige Speisen annähern sollten als satte Probanden wird durch die gefundenen Ergebnisse gestützt. Im Rahmen einer sog. „Annäherungs-Vermeidungs-Aufgabe“ (AAT; Rinck & Becker, 2007; siehe auch Chen & Bargh, 1999) in Studie 7 wurde gefunden, dass hungrige Probanden tatsächlich stärkere unmittelbare Annäherungsreaktionen an eklige Speisen zeigen als satte Probanden. Letztere differenzierten auch auf impulsiver Ebene stark zwischen appetitlicher und ekliger Nahrung,

während hungrige Probanden sich gleichermaßen an appetitliche und unappetitliche Speisen annäherten.

Unterschiedliche Gewichtung hedonischer und funktionaler Nahrungsattribute. Die Hypothese, dass Nahrungsdeprivation auch die Gewichtung von hedonischen und funktionalen Nahrungsattributen im Reflektiven System verändert, konnte in Studie 9 ebenfalls bestätigt werden. Es zeigte sich, dass individuelle Geschmacksvorlieben tatsächlich unwichtiger für die Nahrungsauswahl von hungrigen Probanden waren, als für die Nahrungsauswahl satter Probanden. Wie erwartet, waren im Gegenzug funktionale Nahrungsaspekte wie Portionsgröße oder unmittelbare zeitliche Verfügbarkeit wichtigere Auswahlkriterien für hungrige Probanden als für satte Probanden. Es scheint also tatsächlich so zu sein, dass hungrige Probanden weniger „wählerisch“ sind als satte Probanden. Die vorliegende Arbeit zeigt darüber hinaus auf, dass die unterschiedliche Gewichtung von hedonischen und funktionalen Nahrungsattributen im Rahmen von bewussten Abwägungsprozessen im Reflektiven System mit für dieses Phänomen verantwortlich ist.

Fazit und Schlussbemerkung

Die vorliegende Arbeit zeigt, dass Nahrungsdeprivation die Stärke von nahrungsbezogenen Ekelreaktionen abschwächt und auch die Bereitschaft von Menschen erhöht, eklige Speisen tatsächlich zu konsumieren. Insbesondere wird aufgezeigt, dass dies auch unabhängig von bewussten Intentionen und Bewertungen geschehen kann, so dass klassische Ekeltheorien (z.B. Rozin & Fallon, 1987) in diesem Punkt ergänzt werden sollten. Die Ergebnisse der vorliegenden Arbeit haben darüber hinaus auch Implikationen für klassische Theorien, die sich mit der Regulation des menschlichen Essverhaltens beschäftigen (z.B. Herman & Polivy, 1984). Bisherige Konzeptualisierungen betonten hauptsächlich die Rolle physiologischer Faktoren, wenn es um die Frage geht, warum hungrige Organismen auch unappetitliche oder schlecht schmeckende Nahrung konsumieren. Erstmals werden in der vorliegenden Arbeit auch die genauen psychologischen Mechanismen beleuchtet, die der

größeren Akzeptanz unattraktiver Nahrung unter akuter Nahrungsdeprivation zugrunde liegen. Die vorliegende Arbeit legt nahe, dass sich in einem Zustand homöostatischer Dysregulation auch die unmittelbaren affektiven und motivationalen Reaktionen gegenüber bedürfnisrelevanten Reizen verändern, und dass es zu einer geringeren Gewichtung von hedonischen Nahrungsmerkmalen im Rahmen von bewussten Abwägungsprozessen kommt.

Durch die Anwendung unterschiedlichster biologischer und sozialpsychologischer Messverfahren war es letztlich möglich, umfassende Erkenntnisse über das Zusammenspiel von Nahrungsdeprivation, nahrungsbezogenem Ekel und menschlichem Essverhalten zu gewinnen, die zu einer Überarbeitung bzw. Ergänzung bisheriger Theorien anregen.