The Ins and Outs of Pleasure

Roles and Importance of Hedonic Value

Kristjan Lääne

A dissertation submitted for the degree of

Doctor of Philosophy

Department of Experimental Psychology

Downing College

University of Cambridge

Cambridge

United Kingdom

Ideas are colourful.

Summary

The focus of this thesis was the hedonic value of stimuli, which is more commonly known as pleasure or positive affect.

First, the scientific meaning of hedonic value was dissected.

Second, a classification identifying core causes of positive affect was created. The classification was derived from specific positive moments reported by individuals throughout a day (collected through experience sampling methodology). Seventeen triggers of positive affect were identified, which were extracted from the data rather than originating from theory.

Third, affective influences on reflexive-like motor responses were investigated using an approach-avoidance task. Contrary to previous studies, approach reaction times were not speeded by highly affective stimuli. Instead, a novel non-emotional effect was found on reaction times, which could directly explain the current results, and those of previous studies, in non-affective terms.

Fourth, the propagation of hedonic reactivity from pleasurable to neutral stimuli was investigated. Contrary to expectations, the evaluative conditioning procedure utilised did

not exhibit a phenomenon called blocking. Instead, 'liking' spread non-selectively to all stimuli co-occurring with the source hedonic stimulus.

Fifth, the positive effect of pleasure on goal-directed motivation was established: participants were found to press a food trigger harder for highly palatable snacks compared to bland snacks, even though participants were not informed about the hidden measurement of forces. Additionally, the impact of hedonic value on actual food intake was quantified with best-fit equations that predicted consumption at both the group and individual level.

In the last study, hedonic habituation, or the inhibitory effect of pleasure on itself, was demonstrated: eating pleasant snacks, as compared to bland ones, reduced the hedonic ratings of test foods that were consumed afterwards.

Finally, these inputs and outputs of hedonics were integrated into a model specifying principal roles of pleasure in human behaviour. This pleasure-incentive model explains the effects of pleasure on incentive motivation, and makes important predictions about the mechanisms of pathological conditions such as over-eating and drug addiction.

Preface

The following work was carried out at the Department of Experimental Psychology, University of Cambridge, under the supervision of Professor Anthony Dickinson, FRS.

Correspondence concerning this dissertation should be addressed to Kristjan Laane at K.Laane@psychol.cam.ac.uk

I hereby declare that this dissertation has not been submitted, in whole or in part, for any other degree, diploma or qualification at any other University. This dissertation is the result of my own work.

This dissertation does not exceed the limit of length specified by the Degree Committee, as stated in the Memorandum to Graduate Students.

Please cite this thesis as follows:

Laane, K. (2011). *The ins and outs of pleasure: Roles and importance of hedonic value*. Doctoral dissertation, University of Cambridge, Cambridge, United Kingdom.

Acknowledgements

Foremost, I would like to thank Tony Dickinson, for guidance and feedback extraordinaire; you are the best doctoral supervisor I could have ever wished.

I am also indebted for the support from Jeff Dalley, for my entrance into the psychological sciences, prior to my PhD.

The countless discussions with Balázs Aczél and Jamie Brown have directly and indirectly influenced my thought synthesised into this work and I could not imagine my years in Cambridge otherwise. Similarly, the initiation and execution of this '*grand plan*' would have not taken place without the inspiring collaborations with Allan-Hermann Pool.

I thank Sophie Williams and my family, Sulev, Anu, Erik and Martin Lääne, for enabling a balanced life without which a long-term project like this would have at best been more '*pain*' than pleasure. I would also like to highlight the backing from Melissa Wood, Simon Goldman, Sietse Jonkman, Clare Palmer and Lara Maister.

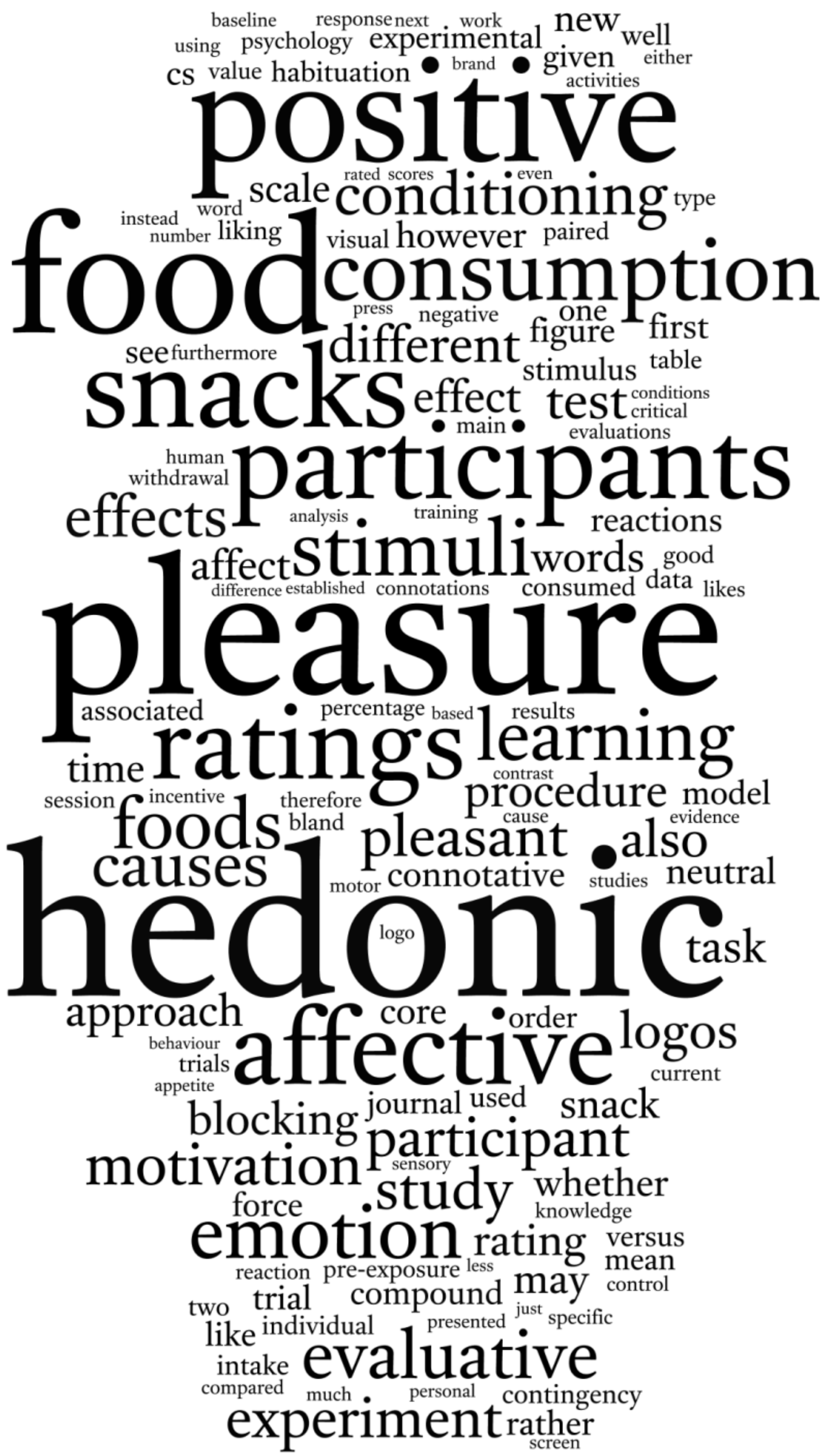
I am truly obliged to Martin Yeomans and Barney Dunn for taking the time and effort to examine this thesis.

Mare Teichmann, Paul Fletcher, Sanne de Wit, Sadaf Farooqi, Luke Clark, Barry Everitt, Trevor Robbins, Mark Haggard, Rudolf Cardinal, Mike Aitken, Julian Gardiner, Graeme Fairchild, Emily Murphy and a large number of other individuals contributed significantly to this thesis, I honour your input.

Finally, I am grateful for the existence and provision of the larger structures, of Department of Experimental Psychology, University of Cambridge, Republic of Estonia, European Union, and the Internet.

Table of Contents

Figures and Tables


baseline
response
next
work
new
well
using
psychology
experimental
cs
value
habituation
brand
given
either
activities
positive
rated
scores
even
scale
conditioning
type
instead
word
number
liking
visual
however
paired
food
consumption
press
negative
one
first
see
furthermore
different
figure
stimulus
table
snacks
effect
test
conditions
critical
main
evaluations
human
withdrawal
participants
effects
analysis
training
reactions
affect
stimuli
words
good
difference
established
connotations
consumed
data
likes
pleasure
associated
percentage
based
results
ratings
learning
time
contrast
session
incentive
therefore
procedure
model
foods
bland
cause
evidence
pleasant
also
causes
connotative
neutral
motor
studies
hedonic
logo
task
approach
core
order
logos
behaviour
affective
trials
appetite
current
journal
used
snack
blocking
participant
motivation
sensory
study
whether
force
knowledge
emotion
rating
versus
reaction
pre-exposure
less
mean
may
two
trial
compound
control
just
specific
like
individual
presented
intake
evaluative
compared
much
personal
contingency
experiment
rather
screen

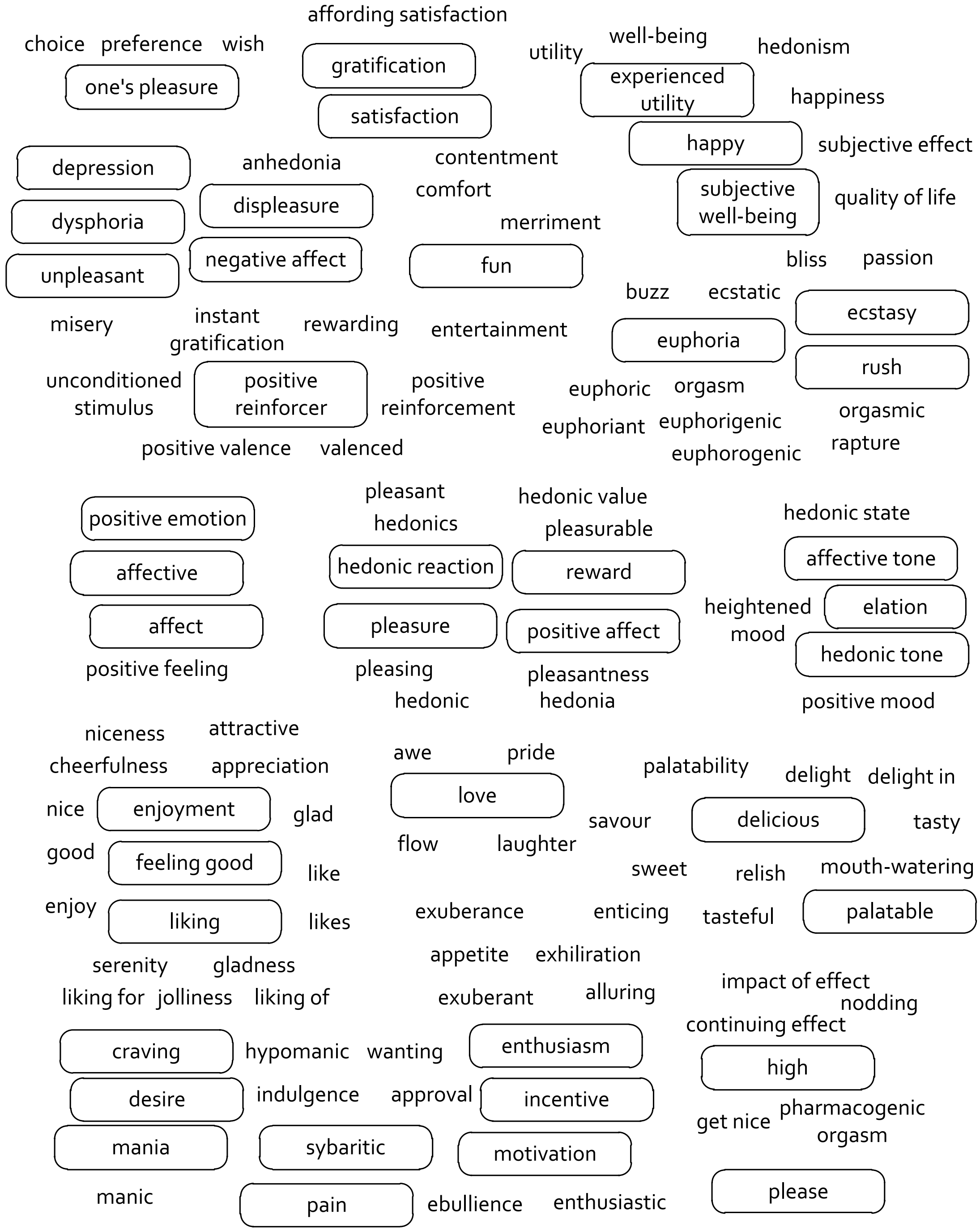
I. What is Pleasure?

The focal point or object of study for this synthesis was pleasure. But what is pleasure? This question is similar in form to asking what any unknown concept is e.g. who is a Martian? To understand who a Martian is, it would help to come across a few Martians, as well as to know what they and their relatives are called. Furthermore, it would be helpful to know something about their '*genetic*' makeup or essence, as well as to learn about their characteristic external features. Last, but not least, we would also need to know how a Martian interacts with the world, what influences it and what it influences, in order to fully grasp the meaning of who, or what, a Martian is. I will adopt similar approaches in order to understand what pleasure is: first I will define pleasure by examples (seeing a few Martians); then I will present a set of synonyms and terms related to pleasure, as a linguistic approach to conveying meaning (learning what the Martians and their relatives are called); third I will attempt a core working definition by identifying necessary criteria for the concept of *pleasure* (their essence); followed by an operational definition that would allow experimental identification of the construct (characteristic looks). Finally, I will describe what processes act upon pleasure or what effects pleasure has on other faculties of the human mind (interactions and influences). The latter will not only help to define what pleasure is, but will also highlight the importance of pleasure in general, through the roles it plays in human behaviour.

Examples and Cognates

Supreme Court Justice Potter Stewart once famously said, when trying to define the concept of pornography, "*I can't define it, but I know when I see it*" (Jacobellis v. Ohio, 1964). In a similar vein, I will first illustrate what pleasure is by pointing to its instances (ostensive definition). Pleasure occurs when eating ice-cream, especially if it is a hot day and you are hungry; pleasure abounds in fun games or sport; we enjoy a good joke; if we expect it to be a rainy day and it is sunny instead, we are happy; when someone praises our good work, we become cheerful; passing an examination with flying colours yields joy; pleasure peaks during orgasm; euphoria rushes through the brain seconds after snorting cocaine; and we mustn't forget breath-taking landscapes and many works of art and so on. A complementary way of understanding what pleasure means is to inspect the different names given to the concept, as well as to related terms. *Figure* 1 presents a compendium of such labels that should highlight the implicit shared meanings of words related to pleasure, and in so doing emphasises the similarities and differences between these representations (see Perry, 1967 for explicit semantic analysis of the pleasure lexicon).

Fig 1. Concepts Related to Pleasure



The figure presents clusters of words that share characteristics with pleasure, while also possessing more or less nuanced differences from pleasure. The existence of such distinct, but closely related labels helps to highlight and pinpoint the meaning of what pleasure is.

The Core of Pleasure

Defining pleasure through examples and listing clusters of related concepts are useful ways of conveying meaning, but a full definition would be lacking without a more formal scientific definition of pleasure. Before dwelling further, however, I acknowledge that the literature review is highly selective here, so as to allow us to focus on the core of pleasure. Further reading on the topics are provided by e.g. Beebe-Center (1965), Frijda (2001), Kahneman, Diener and Schwarz (2003), Snyder and Lopez (2002), Katz (2006), Kringelbach and Berridge (2010), and Russell (2003b). In attempting a core working definition, we need to know what such a definition is and what it gives us, in other words, why it is worth specifying a core working definition of pleasure. For our purposes, core definitions specify a set of necessary conditions (‘*must have or be*’) that together should be sufficient to identify the concept. Having such a specification caters for an explicitly shared understanding, so that we would not talk at crossed purposes, which would lead to long-standing, often undetected confusions and other avoidable inhibitions on scientific progress. Additionally, by having explicit core definitions, these specifications can then be tested and improved to provide meaningful explanations and predictions of real-world phenomena. That is, scientific process does not endeavour to create just any arbitrary concepts, but ones that summarise observations accurately as part of the conceptual framework of the system of interest, which is the human mind for psychological investigations (Hempel, 1952). In summary, we are looking for a set of conditions that anything we wish to call *pleasure* must satisfy, so as to explicate a variable that most closely models the instances of that component in the observable world, instead of providing another '*red herring'* to filter out of our field.

Firstly, is the state of mind which we refer to as *pleasure* a continuous variable or a categorical variable? A multitude of psychophysical tests suggest that *pleasure* does not exist as discrete non-comparable categories, but that *pleasure* comes in comparable portions on a continuous interval magnitude scale (e.g. Cabanac, 1979; Cabanac & Ferber, 1987; Engen & McBurney, 1964; Rashdall, 1899). Furthermore, *pleasure* may even possess ratio properties i.e. have a true zero point (see magnitude estimation in Cardello & Schutz, 2006). To qualify, being a continuous variable does not mean that there are no biases in the measurement of pleasure - there are - but such issues are separate matters to the fundamental nature of the variable. So the first necessary condition for *pleasure* is that it is a state of mind that is a continuous quantity rather than being incommensurable[a].

I turn next to the debate surrounding conscious versus subconscious *pleasure* (or whether subconscious pleasure is an oxymoron). Firstly, by conscious, I mean first-order phenomenal consciousness, not second-order consciousness or self-awareness (for terminology see e.g. Block, 1995; Morin, 2006). I subscribe to two answers: A) *Pleasure* can be subconscious, because the effects of *pleasure* appear to be present in situations where *pleasure* is too weak to be verbalisable (e.g. Berridge, Robinson, & Aldridge, 2009) or when subjects are distracted by other strong stimuli that, so to speak, '*push the*

[a] Impossible to compare / lacking a common quality on which to make a comparison.

pleasure out of consciousness' (e.g. Di Lollo, Enns, & Rensink, 2000; Franklin, 2005). B) In parallel, a relationship holds with the magnitude of *pleasure* and consciousness of *pleasure*, such that the stronger the *pleasure* the more likely it is to be conscious (e.g. Hobson, 1997; Taylor, 1996). Therefore, the vast majority of ecologically interesting everyday *pleasures* are strong enough to be conscious *pleasures* e.g. who would not notice when food tastes delicious. Additionally, subconscious *pleasures* may have too weak effects to play an important role outside of the laboratory, although this claim needs empirical validation. Consequently, on the basis of both premises or at least the first premise, making the subconscious versus conscious *pleasure* distinction may have little functional relevance to the core definition of *pleasure*. The second necessary condition, then, is that all but the weakest of *pleasures* enter phenomenal consciousness.

I shall turn next to the question of whether pleasure has intrinsic value in the minds of the human species. I, and many others, think that it does. The intrinsic part just means that *pleasure* comes with this property rather than something extrinsically attaching this property to *pleasure* i.e. intrinsic value is at the core of *pleasure* and *pleasure* would not exist without it. There are many ways of expressing the (intrinsic) value part, e.g. "*During pleasure - that is, during unmitigated pleasure - things are good as they are*" (Frijda, 2007, p. 69); "*pleasure and pain are unconditional, intrinsic values: in all times and places, cross-culturally and throughout the sentient realm, every pleasure is good and every pain bad in itself*" (Goldstein, 1989, p. 257) or as Epicurus explained "*εὐδαιμονίαν, εἴπερ παρούσης μὲν αὐτῆς πάντα ἔχομεν*" ("*seeing that when happiness is present, we have everything*"; "Epicurus, Letter to Menoeceus 122," n.d.). This is not a behavioural statement, saying that people are motivated to seek pleasure (and to avoid pain; Smuts, 2010), although pleasure does have such effects on behaviour, as we will see later. Introspection, though fallible, may be the only appropriate kind of evidence available to support the statement that being in this state is continually gratifying in itself (Rachels, 2000). Examples of instances in which the physical signals of bodily damage are detached from intrinsically *bad* pain feelings may help to make the case: "*surgeons used to give their patients whisky before operations; as anybody may verify, this does not diminish substantially the intensity of the pain-sensation, but may make it a great deal easier to bear*" (Hare, 1972, p. 88); such a dissociative phenomenon is even more pronounced under modern anaesthesia (C. R. Chapman, 1996). Furthermore, a rare condition exists called *Congenital Indifference to Pain*, in which the physical sensation of pain is intact, but the aversive (nature of) pain is absent from birth (Krafte & Bannon, 2008), akin to seeing sirens of an ambulance flashing, but without the strongly unpleasant feeling from the loud noise that normally co-occurs with the sirens. As the third necessary condition then, for *pleasures* that are privy to consciousness, *pleasure* has the subjective quality of being intrinsically *good*, equivalent to pain consisting of intrinsically *aversive* qualia.

What is the relation of *pleasure* to hedonic tone or mood? When talking about *pleasure* we primarily refer to the momentary hedonic reactions to specific stimuli, but this does not mean that *pleasure* is necessarily always stimulus-locked and fleeting: instead, *pleasure* can also be objectless (or non-intentional in philosophers' jargon) and last for more than minutes or hours. This background or baseline hedonic tone, even though it has a relatively low magnitude level, or is almost neutral for most people, is still the same psychological kind as the more conspicuous but short-lived peaks of *pleasure* (Watson, 2000). This position is thoroughly substantiated by Russell (2003a), and he chooses to call pleasure *core affect* in order to emphasise that point. As more intuitively obvious examples of the background hedonic tone being a longer-lasting instance of *pleasure*, consider the prolonged high of 2-14 hours derived from methamphetamine (Mayfield, 1973), or even more extremely, the minimum period for diagnosing hypomania in bipolar disorder being 4 days (American Psychiatric Association, 2000). Further, this unification of the peaks and the baseline highlights that *pleasure* is strictly speaking not a property of a stimulus: instead, *hedonic value* is a property of a stimulus that refers to the capability of the stimulus to elicit a *hedonic reaction* or *pleasure*. As the fourth condition for *pleasure*, *pleasure* constitutes not only the fluctuating peaks but also the ever-present baseline *pleasure*, on top of which those transient signals vary.

I deal next with the bipolarity of *pleasure* i.e. the presence of negative magnitudes on the *pleasure* dimension and what that negative represents. To begin with, pain is not the negative extreme on the scale of *pleasure*, even though common expression - *pleasure and pain* - suggests otherwise: pain is a different dimension and is an antonym of *pleasure* only in the sense of constituting *aversive* rather than *good* qualia, as described above (Hunt & Koltzenburg, 2005). If anything, depression is a state in which baseline core affect has dropped below zero (Lorr, Mcnair, & Fisher, 1982). Such a conceptualisation provides further evidence for a true zero point in that both long-lasting and short-lasting dips into the negative co-occur with a corresponding flip in qualia from *good* to *bad*. This bipolarity makes the *pleasure* criterion of intrinsically *good* qualia conditional on the magnitude or sign of *pleasure*. Whether you agree with such a bipolar one-dimensional nature of *pleasure*, however, is not of high impact here as I primarily scope the positive / intrinsically *good* side of *pleasure* in this thesis.

Thereafter, I list two critical negations ('*must not have or be*') in order to ensure that *pleasure* is not confused with important related, but distinct concepts. I start with *pleasure* as emotion. *Pleasure* with its effects and concomitants, such as arousal, action tendencies, bodily reactions, cognitive appraisals, may qualify as a fully-fledged emotion, but the core concept on its own is not an emotion (Scherer, 2005). As such, *pleasure* is not equated with action tendencies or arousal or sensations or other individual components of emotion (or their combinations), except for the subjective feeling component, which may be identical to *pleasure* in the case of positive emotions (Russell & Barrett, 1999). The identification of pleasure as a separate identity to the other components of positive emotion does not mean, of course, that the components do not occur together. Normally, pleasure, arousal, action tendencies and many other phenomena do occur together, albeit at different levels of activation depending on the emotional episode. I.e. the experience or state of *pleasure* can be identified as a separable, but integral component of positive emotions. Also, the separation of *pleasure* from appraisals and so on is not to be confused with what causes *pleasure*: *pleasure* can indeed be caused by appraisals, for instance, but the causation of *pleasure* is a different matter to the core experience of *pleasure*, which does not equal to appraisal etc. Furthermore, the '*heterogeneity problem*' (Mason, 2007) needs to be dealt with here:

obviously, sexual pleasure is a different beast to pleasure resulting from completing a work task i.e. no doubt a lot of things are different across these situations such as different causes of the pleasures, different thoughts, levels of arousal etc. But according to the core affect position, one of the fundamental components is the same across all these instances, *pleasure* (Smuts, 2010); although I, of course, remain open to the possibility that *pleasure* may need to be subdivided into multiple core kinds that are fundamentally different under these different circumstances. So *pleasure* is not an emotion on its own, but a key part of all positive emotions, if not the thing that makes the positive emotions positive.

Secondly, is *pleasure* the same as desire, incentive, motivation, craving, appetite? No. This distinction has been advocated by many people and in many forms, one of them being the liking and wanting distinction (e.g. Berridge, 2004; Dai, Brendl, & Ariely, 2010): in short, liking is intrinsically *good*, but does not directly motivate behaviour, whereas wanting is not intrinsically *good*, while it does influence behaviour directly. In fact, *liking* appears to influence behaviour indirectly through *wanting*, mediated by a process called incentive learning (Dickinson & Balleine, 2002), but more about that under the effects of *pleasure*. In terms of language, however, liking and wanting (or *pleasure* and incentive) are often grouped together and when I do not distinguish between them, I use the word *affective*. I conclude the core definition of *pleasure* by stating that *pleasure* is an entity distinct from incentive.

Measuring Pleasure

Now that we know the nature of the object of study (*pleasure*), we need to find an actual way to identify the entity in the observable world: we need an operational definition of *pleasure*. Before proceeding, however, I point out the concentrated nature of the following synthesis, for a broader context please refer to Hein and colleagues (2008), Kahneman and colleagues (2003), and Parducci (1995), for example.

Currently, the best measure available for *pleasure* is affective self-report. Asking people how good they feel during events of interest surely has both pros and cons, as do all experimental techniques. On the limitations side, evaluative ratings are subject to a multitude of confounding influences with respect to its use as an instrument of *pleasure*: expectation biases and cognitive categorisation effects, potential attitude, misattribution and social desirability biases, sensitivity to incentive/desire not just *pleasure* and so on (Kuznicki, Johnson, & Rutkiewic, 1982; Larsen & Fredrickson, 2003). The key advantages of event-contingent affective self-report on the other hand are that it is sensitive to *pleasure* or the *goodness* of feeling, in fact it may be the only currently available tool capable of capturing such personal subjective experiences (Tiffany, Carter, & Singleton, 2000). Furthermore, except for the weakest subconscious *pleasures*, it appears that all the necessary features for *pleasure* can be assimilated with an appropriate hedonic rating scale, such as the *Labelled Affective Magnitude* scale (*LAM*; Schutz & Cardello, 2001): that is to say, *pleasure* can be identified as a continuous bipolar conscious variable that is intrinsically *good* on the positive pole of the dimension. In terms of using the *LAM* scale rather than any other self-report instrument as the pleasure measure, its merits include using semantic labels - e.g. *Like Very Much*, *Like Extremely* – rather than having solely numbers on the scale, allowing for more absolute judgments to be made that are more comparable than the more relative judgments provoked by purely numbered scales (Nicolas, Marquilly, & O'Mahony, 2010). Another virtue of *LAM* arises from the positioning of these semantic labels with respect to the numbers, such that they are non-aligned to the numbers, placed according to the anchoring that is empirically derived using the *magnitude estimation technique* (Schutz & Cardello, 2001). That is, the conventional meaning of a phrase such as *Like Moderately* does not necessarily correspond exactly to 30, 40, 50 or 60 on a 100 point scale, the shared meaning of *Like Moderately* is instead found to map to 36 on the *LAM* scale (Cardello & Schutz, 2004). Raw estimates from magnitude estimation are generally not normally distributed, however, but this problem was corrected in the development of the *LAM* scale with a normalisation procedure with geometric means (see p. 123 in Schutz & Cardello, 2001). As a downside to the *LAM* scale there tends to be clustering of ratings around the semantic anchors.

You are now probably thinking that it would be great, if not critical, to use non-self-report / behavioural / physiological measures of *pleasure*, and I agree, it would be very useful to complement self-report ratings with other types of measures that are not confounded by the same factors as self-report. Unfortunately, we do not currently have alternative measures that have been properly validated in terms of being discriminably sensitive to the key necessary characteristics of *pleasure*. Measures such as *facial* *electromyography* (*fEMG*; Hu & McChesney, 1999; Huang, Chen, & Chung, 2004) or *affective priming* (Fazio, 2001; Ferrand, Ric, & Augustinova, 2006) show promise, but they have not been properly tested in prototypically pleasurable situations, such as when eating delicious foods, taking euphorigenic drugs or even during sexual stimulation. For instance, *fEMG* signals were found to correlate with the unpleasantness / pleasantness of different drinks (Hu et al., 1999), but it is not known how much of that sensitivity originated from the unpleasant / disgust reactions rather than the positive pleasurable properties of the flavours; in addition, it is not known whether fEMG is sensitive to strong obvious pleasures from other sources such as highly euphoric drugs, which evaluative self-report is sensitive to. The bottom line is that it is currently unclear whether such techniques really measure hedonic properties as opposed to being sensitive to aspects of negative emotion instead or to arousal, familiarity or similar (Degner, Wentura, & Rothermund, 2006). In conclusion, as long as care is taken to minimize the main confounds by using appropriate designs and analyses, then non-retrospective affective ratings stand as the current best operational definition of *pleasure*, until complementary non-self-report methods are properly validated.

Pleasure as a Function

Now that we have a core working definition and an operational definition for *pleasure*, let us delve into what *pleasure* does. That is, the remainder of this work will deal with the ins and outs of *pleasure*, so that this entity could be put on a map and made functional through specifying its roles in the human mind and behaviour. Furthermore, knowledge about its effects, and the circumstances when those effects arise, allows us to learn about the importance of *pleasure*, in terms of its significance in the everyday and clinical realms. We start by identifying when pleasure occurs, in the following chapter, by creating an empirical classification of all the different core inputs capable of triggering positive affect. Then we study what one might call the most basic influence affect might have, which is the effect of affect on fast, reflexive-like approach and withdrawal reactions. In the third empirical chapter we explore the development of new likes, or what pleasure does to neutral stimuli co-occurring with the hedonic reactions. Next, we describe perhaps the most important effects that pleasure produces: the impact of pleasure on incentive motivation and on actual choices / consumption. The fifth experimental chapter investigates whether pleasure inhibits itself, by examining whether hedonic habituation occurs with foods. The last concluding chapter attempts to bring all these disparate findings together to form a bigger picture that specifies an integrated model of the important roles of pleasure in our minds and behaviour. This framework is then applied to determine the significance of pleasure in everyday life, as well as the importance of pleasure to some compulsions entailing excessive consumption.

II. Causes of Positive Emotion

Cakes, spreadsheets, colleagues and clocks, what do they have in common? You are likely to enjoy the taste of a piece of cake, finishing your work on a spreadsheet will elicit a positive feeling, your colleagues might lift your mood through praise and you might be positively relieved after meeting a stressful deadline. These examples illustrate the key aim of this study, which was to identify what are the core causes of positive emotion at the workplace. To clarify, by core causes we do not mean a list of objects, like cakes or spreadsheets, that are sometimes involved in eliciting positive emotion, and nor do we mean activities that are sometimes pleasant, such as eating or entering data, as being the core causes. Instead, our aim was to identify primary and separable core triggers: not, therefore, the finishing of data-entry on your spreadsheet per se, but the perception of the achievement of a desired state of affairs, which is directly responsible for causing positive emotion, plus many other core causes of positive emotion.

Although a number of studies have investigated the sources of positive emotions at work, the aims of such studies have not been to identify the core causes of positive emotion. Rather than seeking to identify a full classification of primary triggers that directly mediate the causation of positive emotion, existing works have mostly focused on a small set of secondary causes of positive emotion. The following types of secondary causes of positive emotion have been studied: positive activities, such as interacting with customers or involvement in planning (e.g. Basch & Fisher, 2000); job features, such as difficulty of work tasks (e.g. Saavedra & Kwun, 2000); personal states and traits, such as level of interest (e.g. Fisher & Noble, 2004); broad collective categories, such as acts of co-workers (Miner, Glomb, & Hulin, 2005); and many other types of important secondary triggers of positive emotion (e.g. Kanis, Brinkman, & Perry, 2009; Shraga & Shirom, 2009). In some cases, core causes of positive emotion have indeed been studied, but then focusing on only a few core candidates rather than trying to establish a full classification e.g. investigations of the effect of perceptions of goal progress or achievement on positive emotion (Alliger & Williams, 1993; Basch & Fisher, 2000; Goetz, Frenzel, Stoeger, & Hall, 2010). By contrast, establishing a full classification of core causes that directly elicit positive emotion has not, to our knowledge, received experimental attention.

Experience sampling methodology (*ESM*) is a fit method for studying everyday experience. Assessing positive emotion prospectively near the time the events actually occur provides more accurate measurements than retrospective interview or survey techniques, thanks to limiting recall and integration biases involved in retrieving information from the more distant memories (Reis & Gable, 2000). Another classic advantage of *ESM* is its ability to study the phenomena of interest in their natural context, at least in comparison to the other methods available. Furthermore, *experience sampling* has previously been employed for the study of positive affect showcasing its use for our purposes (e.g. Kashdan, Uswatte, & Julian, 2006; Peeters, Nicolson, Berkhof, Delespaul, & deVries, 2003).

In order to identify what are the core causes of positive emotion at the workplace, office-workers were instructed to keep open an online form. Whenever the office-workers experienced positive emotion, they were asked to fill in and submit a detailed description of what was happening when they felt good. The reports collected using this *experience sampling methodology* were then thematically analysed using a qualitative factor analysis technique. Applying this *Critical Incident Technique* (*CIT*; Bitner, Booms, & Tetreault, 1990; Flanagan, 1954) enabled the extraction of elements common to the positive emotion experiences recorded by the participants and resulted in an empirical classification of causes of positive emotion. These different types of core causes of emotion that were derived from the data (*Table 1*) plus associated quantitative hedonic ratings that were also taken (*Figure* 2), constituted the main results of the study.

Experience Sampling Experiment

Participants, Apparatus and Stimuli

Sample. 84 office-based workers (49 female), mean age 33.3 years (SD = 9.7), were included in this experiment. The occupations of the participants were primarily project manager, lecturer, engineer and lead administrator. Recruitment took place through employers who were members of an Estonian cross-organizational e-mail list and who passed the study advert on to their employees. We do not know the response rate i.e. how many individuals signed up compared to how many were approached. The participants received an invitation linking to a web-based recruitment questionnaire at http://tinyurl.com/ESstudy that served as a common introduction to the study (the link provides an English translation of the distributed Estonian web-page). The sample size was not pre-set beforehand, but was set by demand by way of how many volunteers signed up during our recruitment period. The achieved sample size appears to be satisfactory to detect differences for a large effect in the hedonic ratings associated with the different pleasure categories (with power .8; see *Figure* 2), for which approximately 30 participants would have been needed. We specified a large (f = 0.4) effect rather than a medium or small effect, because, at least initially, only substantial differences in the quantitative hedonic profiles are of interest, rather than spending resources to detect small differences that may have little real-world relevance or applicability. Recruits received no monetary compensation for participation in a full work-day session. The study was carried out according to the local ethical regulations in Estonia.

Experimental Setup. Participants were tested in their normal office environments with the help of their own office computers. Participants kept an online form open throughout the study day (http://tinyurl.com/ESform) and were instructed to fill in the form whenever they felt positive emotion on that day. Workdays lasted from about 0800 to 1700.

Stimuli and Scales. Participants were provided with a text box to enter full descriptive details about what was happening when they felt good (see http://tinyurl.com/ESform). To provide quantitative evaluative ratings, positive feelings were rated on a digital version of the *Labelled Affective Magnitude* (*LAM*) scale (Schutz & Cardello, 2001). The *LAM* scale is a Visual Analogue Scale (VAS) that displays the following positive semantic anchors: like extremely; like very much; like moderately; like slightly; neither like or dislike. The positioning of the labels is not uniform on the

LAM scale, however, but has been derived through magnitude estimation to yield ratio properties (for further details see Cardello & Schutz, 2004).

Procedure

On the morning of the study day, the participants opened the introduction page (http://tinyurl.com/ESstudy), where the procedure for the rest of the day was fully explained (see *Appendix A*). The most important instructions were, firstly: *"We ask you to enter the positive events as soon as possible after they occur, and to make sure you fill in the main questionnaire at least once every hour."* and *"… you might enter something like "I finished filing the documents" or "my colleague said my Excel table looks good". Note that we ask you to enter all positive events in the workplace, which includes things like having a chat with a friend about shopping or reading an anecdote online etc. Additionally, please make sure to enter events associated with weak feelings, we are just as interested when you feel slightly good as we are interested when you feel extremely good."* Secondly: "*Use the scale (2) to indicate how much you liked the moment you described in 1). In doing so, please do not use only the numbers on the scale, but read the text labels as well e.g. Like Moderately. And note that the text labels are supposed to be non-aligned with the numbers.*" Before opening the main study form, we emphasised the anonymity of taking part and asked the participants to provide a couple of demographic variables such as gender and age. Participants then proceeded onto the main study form (http://tinyurl.com/ESform), which they were instructed to keep open for the duration of the day. Whenever a positive feeling occurred during the work-day, the participants were asked to fill in and submit the form, which consisted of the aforementioned text box to describe what exactly the participant was doing when the positive emotion occurred and which consisted of the aforementioned *LAM* scale to quantify how good the participant felt. The participants carried through with the learned procedure of filling in the main form as soon as possible after any positive event occurred, until the evening. Before leaving work, the participants filled in a final questionnaire (http://tinyurl.com/ESfinish) that asked for general feedback on the study.

Data Analysis. In order to derive core categories from the 438 positive event reports received and reveal a list of data-based core causes of positive emotion, we used *Critical Incident Technique* (CIT; Bitner et al., 1990; Flanagan, 1954). The key steps in this qualitative analysis technique were firstly to define the nature of the categories to be extracted, which was chosen by design as core causes of positive emotion. Next, critical incidents were identified by filtering out any reports that did not fulfil the following criteria: incident was rated above zero on *LAM* scale; incident was a discrete event, not a fact etc; incident happened to the respondent, not to some other individual; respondent provided detailed enough description relating to the source of positive emotion. After identifying the critical incidents, we processed these reports by abstracting the meaning of the core words of each report. If a report contained more than one candidate cause of positive emotion, we selected the first one mentioned in the text.

After these tentative categories were established, brief definitions were made of the cause categories that had surfaced (*Table 1* in *Results* section). When formulating the criteria that made up the cause definitions, the following question was considered in order to confirm that the grouping of reports was according to the associated core causes of positive emotion: What features or attributes of these events are most critical for triggering this type of positive emotion; or in other words, what qualities or patterns does this affective process recognize? Finally, the categories were reviewed to further ensure that the causes that surfaced were as separable and non-overlapping as possible. The procedure was carried out by two researchers with iterative discussions allowed after report categorization. As a separate analysis, the reports were classified according to which type of activity they primarily involved: for example, reading or talking. In order to map reports to specific activities, we utilised a modified version of a taxonomy of activities called *Alternative Classification of Time Use Activities* (*ACTUA*; Hoffmann & Mata, 1998). All quantitative analyses were carried out using Microsoft Excel 2010, R software (version 2.10.1; http://www.r-project.org/) and PASW 18 packages.

Results

In order to build a classification of core causes of positive emotion, we analysed the positive event reports written by office-workers and extracted the common elements from these reports using *Critical Incident Technique*. As specified in *Table 1*, we identified 17 separable triggers for eliciting positive emotion. The different ways by which positive emotions were induced were *Attachment*, *Auditory Aesthetics*, *Euphorigenic Drugs*, *Eureka*, *Fulfilled Expectations*, *Humour*, *Improvement*, *Joy of Others*, *Knowledge Gain*, *Liquid*, *Pleasant Cues*, *Positive Self-Image*, *Relief*, *Synchrony with Others*, *Tastes and Smells*, *Temperature Normalization* and *Visual Aesthetics*. The meanings of these labels are detailed in *Table 1*.

Table 1. Core Causes at the Workplace

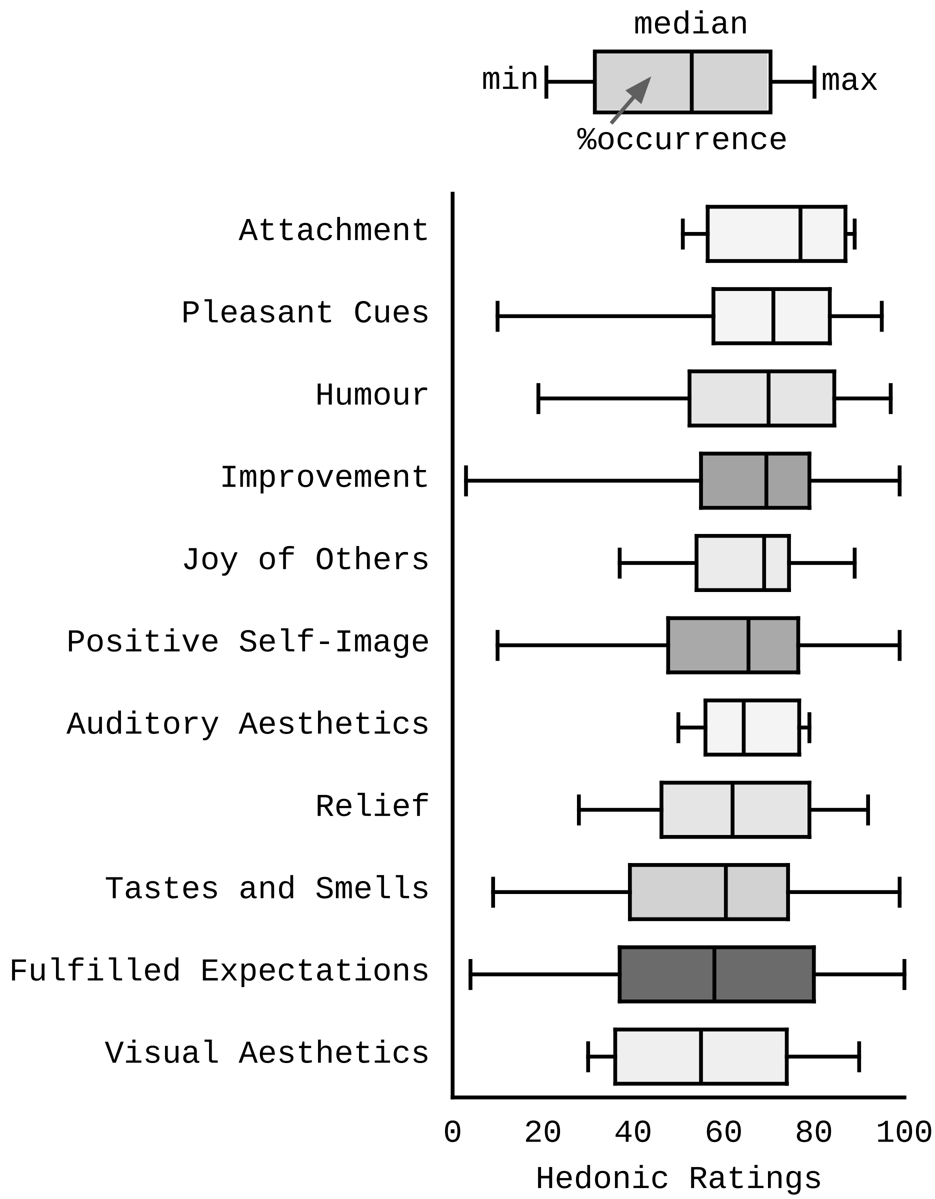
Cause Name	**Characterization of the Cause Derived From Data**	**Specific Examples**
Attachment	When: participant feels good about an individual, e.g. friend, family, lover or pet, for whom the participant holds long-term stable affection.	A friend called me who I had not heard from for a long time.
Auditory Aesthetics	When: participant enjoys the melody and rhythm of an auditory stimulus.	I listened to my favourite song on the radio.
Euphorigenic Drugs	When: experience involves pharmacological substances, which induce pleasure by acting directly on the central nervous system.	I had my morning cigarette; I took a breath of fresh air.
Eureka	When: the reported experience involves discovery of a connection. And when: that connection perceived to explain a puzzle or perfectly fill a gap.	I suddenly thought of a perfect solution to my software bug!
Fulfilled Expectations	When: an expectation or goal, that has previously been set, is met or exceeded.	The results of my experiment turned out as I expected, perhaps even slightly better than I expected.
Humour	When: experience incorporates recognition of an unusual pattern. And when: that recognition leads to amusement or laughter.	What do you call a penguin in the Sahara Desert? Lost.

Improvement	When: circumstances are subjectively perceived to change from worse to better. And when: goals or expectations relevant to the circumstance were not set beforehand.	I noticed they had fixed the road.
Joy of Others	When: expressions of joy are sensed.	I saw a baby smile on the street; I saw that my son was happy.
Knowledge Gain	When: gaining knowledge that you care about or that you can apply.	I learned of a technical nuance about the resistors we use.
Liquid	When: liquidness of a drink is sensed.	I drank water.
Pleasant Cues	When: memories or sensory stimuli are activated that have become capable of eliciting positive emotion on their own through past association with positive affect.	The characteristic smell from my summer cottage made me feel very good.
Positive Self-Image	When: a situation is perceived to reflect well on self.	My boss praised me.
Relief	When: negative affect diminishes.	After I had finished giving my stressful presentation, I felt extremely good.
Synchrony with Others	When: participant realises that another person is thinking or feeling similarly to the participant.	I realised we think and feel the same way about a TV program that aired yesterday.
Tastes and Smells	When: experience involves gustatory flavours i.e. food taste, smell or oral texture.	I ate a chocolate bar.
Temperature Normalization	When: sense warmth while body is cold or cold while body is too warm.	I enjoyed the warm water flowing over my cold hands.
Visual Aesthetics	When: participant enjoys a visual stimulus.	I saw a picture of a particularly pleasing landscape.

In deriving the causes of positive emotion from the data, we also established inter-rater reliability: this was assessed as number of agreements over total number of reports. A native Estonian speaker, previously not involved with the study, was provided with unidentified data and the categories in *Table 1*, so that she could independently categorize the reports. No additional information was provided. An agreement was counted whenever the raters assigned a given report to the same core cause category; otherwise a disagreement was counted. *Joint probability of agreement* was then calculated as number of agreements over number of disagreements + agreements (Miles & Huberman, 1994). Inter-rater agreement was satisfactory, at 68%, with most disagreements arising from incomplete understanding of the categories in the early phase of processing.

Next we determined the profile of the hedonic ratings and frequencies associated with each cause of positive emotion. *Figure* 2 presents the averages and spreads of the hedonic ratings (the box plots) as well as how often the causes of positive emotion occurred (greyness of the boxes). Rare causes are omitted, such that only causes that occurred on more than 1% of all occasions are shown. As *Figure* 2 illustrates, the cause hedonic ratings did not differ significantly from each other, $F(10, 343) = 1.00$, $MSE = 528.20$, $p = .43$. However, the incidence of causes did differ significantly from each other, $\chi^2(10) = 339.99$, $p < .01$. *Fulfilled Expectations* were reported by far the most often, at 30.5% of all the common cause occurrences (binomial test $z = 14.01$, $p < .01$), followed by *Improvement* and *Positive Self-Image*, at 18.3% ($z = 6.06$, $p < .01$) and 18.0% ($z = 5.88$, $p < .01$), respectively. All the other causes were reported less than 10% of the time.

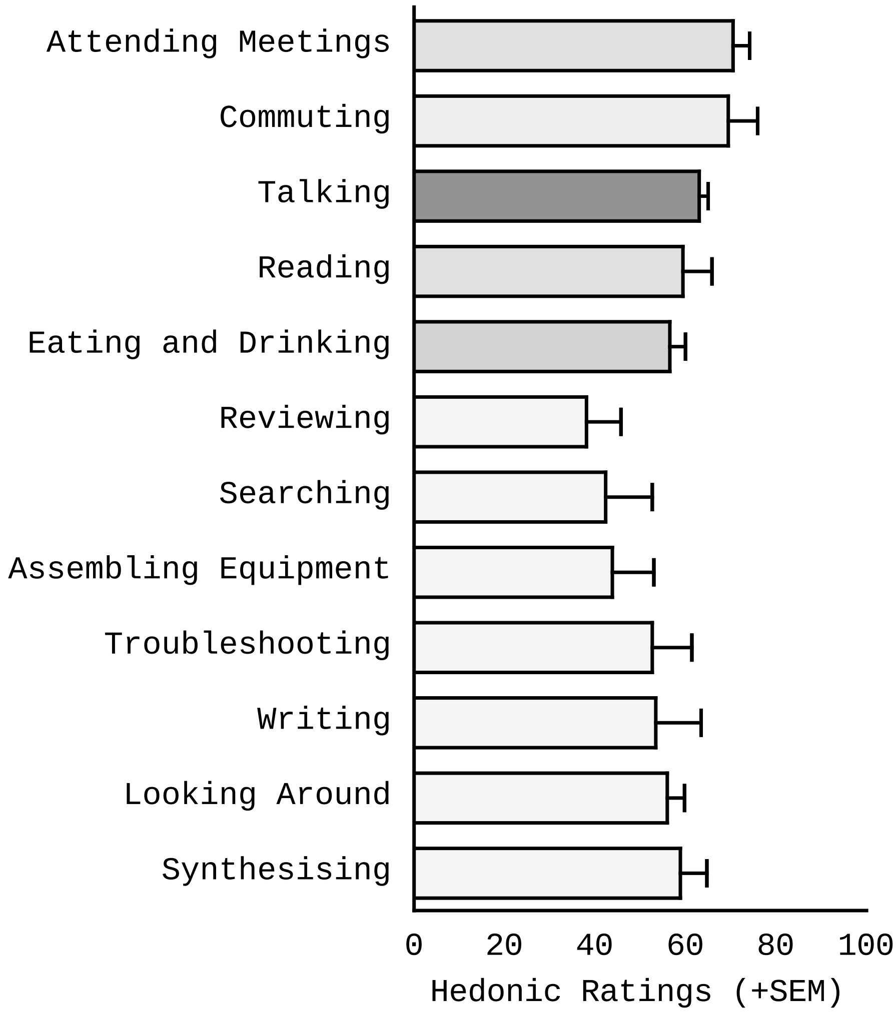
Fig 2. Hedonic Ratings of Common Causes



The ranges of hedonic ratings that the causes are capable of producing are indicated by the box-and-whiskers plots. The hedonic potencies of the causes do not differ significantly from each other. The greyness of each box provides a relative indication of how often each cause occurred: the darker the higher the percentage occurrence. Causes shown are those that occurred more often than 1% of all causes registered.

In order to identify which activities were associated with the most positive causes of positive emotion, we grouped together different causes of positive emotion that occurred during the same activity. This grouping produced a hedonic ranking of activities according to the mean hedonic ratings of all the positive events that took place under each activity. As *Figure* 3 illustrates, the hedonic ratings associated with activities differed from each other significantly, $F(11, 234) = 2.79$, $MSE = 489.93$, $p < .01$. *Attending Meetings* and *Commuting* were associated with a more than 20-point (SEM ±8) hedonic rating increase above the mean rating, corresponding approximately to an increase from *Like Moderately* to *Like Very Much*. Activities of *Talking*, *Reading*, *Eating and Drinking* were also associated with a significant increase of more than 15-points (SEM ±7) above the mean. Remaining activities were not associated with a significant effect on magnitude of hedonic ratings. The incidence of positive activities also differed significantly from each other, $\chi^2(11) = 269.90$, $p < .01$. The occurrence of *Talking* was by far the most common, at 34.5% of all the common positive activity occurrences (binomial test $z = 14.87$, $p < .01$), followed by *Eating and Drinking* at 15.0% ($z = 3.80$, $p < .01$). All the other positive activities occurred at 10% or less of the time.

Fig 3. Activity Ratings



The top five activities shown were the activities that separately surfaced as having significantly larger hedonic ratings than the other activities. The greyness of each bar provides a relative indication of how often each positive activity was reported – the darker the higher the percentage of reports. Activities shown are those that occurred at least as often as 1% in proportion to all activities registered. Error bars represent Standard Error of the Mean (SEM).

Discussion

This study identified a classification of core causes of positive emotion that was not manufactured from theory but derived from empirical data. Resultant causes were, for example, *Fulfilled Expectations* whereby positive emotion is experienced whenever a desired goal is reached; or *Positive Self-Image* whereby positive emotion is caused when perceiving any state of affairs to reflect well on oneself; see *Table 1* for the full taxonomy. The two aforementioned examples and *Improvement* were the most commonly occurring causes of positive emotion at the workplace. When the extent of positive emotion arising through such different routes was quantified (*Figure* 2), however, the different causes did not differ significantly from each other in the magnitudes of positive emotion the causes were capable of eliciting. Finally, activities such as *Eating and Drinking* and *Talking*, did differ in the extent to which they produced positive emotion (*Figure* 3) **–** the two examples plus *Reading*, *Commuting* and *Attending Meetings* were associated with significantly higher than average hedonic ratings.

We have purposely evaded the issue of the positive emotion response being one or many different kinds of response, so that the classification of causes could be treated as a separate investigation from the investigation of how many types of different resultant positive emotion there are. We remain open to the possibilities that there is a one-dimensional positive affect response arising from different contexts (e.g. Ortony & Turner, 1990; Russell, 2003a) or alternatively that there are multiple qualitatively different positive basic emotions such as love, awe, joy, enthusiasm, contentment, laughter and others (e.g. Ekman, 1999).

The nature of this study was correlational and depended critically on self-report: therefore, the classification derived is not necessarily a classification of causes and may reflect what people think caused an emotion (attitudes or misleading attributions) rather than what actually caused the emotion. The impact of these limitations for the current enquiry can be evaluated with further research, although we did choose non-retrospective design parameters that should have already minimised misattributions. Given that confounding influences may be more or less dominant under different sets of circumstances, then unless the aforementioned limitations are shown to critically confound the reports given under current conditions, we regard the classification produced to contain valid new information. Therefore, our default interpretation is that *Table 1* provides an empirically-derived comprehensive taxonomy of causes of positive emotion at the workplace.

Quantitatively, however, we are highly concerned about making comparisons between cause types e.g. when rating how much you like a brownie, you compare this brownie to the pleasantness of other brownies and desserts, or foods in general, but not as much to the extent to which you enjoy praise from your superior, for instance. Such a categorization effect makes it difficult to compare the hedonic ratings of different classes of experiences (Zellner, 2007), which is a serious concern when comparing the ratings given to the different causes in this study. In future studies, *magnitude matching* technique might help to alleviate this issue of relative interclass comparisons of hedonic ratings (using a scale such as the hedonic gLMS, see D. J. Snyder & Bartoshuk, 2009, p. 577). Further issues may arise from comparing estimates of positive emotion magnitudes from different people (Klocksiem, 2008). However, it is not known how large of a bias such confounds create. It is therefore possible that the relative nature of evaluative judgments as well as issues arising from interpersonal comparisons do not produce large enough effect sizes to warrant an alternative interpretation. Our default interpretation, therefore, is that the different causes do not genuinely differ in their potency to elicit positive emotion. We had sufficient power to detect large affect differences between the cause categories, but it is clear that the same cannot be claimed about smaller differences. A larger sample size is needed in future studies to ascertain whether smaller differences differentiate these causes of positive emotion, because the current results can not inform our judgment about that: all we can evidence with this study is that large differences did not exist between the cause quantitative profiles. Instead, what appears to differentiate between a single cause producing a weak positive emotion versus the same cause eliciting an extremely strong positive emotion, is the modifiers or the values of the critical parameters involved in the causal mechanism. For instance, for *Fulfilled Expectations* goal achievement is enjoyed much more when the desired state of affairs is exceeded rather than just reached. Therefore, if we wish to increase positive well-being at a personal or organizational level, it is not only a matter of trying to increase the frequencies of causes, but also a matter of understanding the causal mechanisms better, in order to create the circumstances that would maximally tap into the cause mechanisms

(Diener, 2009; Kahneman et al., 2003; Seligman & Csikszentmihalyi, 2000; C. R. Snyder & Lopez, 2007).

Of the more enjoyable activities, only *Attending Meetings* was directly related to work. By contrast, it is not so much that *Commuting* per se was enjoyable but that *Commuting* was mostly associated with leaving the work-environment, either for lunch or to go home at the end of the day, and such escapes appeared to primarily improve positive emotion. *Talking* and *Reading* were also not intrinsic work rewards, but contained mainly chatting with colleagues or reading news or jokes online. Based on the content of the top activities it seems that the activities that were associated with the highest gratification had a social component (*Attending Meetings*) and/or were not directly work-related, or involved food: suggesting that working alone was not enjoyed to a great extent. This does not necessarily mean that participants did not work at their workplace, just that they did not enjoy working alone.

Figure 3 presents only the positive aspects of the listed activities, i.e. the hedonic means presented do not take into account any negative events that might have occurred during the same activities. For instance, it is possible the activity associated with the highest peaks was also the activity that produced the most negative emotions. Secondly, the estimates in *Figure* 3 do not take into account the duration of the emotions either. For instance, an activity could have lasted three hours, but within those hours there may occurred only a single short positive event. That is, this study evaluated only one of the three critical aspects required for complete affective ranking of activities: the positive aspect. A full emotional profile of activities would incorporate positive emotions minus negative emotions weighted with time durations or frequencies of individual events. Note that the timescales or frequencies also incorporate repeatability, such that some pleasure triggers may be short-lived and not repeat themselves spontaneously (e.g. enjoying a bit of chocolate), whereas others may last much longer and resurface on their own (e.g. winning a Nobel prize and re-living that for years after).Report data in this study did not allow us to specify some of the causes as precisely as others. For example, if a participant enjoys a visual stimulus, this does not mean that they enjoy any or every visual stimulus, but rather those with specific visual patterns. Additionally, some causes of positive emotion are missing altogether from *Table 1* e.g. *Sexual Stimulation*. In order to provide a more thorough classification of causes of positive emotion, we present *Table 2* with speculative elaborations on the empirical classification of *Table 1*. The three added core causes, *Fragrances, Mania* and *Sexual Stimulation*, and further specifications of existing causes may allow the total classification to be representative of not just causes of positive emotion at the workplace, but outside as well.

We have already mentioned the pros of *experience sampling methodology*, but obviously ESM has drawbacks as well that pertain to the interpretation of our results. Firstly, demand effects: individuals were unlikely to report their positive experiences when they arose from sources associated with negative connotations e.g. sexual or erotic events. In addition, participants were less likely to register events that they perceived to be inappropriate as activities at work, such as browsing extensively online or taking long breaks; although we did receive some reports of this kind. These issues limit the breadth of our dataset. Secondly, the act of observation may actually change what is observed, so that the participants did not go through their workday and the encountered positive events in a normal way, because they were making observations about their experiences.

Table 2. Further Core Causes

Cause Name	**Additional Non-Data-Based Characterization**
Attachment	Also if: the source is a favourite toy or object e.g. old T-shirt.
Auditory Aesthetics	More specifically if: the sounds contain specific, but currently undefined, melodic and rhythmic patterns capable of eliciting positive affect.
Fragrances	If: participant enjoys non-food scents. And if: these perfumes are not made more pleasant by hunger.
Humour	Also if: participant recognises unusual relations in interesting did-you-know type of facts, for example, *the opposite sides of a dice always add up to seven*.
Joy of Others	More specifically if: *genuine* expressions of joy are sensed.
Liquid	More specifically if: increasing thirst amplifies this pleasure i.e. thirst is a positive modulator uniquely amplifying pleasure from liquid source.
Mania	If: positive effect does not require cognitive processing. And if: the positive effect is dominantly self-generated from the body itself without requiring external stimulation.
Sexual Stimulation	If: involves physical stimulation of excited erotogenic body parts.
Tastes & Smells	More specifically if: increasing hunger amplifies this gustatory pleasure i.e. hunger is a positive modulator uniquely amplifying pleasure from food flavours.
Visual Aesthetics	More specifically if: the visual stimuli contain specific, but currently undefined, visual patterns capable of eliciting positive affect.

The current study is positioned to specify the arrow in *Affective Events Theory* (*AET*; Weiss & Cropanzano, 1996) that starts from affective events and ends with positive emotion. As such, through the broader framework of *AET*, causes of positive emotion have implications for job satisfaction and subjective well-being in general (Fredrickson, 2001; Staw, Sutton, & Pelled, 1994; Wegge, van Dick, Fisher, West, & Dawson, 2006). The significance of the current classification may be even broader, in that as a comprehensive classification of primary / direct causes of positive emotion, then any and all secondary influences on positive emotion would work through a mixture of such primary / direct causes. So, for instance, positive activities such as playing a game, watching TV, hiking or going out might all be recipes with the causes as the ingredients. As such, if we were to understand the direct causal mechanisms better, including the modifiers that trigger the mechanisms most powerfully, that would go a long way towards manipulating these subjective utilities for subjective well-being (Hudlicka, 2003; Ryan & Deci, 2001). Furthermore, potential causes of positive emotion from broader levels of classification, such as income, personality, type of work, having children and climate, might ultimately all have their positive impact through the most proximal causes of positive emotion, the primary core causes we have identified (Dolan, Peasgood, & White, 2008).

This study provides the first classification of core causes of positive emotion. As for any first classification, more data are needed to test and adjust the taxonomy. The classification should be validated and modified from data across a wide range of samples and settings for the results to become generalisable. That is especially true in terms of generating an understanding of core causes that are present outside the workplace, given our sample included only office-work (out of practical convenience). A major issue with relying on reports from work to create a classification of pleasure sources is that individuals often do not enjoy their work and as such many of their pleasures would not be registered, compared to carrying out the same study over a weekend, for instance. Furthermore, the activities outside work need to be included in future studies, because even when individuals enjoy their workplace life, non-work activities may involve a distinct set of pleasure sources from work activities. For the main quantitative analysis, the study appears to be sufficiently powerful, but that does not mean the study has the power to detect a full range of pleasure sources in the qualitative sense. It is difficult to estimate power for qualitative analyses, so that question remains largely unanswered, other than the sample and report size being on par with other studies in the literature. Most notably, two of the more closely relevant articles, Basch and Fisher (2000) and Bitner and colleagues (1990), had a similar sample size and a slightly smaller number of reports compared to this study (approximately 100 fewer positive reports). Another potential issue for generalisability may be response rates: it is possible that only a small percentage of the individuals approached actually took part in this study, leading to issues with selection and having a representative sample of the population. The possibility of a substantial self-selection bias is problematic and may be eliminated if all individuals in a given organisation were required to participate in a future study of this kind. The latter approach may introduce its own problems, however, and an alternative would be to incorporate methods for measuring response rate so as to become informed about the real extent of this potential issue. Non-correlational studies that directly manipulate the candidate causes to determine if they actually work are needed as well (Roseman & Evdokas, 2004). In terms of differentiating the causes by their effectiveness potentials, at first sight e.g. *Sexual Stimulation* and orgasm as the pinnacle of that, may be a much more potent cause than for instance *Positive Self-Image*. However, it seems that all causes are capable of eliciting a wide range of positive emotion, from weak to extremely strong. Imagine winning the Nobel Prize, as an example of *Positive Self-Image*, which would seem capable of competing with even the best *Sexual Stimulation*. Given the equipotency of the different causes in terms of the wide range of emotional strengths that all causes are capable of producing, then the burden of increasing positive emotions is placed on understanding these causal mechanisms more fully: so as to alter the circumstances that can fuel the maximal horsepower of the core causes.

This chapter identified the inputs of *pleasure*, assuming the reported positive experiences are similar to each other because of the shared *core affects*. Knowing the different triggers of hedonic reactions gets us closer to identifying *when* pleasure occurs, which is important because it allows us to identify the circumstances when *pleasure* could be part of everyday life, or be part of psychiatric aetiologies. It appears that *pleasure* is not a fringe phenomenon that rarely takes place, for instance, once a month and only in extreme and artificial situations (including only in the laboratory). Instead, *pleasure* seems to be a much more widespread happening with a multitude of sources ranging from daily enjoyment of foods to fulfilment of goals and hopefully some humour and other sources of fun in the evenings.

Having established the non-negligible presence of *pleasure* at the minimum, and daily ubiquity of *pleasure* at the other extreme, questions arise as to what are the consequences of these *pleasures*? The following chapters deal with just that. In this chapter, we identified eating and drinking as a non-trivial source of *pleasure* and we therefore decided to study the products of this source of pleasure, because food is a more experimentally tractable source than many of the other major ones, such as those stemming from personal interactions. The initial stage in this analysis was to examine whether basic approach/withdrawal responses to food-related stimuli were determined by their affective valence.

III. Effects of Affect on Motor Reactions

Bacteria tend towards high concentrations of food. Seeing nectar may make bees start to fly faster. Your hand may be quicker to approach a bar of chocolate than to withdraw from it. Hungry sleep-walkers may be magnetically drawn to their fridges? How does hedonic value of a stimulus influence motor responding was the broad question posed by this study. More specifically, the aim was to determine whether higher hedonic value of a stimulus facilitates the speed of approach to the reward and congruently[b] slows down the withdrawal response (Solarz, 1960). Furthermore, the aim of this study was to evaluate sub-second reflexive-like hedonic congruence effects on reaction times, rather than supra-second influences on muscular activities.

Existing studies (see *Discussion*) have pre-selected their stimuli primarily based on the connotations of the stimuli (positive and negative meaning), as opposed to the genuine affective reactions the stimuli elicit (pleasantness and unpleasantness), so the effects on responding that have been observed may be due to the connotations rather than the intrinsic pleasantness of the stimuli. To clarify what we mean by connotations, let us play a free association game and notice what are the first words that come to your mind when you read, for instance, dog …… weak …… white …… Or, what do cows drink? Whatever words or associations came to your mind are examples of connotation, which is related to cognitive concepts such as semantic memory association; paired-associate learning; implicit attitudes; semantic differentials and in this context, evaluative labelling.

---

[b] In the current context, congruent means faster to approach a pleasant stimulus than to withdraw from it.

We are drawing a critical distinction between connotations of a stimulus on the one hand and on the other hand, the intrinsic affective value of a stimulus. The affective property of a stimulus is its core affect- or emotion-eliciting capability, which is presumed to be the independent variable underlying the effects of affective responding described in the aforementioned studies. For example, when you read words like flowers, friend, happiness, or monster, guns and poison, do you feel genuine positive or negative emotion? At the same time, what connotations would you class or label the words to possess? In fact, it may not be easy to stop yourself from making such semantic connotative links. The distinction is that such words do not necessarily make you feel good or bad, but are at the same time associated with positive or negative meaning, in a non-experiential sense. Furthermore, at times connotations can actually trigger true affective reactions, so the two phenomena can influence each other, but the critical distinction is that connotations and affect are different things, and as such at other times they do dissociate.

Even though existing studies have employed stimuli that possess strong connotations, a distinction between connotative and affective properties has not been made previously. Therefore, to investigate the potentially independent contributions of stimulus affective and connotative values on approach and withdrawal reactions, this study did not pre-select its stimuli based on their connotations. Instead we used a mixture of stimuli, which the participants rated for their intrinsic pleasantness and separately for the connotations the stimuli produced. Separating the two was particularly important, because the effects on responding observed in this field are attributed to the intrinsic affective reactions the stimuli elicit rather than the connotations, while the effects could be mediated by connotations alone, if the two are dissected apart.

Other than establishing whether responding was really influenced by the affective values of stimuli, a second aim of this study was to investigate affective and connotative effects in overweight individuals, who are trying to lose weight. Studying such a population in the current context was relevant, because genuine affective reactions to foods and automatic cognitive associations may both play an important role in determining their levels of consumption. Furthermore, this special sample possesses strong attitudes towards foods as well as strong health goals, which is why we chose food words as the primary stimulus type for this study. These in turn may have clinical implications. For instance, this study may reveal that overweight individuals have strong affective reactions to food that also drive food intake, indicating that a simple reaction time task may be of utility as a clinical marker of such hedonic eating. Alternatively, this study may reveal that reaction times are not influenced by the pleasantness of foods, while showing that food elicits strong cognitive associations in overweight individuals, which again could be indexed with a simple reaction time task. In addition, it would be informative to know how these automatic associations influence food intake, in particular, whether they help to reduce or do they increase the amounts eaten, in order to then target interventions accordingly. Of course, in order to know whether our results are characteristic to overweight individuals we later need to carry out similar comparative studies with healthy volunteers.

The current study employed a computerized version of an approach-avoidance task. Specifically, we employed the manikin version of the affective Simon task (De Houwer, Crombez, Baeyens, & Hermans, 2001; De Houwer & Eelen, 1998). In order to determine whether affective or connotative properties of stimuli influence approach and withdrawal responses, overweight participants were presented with different food words, one at a time in the middle of the screen, and a man-like stick-figure randomly on either the left or right side of the stimulus word. On each trial the participant was instructed to make the manikin either approach towards or withdraw away from the food word by way of left or right key presses. The required response type - approach or withdrawal - was determined by a feature irrelevant to the affective and connotative values of the stimulus: participants were required to approach if the target food word was written in lowercase letters and withdraw if the word was in UPPERCASE (with mappings reversed for half of the sessions). The original reason we chose to use the affective Simon task rather than the Implicit Association Test, for instance, was its face validity for studying emotion/affect rather than attitudes. As the name suggests, affective Simon task was designed to incorporate affective stimuli as the independent variable, while measuring these affective effects on response reaction times. Furthermore, we chose the task for pragmatic reasons as we had already programmed a version of the affective Simon task for another project we carried out. This study was incorporated under a larger study involving a weight-loss agent sibutramine and satiety manipulations. The prime reason for this was of pragmatic nature, in terms access to overweight individuals and through such collaboration a convenient opportunity to carry out our study in the first place. The drug and satiety manipulations per se were primary manipulations for studies other than ours, which is why they were introduced.

Unlike in previous studies, the stimuli used in this study were not pre-selected purely on the basis of their connotations[c]. Instead, participants were asked to give connotative and affective ratings to all the food stimuli utilized in this study. The connotative scale asked the participants to rate how healthy they found the foods, and the affective scale asked the participants to rate how pleasant they found the foods. Such ratings allowed identification of stimuli that had: 1) positive connotations, but were affectively neutral e.g. oats, salad, carrots; 2) foods that had negative connotations but which at the same time were neither strongly liked nor disliked; 3) pleasant-affective stimuli without strong connotations; 4) unpleasant-affective stimuli without strong connotations. Furthermore, the groupings of stimuli were done individually for each participant, allowing creation of accurate categories according to personal likes and dislikes. The approach and withdrawal response reaction times were then analysed according to either the affective values of the stimuli (pleasant versus unpleasant) or according to the connotative values (positive versus negative). The key prediction was that pleasant approach would be faster than pleasant withdrawal, and pleasant approach would also be faster than unpleasant approach. Alternatively, positive-connotative approach rather than pleasant approach would be the fastest response, if the effects on

[c] As explained above, connotations are positive or negative meaning associations to words like peace, happiness, monster and prison, which enter the mind at a cognitive, non-emotional level.

responding are actually mediated by the connotative rather than the affective properties of the stimuli.

Affect vs Connotation Experiment

This study consisted of four tasks: the reaction time manikin task (aka the *affective Simon task*), the affective rating task, the connotative rating task and a popcorn task.

Participants, Apparatus, Stimuli and Scales

Sample. 28 overweight volunteers (6 female), mean age 34.3 years (SD = 7.2), were included in this experiment. Their mean Body Mass Index (BMI) was 27.3 kg/m^2 (SD = 1.6). The participants were also trying to lose weight. We chose to focus on such a sample in order to characterise their affective and cognitive reactions to food, because having such an understanding may become useful for devising better interventions for weightloss. Furthermore, the reaction time task employed in this study may serve as a clinical marker for differentiating certain types of overeating. This study was part of a large series of studies carried out in the UK over two two-week periods and the participants were recruited for the whole project rather than separately for the individual studies. The sample size was planned by the organisers of the larger study. It was sufficient to detect a large effect between response and stimulus types (see *Figure 4*). That is, a minimum of 20 participants, thanks to the large number of trials included in this design, would have been required for this design to be powerful enough to detect large effects. Again, we were interested in large differences in reaction times rather than smaller ones, because of the correspondingly larger meaningfulness large effects carry, especially in the context of clinically relevant research. The latter is a matter of resource and time investment, and, of course, different sample sizes may become desirable in future studies depending on the outcomes of this study. Ethical approval and procedures for the study were also implemented by the organisers of the larger study, including the regulations pertaining to drug administration. Recruits received no separate monetary compensation for participation in the affective Simon, ratings and popcorn tasks of this study.

Experimental Setup. For the affective Simon (reaction time) and rating tasks, participants were tested individually in a test room in which they sat at a table facing a computer screen (laptop with a 1280x1024 resolution display). The software package providing the reaction time trials, as well as delivering all the instructions and rating scales to the computer screen, was custom-coded for this study in Visual Basic 2005 (.NET 2.0). For the reaction time task, the "*z*" and "*?*" keys on the keyboard were marked using left and right arrow stickers. The affective Simon and rating tasks were repeated on four different session days, with new stimuli each session, with the aim that on half of these days participants would be under the influence of a weight-loss drug sibutramine. The sessions also differed from each other in that the participants were fasted on half of the sessions (no food that morning), whereas participants had been pre-fed for the other half of the sessions (breakfast). The order of these sessions was counter-balanced between-subject. Each participant also had a *'break from experiments'* in a TV room on their first session day, where comfortable seating was positioned near a pre-weighed bowl of popcorn. This and the availability of episodes of The Simpsons and Friends comprised the setup for the popcorn task.

Stimuli and Scales. A total of 128 common food words were used in the affective Simon and rating tasks. The food words were, for example, *carrot, chocolate, cucumber, lollipop, marmalade, omelette, onion rings, salad, sandwich, toffee* and *tofu*. The whole word list was homogenized for number of letters, and contained commonly known foods, half of which belonged to high-calorific category and the other half to low-calorific category. A further 128 non-food words were presented to the participants, such as *fax machine, needles* and *sunlight,* inter-mixed with the food words. The non-food words were not included in the rating tasks, however, and were therefore not used in the analyses. Additionally, each word was shown twice, once in UPPERCASE and once in lowercase letters, which indicated to the participant whether approach or withdrawal was the correct response (see *Procedure*). The practice stimuli were always the same and were not re-used in test trials: four non-food words presented in both letter-cases. The order of the test stimuli was randomized by the software, separately for the reaction time task, the affective rating task and the connotative rating task.

For the affective rating task, the stimuli were rated on the affective version of the 9-point scale called *Self-Assessment Manikin* (*SAM*; Hodes, Cook, & Lang, 1985; Lang, 1980). The computerized version of this *affective SAM* scale presented each word with the question "*How pleasant is this food to you?*". The rating was chosen according to a series of horizontal icons that changed from a happy/smiling figure to an unhappy/frowning figure, with semi-happy, neutral and semi-unhappy figures in-between. Additionally, the horizontal left extreme was labelled "*pleasant*" (in green letters), the middle "*neutral*" (in black letters) and the horizontal right extreme "*unpleasant*" (in red letters). The most pleasant rating possible on the scale corresponded to the maximum value of 9, neutral to 5, and the most unpleasant rating to minimum value of 1; but no numbers were actually displayed on the scale. Ratings were provided on a continuous *Visual Analogue* type scale rather than a discrete integer-only *Likert*-type scale. The connotative ratings task used the connotative version of the *SAM* scale, which was different from the *affective SAM* scale with respect to the question presented and the extreme labels: the *connotative SAM* asked "*How healthy is this food to you?*", and the leftmost and rightmost labels were "*healthy*" and "*unhealthy*", respectively. The *connotative SAM* did not display any affective figures. The *SAM* scales rather than the *LAM* scale were used in this study, because they allowed both affective and connotative ratings to be measured.

Procedure

Procedures involving the experimenter were carried out according to a Standard Operating Procedure (SOP)[d] to maximize accurate and consistent execution of experimental protocol.

[d] SOP consists of detailed written instructions for the experimenter to follow when setting up and running the experimental tasks.

Affective Simon Task. The first screen introduced the reaction time task as follows "*This game will feature a stick-man, which represents a person. In the following screen you are presented with different words in either lower or UPPER case and all you should do is make the stick-man approach the word if the word is in UPPER case, but make the stick-man move away from the word if the word is in lower case.*" An interactive tutorial of the main trial type then led the participant through a sample trial (see *Appendix B*). The figure manikin, with a head as a circle; body, arms, legs as lines; and height of 222 pixels, appeared randomly on either the mid-left or mid-right side of the screen. After 750 ms the stimulus word appeared in the middle of the screen (*farmer* for the sample trial) and reaction time measurement started. The participants learned what to do through the following instructions "*After a short pause, a word with a stick-man is displayed like this. As soon as you see the word your task is to move the stick-man by pressing either the marked ← or → key on the keyboard. Specifically, please make the stick-man move away from the word if the word is in lower case and move the stick-man towards the word if the word is in UPPER case.*" As soon as the participant pressed down either the key marked "←" ("z") or the key marked "→" ("?") reaction time measurement stopped. As a consequence, the manikin either moved into the word (into the middle) or away from the word (out of the screen), depending on which key the participant pressed and which side of the word the manikin appeared in the first place. The movement of the manikin was animated as smooth horizontal sliding (by 4 pixels every millisecond). Next, eight practice trials allowed the participants to apply their understanding of the task in action. A notification appeared after the eight practice trials, informing the participant that test trials are about to begin. However, the first ‘*test*’ trial was actually a ninth practice trial, as the data from that trial were not used in analyses. 128 test trials followed. The inter-trial interval (ITI) was 1500 ms. Numbers of incorrect responses were also registered, depending on whether the participants approached or withdrew from the word appropriately, as indicated by the word letter-case. The letter-case assignment was counter-balanced such that half of the sessions required approach to lower case and the other half required approach to UPPER case words.

Rating Tasks. As shown in *Appendix B*, the first rating task was always the affective rating task and started with the following instruction “*Now please rate the words according to how much you personally like these foods. Simply rate how much you would enjoy eating each food!*” All the food words that had been presented in the previous reaction time task were then presented one by one, together with the *affective SAM* scale described above. The next task was the connotative rating task, which was introduced with “*Now please rate the words according to how healthy you personally think they are for you.*” Again, all the food words were presented in random order, but with the *connotative SAM* scale described above.

Popcorn Task. Participants were individually given a ‘*break*’ from tasks, which they spent in a TV room watching either an episode of Friends or The Simpsons. Beforehand, a pre-weighed food bowl with popcorn had been placed near their seat as freely available snack food. Participants were allowed to relax and eat for ten minutes, if they so wished, and the food bowl was weighed again afterwards to determine the amount consumed. Unrelated to this study, the TV episodes also contained subconscious stimulus presentations, but the subliminal stimuli were allocated randomly with respect to overall intake comparisons for the whole group, which was the data of interest for this study. Participants were debriefed afterwards according to the approved ethical protocol of the study.

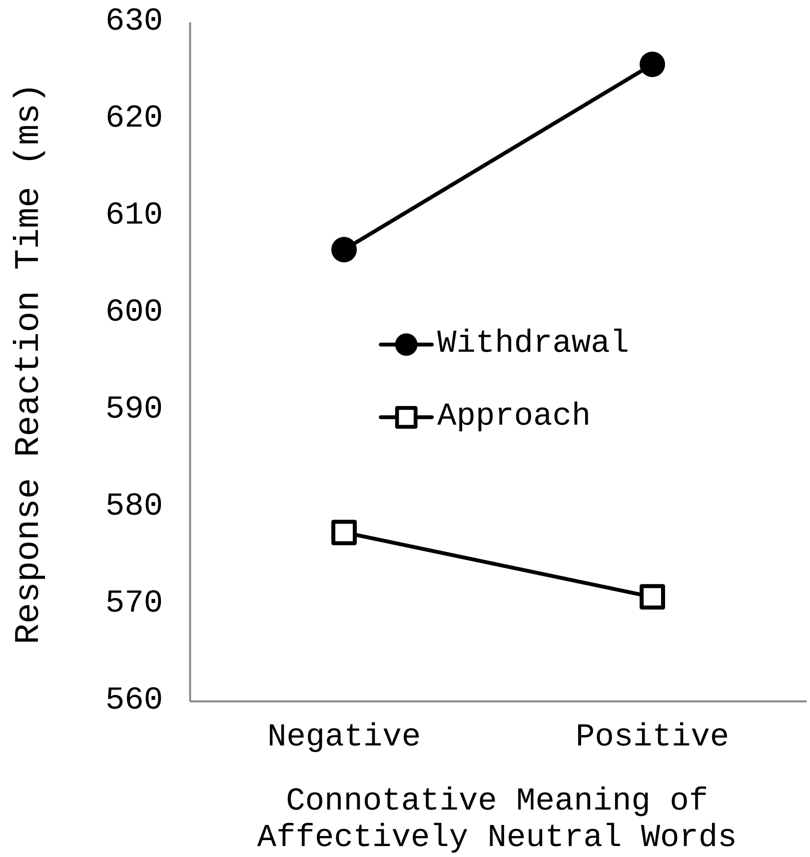
Data Analysis. All data points with reaction times below 150 ms and above 1500 ms were excluded from analyses, except for calculation of percentage of incorrect responses. Beforehand, extreme raw outliers were also removed, separately from each participant's set of reaction time scores per session, using Tukey's fences box-plot method (Brant, 1990). Unpleasant-affective and pleasant-affective stimuli were determined separately for each participant, based on their *affective SAM* ratings (unpleasant < 5, pleasant > 5). The same cut-offs were applied for identifying negative-connotative and positive-connotative stimuli for each participant, but on the basis of *connotative SAM* ratings (negative < 5, positive > 5). Three out of twenty eight participants that completed the experiment had to be excluded from all analyses, because these participants did not provide a sufficient range of affective and connotative ratings, which resulted in incomplete ANOVA cells. Percentage incorrect responses were calculated per condition as number of incorrect trials over number of total trials for the given condition. Data and statistical analyses were carried out using Microsoft Excel 2007,SPSS 17 and 19, and R 2.11.1 packages, except for Cohen's *d* effect size values, which were retrieved from http://www.uccs.edu/~faculty/lbecker/

Results

Firstly, we sought to determine the influences of the larger study context into which the *affective Simon task* was incorporated. For that purpose, we conducted an ANOVA with the following within-subject factors: pharmacon (sibutramine or placebo), fullness (fed or fasted), affect (pleasant or unpleasant), connotation (positive or negative) and response (approach or withdrawal). Fullness and affect did not influence reaction times, *F*s < 1. We also added a between-subject factor of order, with the levels determined by whether sibutramine or placebo was administered first. Again, this did not influence reaction times, $F < 1$. Furthermore, only three significant effects were found in this global analysis. A) Under the influence of sibutramine, mean reaction times (RTs) were generally shorter than RTs in the placebo condition, 551.8 ms (SEM = 19.9) versus 597.3 ms (SEM = 25.5), $F(1, 24) = 10.59$, $p < .01$. B) Participants were also generally faster to approach than to withdraw, 556.9 ms (SEM = 21.2) versus 592.8 ms (SEM = 22.4), $F(1, 24) = 9.12$, $p < .01$. C) Finally, there was a three-way interaction of pharmacon X connotations X response, $F(1, 24) = 5.80$, $p = 0.01$, which we will explore further and contrast against lack of influence of affect.

The nature of the interaction involving sibutramine or placebo was evaluated further by determining whether connotations interacted with responses under sibutramine alone. This was not the case, $F(1, 24) = 1.65$, $p = 0.13$. That is, under the influence of sibutramine, reaction times did not differ significantly from each other as a function of connotations and response, with 538.7 ms (SEM = 21.2) versus 540.2 ms (SEM = 20.5) as positive-connotative and negative-connotative approach RTs, and 557.2 ms (SEM = 19.4) versus 571.6 ms (SEM = 20.6) as positive-connotative and negative-connotative withdraw RTs. The overall three-way interaction arose from the placebo condition given congruency effects were not present under sibutramine (above), so next we assessed congruency under placebo alone. To assess whether connotative instead of affective properties of the stimuli influenced the speeds of approach and withdrawal responses under placebo, we compared the RTs for positive-connotative versus negative-connotative approach and RTs for withdrawal from positive-connotative versus negative-connotative words. For the following analyses the two independent categories were not affective but connotative in nature, based on healthiness ratings given to each food word in a separate rating task: negative stimuli (*connotative SAM* < 5) versus positive stimuli (*connotative SAM* > 5). As *Figure* 4 illustrates, mean approach RTs to positive-connotative words were shorter than approach RTs to negative-connotative words (bottom line). In a compatible inverted manner, mean withdrawal RTs from positive-connotative words were longer than withdraw RTs to negative-connotative words (top line in *Figure* 4). This response-dependent effect of stimulus connotations on RTs, as opposed to the aforementioned lack of affective effects, was confirmed as part of the four-way ANOVA with response (approach versus withdraw) and connotative rating (positive versus negative) as well as fullness (fasted versus fed) and affective rating (pleasant versus unpleasant) as within-subject factors: there was an interaction of response and connotative rating, $F(1, 24) = 3.06$, $p = .05$, together with the presence of a general approach tendency, $F(1, 24) = 9.44$, $p < .01$, and no evidence of non-specific main effect of connotative rating, $F(1, 24) < 1$. In order to determine whether shorter reaction times (RTs) were associated with approach rather than withdrawal responses to pleasant-affective words, we compared the RTs for pleasant approach versus withdrawal and also RTs for unpleasant approach versus withdrawal responses under placebo. The two affective categories were based on pleasantness ratings given to each food word in a separate rating task and the assignments were determined individually for each participant and each stimulus: unpleasant stimuli (*affective SAM* < 5) versus pleasant stimuli (*affective SAM* > 5). Mean approach RTs to pleasant-affective words were shorter at 580.2 ms (SEM = 26.5) from withdraw RTs at 616.4 ms (SEM = 27.0).

Fig 4. Non-Affective Approach Speeding



Influence of connotative ratings on approach and withdrawal reaction times. Connotations are cognitive associations that automatically enter your mind in terms of how good or bad something is, but without necessarily making you feel genuine emotion. Approaching positive-connotative words took shorter time than approaching negative-connotative words, even though these stimuli were affectively neutral. Correspondingly, withdrawing from positive-connotative words took longer time than withdrawing from negative-connotative words. These observations contrasted with lack of effects on responding when affective-pleasant versus affective-unpleasant stimuli were compared.

However, mean approach RTs to unpleasant-affective words were also shorter from withdraw RTs to unpleasant-affective words, at 570.4 ms (SEM = 23.6) versus 623.6 ms (SEM 26.6), respectively. Furthermore, the means indicate that approach to pleasant-affective words took longer than approach to unpleasant-affective words. The aforementioned general fastness of approach as well as lack of consistent affective effects on RTs was confirmed by the same four-way ANOVA as above: there was the main effect of response, whilst there was no evidence of an effect of affective rating nor an interaction of response and affective rating, $Fs < 1$.

As control analyses, we determined whether the connotative categories above had fortuitously become confounded by similarly changing affective ratings, by identifying whether the positive-connotative condition was associated with pleasant affective ratings, and whether the negative-connotative category was associated with unpleasant affective ratings. Affective ratings of positive-connotative stimuli with a mean of 4.7 (SEM = 0.1) were similar to affective ratings of negative-connotative stimuli which also had a mean of 4.7 (SEM = 0.2). Lack of any affective differences between all the connotative conditions was confirmed by an ANOVA with positive-connotative approach, negative-connotative approach, positive-connotative withdrawal, negative-connotative withdrawal as the within-subject cells: there was no evidence of any affective differences, $Fs < 1$. Furthermore, these scores together did not differ from 5 on the *affective SAM* scale, which indicates affective neutrality: one sample t test, $t(24) = 1.68$, $p = .10$. The same question regarding cross-contamination, this time by connotative ratings to affective categories, was evaluated next i.e. given pleasant-affective and unpleasant-affective stimuli did not affect responding, then the pleasant stimuli should not have strongly positive connotative ratings and the unpleasant stimuli should not have strongly negative connotative ratings, because connotative ratings did influence responding. Again, there was no evidence of mixing, with equivalent connotative ratings for the pleasant-affective and unpleasant-affective stimuli, with means of 5.6 (SEM = 0.1) and 5.4 (SEM = 0.1), respectively (*Fs* < 1).

Next we determined whether number of errors made also differed in accord with the effects observed on reaction times. An error trial was registered if the participant approached (or withdrew from) the stimulus when the correct response was the opposite: withdrawal (or approach), as determined by the letter case of the target word (see *Method*). Mean percentage incorrect responses were very low overall, at 1.5% (SEM = 0.1). Furthermore, an ANOVA of identical structure as the first global ANOVA with factors of pharmacon (sibutramine or placebo), fullness (fed or fasted), affect (pleasant or unpleasant), connotation (positive or negative) and response (approach or withdrawal), showed no evidence of any differences between the percentages of incorrect responses across conditions, with non-significant main effects and interactions, all *Fs* < 1. See Table 3 for the respective mean values.

Table 3. Percentage Errors

Condition with Levels	**First Level Mean (SEM)**	**Second Level Mean (SEM)**
Pharmacon: Sibutramine vs Placebo	1.1 % (0.3)	1.9 % (0.5)
Fullness: Fed vs Fasted	1.5 % (0.4)	1.6 % (0.4)
Affect: Pleasant vs Unpleasant	1.8 % (0.3)	1.3 % (0.3)
Connotation: Positive vs Negative	1.7 % (0.4)	1.4 % (0.2)

Response: Approach vs Withdrawal	1.4 % (0.3)	1.7 % (0.4)

Finally, we assessed the question whether the connotative or affective ratings of the food words were able to predict consumption of actual food, in a separate popcorn task carried out in a natural setting on the same set of participants. The essence of the popcorn task was that a bowl of popcorn was weighed, unbeknownst to the participant, before and after a participant had a break from tasks in a TV room, where they watched Simpsons or Friends, and could help themselves to popcorn. Neither of the covariates predicted grams of popcorn eaten: mean affective ratings from each participant did not predict popcorn eaten [$F(1, 24) = 1.59$, $p = .14$] nor did mean connotative ratings ($F < 1$). This same ANCOVA also contained fixed factors of fullness and pharmacon and showed that fullness did not influence grams of popcorn eaten either, fasted participants ate 31.3 g of popcorn (SEM = 3.8) versus fed participants eating 32.2 g (SEM = 4.6), $F < 1$. The only significant effect was that of pharmacon, $F(1, 24) = 5.36$, $p = 0.02$, such that participants ate less popcorn under the influence of sibutramine, 28.2 g (SEM = 4.0), than under placebo, 35.2 g (SEM = 4.6).

Discussion

This study demonstrated that *pleasant-affective* stimuli did not speed up approach reactions and nor did they slow down withdrawal reactions. By contrast, *positive-*

connotative stimuli[e] did speed up approach reactions, as well as slow down withdrawal reactions. However, the latter occurred only under the placebo condition, such that there were no congruence effects found under the influence of sibutramine.

Firstly, we interpret the lack of interaction or flattening of the reaction times under sibutramine to be a result of a floor effect. Specifically, sibutramine produced a general speeding of all responses, which is likely to make the detection of further speeding more difficult, including e.g. the detection of further speeding of approach to positive-connotative words. Alternatively, sibutramine has been found to enhance attention and general performance (e.g. Wesnes, Garratt, Wickens, Gudgeon, & Oliver, 2000), and this may underlie the general speeding effect as well as the lack of specific effects by over-riding any detriments to response times. Furthermore, as the effects of sibutramine were not the prime focus of the current study, we will now concentrate on the effects observed under the placebo condition. We do admit, however, that incorporating this study under a larger one may limit the interpretability of this study, because of the involvement of a plethora of manipulations and tasks from the larger study that were not primary for our design; yet these might have still influenced our results. That is, the possibility remains that if we had executed this study on its own then the results would not be confounded by factors from the larger study, and thus be different. Furthermore, part of the limitation is that it is difficult to know whether any such critical confounds exist or not.

[e] I.e. words that produced positive cognitive associations

We already know that affective stimuli do not directly modulate specific voluntary muscle contractions. Chen and Bargh (1999) provided evidence for the original proposition that humans have biologically hardwired affective predispositions. That is, according to this specific-muscle-activation hypothesis, pleasantness automatically influences muscular contractions such that faster arm flexion, as opposed to arm extension, is observed when pulling positive stimuli towards our body (for invested theoretical accounts see e.g. LeDoux, 1996; Zajonc, 1980). Although such tendencies have evolutionary face validity and the idea presents as an attractive meme, newer evidence has challenged the claim (Lavender & Hommel, 2007; Markman & Brendl, 2005; Rotteveel & Phaf, 2004). As an example, Markman and Brendl (2005) found that pulling a reward stimulus towards one's body was associated with the opposite effect to what is predicted by the specific-muscle-activation hypothesis: the counter-evidence brought forward that pulling a positive stimulus towards the participant's body was found to be slower than pushing it away. In fact, Markman and Brendl (2005) found that participants were faster to move the positive stimuli not towards their body, but instead towards their name, which was written on the computer screen. As a substitute to the specific-muscle-activation account then, distance-regulation hypothesis posits a more complex influence of pleasantness on motor responding, in that we are faster to cause movements that decrease the distance between a representation of ourselves and the affective stimulus.

With regard to the first main question posed by this study, however, our findings suggest that motor responses are not modulated by affect. The sample size for this study was large enough to detect large differences in responding, but not smaller ones, so the lack of affective congruency effects may be a false negative. Although it is noteworthy that we were able to demonstrate connotative differences - in contrast to the lack of affective differences, while using similar measures - we have no confidence to posit that smaller affective congruence effects did not exist. Given small affective congruence effects would also possess theoretical implications, the results of this study cannot be taken to fully support the distinction between connotative and affective effects. Future studies with more power are needed to test the weight of this alternative interpretation. We also acknowledge that we did not specifically control for the imageability and concreteness of the word stimuli and the lack of such matching may damage the signal-to-noise ratio for our primary conditions of interest. Furthermore, these uncontrolled factors, or any others for that matter, may not only produce reliable effects on reaction times but also correlate with our independent variables, highlighting a limitation in the interpretation of our results; that is, the primary effects may have not arisen due to connotations, but due to co-correlating imageability of the stimuli, for instance. At first sight, this interpretation may seem to conflict with a number of previous studies that have reported the influence of affect/emotion in the affective Simon task. However, if it has been the connotative properties rather than the affective properties of stimuli that have produced those effects, then this seemingly conflicting evidence would turn into converging evidence. Studies investigating affective effects on motor responding seem to have indeed pre-selected their stimulus sets based on the connotations rather than the genuine affective potencies of the stimuli. 1) De Houwer and Eelen (1998) used words like monster, gangster, liar and flowers, peace, love, based on a word list from Hermans and De Houwer (1994); 2) Based on the same word list, De Houwer and colleagues (2001) used words like enemy and friend. In fact, the scale used to test and choose the source words used labels from "negative" to "positive", rather than scoring with “unpleasant” to “pleasant” or similar; 3) Zhang and Proctor (2008) used visual icons that had clear stereotypical meanings e.g. a picture of the skull that labels poisonous bottles; 4) Eder and Rothermund (2008) pooled aggressive, annoying, bad, loyal, nice, sunny etc from Schwibbe and colleagues (1981). Again, what differentiates these words most clearly are their negative and positive connotations, respectively, rather than being differentiated by the genuine unpleasant and pleasant affective reactions the words elicit; 5) The study by Krieglmeyer and Deutsch (2009) utilized stimuli like kiss, crime, prison, baby, slave, kitten and butterfly, from Hager and Hasselhorn (1994) and Klauer and Musch (1999). Again, it is not difficult to guess which of these words had negative and which had positive connotations, in fact, such associations tend to be automatic; 6) Krieglmeyer and colleagues (2010) also found effects on responding with words like violent, arrogant, cooperative, tolerant and so on, based on Wentura and colleagues (2000). Therefore, if connotative value is a substitute for affective value as the independent variable underlying the effects seen in these tasks, then the body of evidence supporting the idea that highly affective stimuli speed up approach responses, is critically weakened.

On the basis of the observations above, we predict that connotations are necessary for the effects on responding to arise and furthermore that it does not matter how these connotations are evoked, as long as these associations do arise. In simple cases, the stimuli have acquired strong connotations themselves, such that the associations are evoked automatically without any additional conditions needing to be satisfied. However, genuinely affective stimuli that do not possess strong default connotations would still produce such cognitive associations, but only if participants are asked to directly categorize and respond on the basis of the affective values of the stimuli. In other words, these connotations would arise only if the affective value is the relevant feature that needs to be cognitively processed in order to make the correct response (Lavender & Hommel, 2007; Mogg, Bradley, Field, & De Houwer, 2003; Rotteveel & Phaf, 2004). If the connotative properties of the stimuli are strong enough, however, then they might still influence performance, even if the responding criterion is an irrelevant feature, such as letter-case. The necessity for cognitive labelling of stimuli extends the evaluative coding account of responding effects (Eder & Rothermund, 2008), which found that cognitive labelling of the approach and withdrawal responses was also required for the responding effects to occur.

The meaning of our findings becomes clearer with the realization that affective ratings given to food words reflect the motivational values of the stimuli, not how much actual pleasure is elicited when reading those words. For example, when you walk around a supermarket and see all the different food options, you might really want some of the items, and not want other items so much. This does not mean that you actually enjoy the foods right there in the food-store, most of the pleasure is experienced later while eating the foods. Similarly, food words are predominantly motivational triggers predicting likely future pleasures that will be elicited later on when tasting the actual foods. That is, affective self-report is sensitive to not just the pleasure from stimuli (hedonic reactions or actual liking), but the ratings can also be indicative of the desire for stimuli (incentive motivation or wanting; Booth, 2009; Finlayson, King, & Blundell, 2007b). Affective ratings are a non-selective composite of hedonic value and incentive motivational value, and food words, which are signals of pleasurable events (conditioned representations of unconditioned stimuli), possess primarily incentive motivational rather than hedonic value (Dickinson & Balleine, 2002). With the realization that affective ratings reflect motivational value of food stimuli rather than the pleasure the words elicit, the interpretation of the current findings with respect to the first key question of this study needs to be revised. I.e. we can assert that motivationally potent stimuli do not affect responding, but we cannot assert the same about the effects of online hedonic reactions any more. In fact, to answer whether current pleasure affects responding requires an experimental design whereby pleasure is induced at the time of making the approach or withdrawal response, and not after. Most affective stimuli used, however, do not cause pleasure at the point that access is gained to them, the pleasure is caused after approach or withdrawal in the consummatory phase. Perhaps using pleasant odours, or inducing a positive mood would serve to investigate modulation of responding by online pleasure reactions. As a qualification on the main null result with affective ratings then, given that the affective ratings to food words reflect motivational potency rather than current pleasure, it is possible that effects on approach and withdrawal reaction times may still be observed when current pleasure is present at the time of making such responses.

Another recognition that clarifies the scope of the current study is that the type of design employed does not allow statements to be made with regard to the effects of affect on slower voluntary actions. That is, such designs allow investigating facilitation of fast post-trigger movement selection or movement execution, but not planning, choosing and execution of intentional movements, which appear to be a different kind than reactive movements. The following excerpt illustrates the distinction: "*Nobel laureate Niels Bohr considered why, during a gunfight, the man who drew first was the one to get shot. He suggested that the intentional act of drawing and shooting is slower to execute than the reactive action in response (Cline, 1987), an idea grounded in the everyday trade-off between stimulus-driven behaviour and intentional, planned actions. This distinction between different classes of action is not merely semantic* …" (Welchman, Stanley, Schomers, Miall, & Bulthoff, 2010, p. 1)

The second key aspect of this study was that our sample consisted of overweight individuals who were attempting to lose weight. In that regard, our participants may have possessed special or particularly strong food associations. In fact, it is possible that the connotative effects on responding are an indication of such health goals and food attitudes that only this select population possesses, and which would not be present in healthy volunteers. Therefore we can only present hypotheses, but not generalise these effects to non-overweight samples. Furthermore, the participants were highly aware that the study was focussing on their weight, which makes demand effects more likely to occur. Although such reaction times are fast and relatively hard to control, a limitation of the current design is that such appetitive responses may have been confounded.

What is the predictive validity of the effects we found? Firstly, it is good to witness that the anti-obesity drug sibutramine did indeed reduce the amount of popcorn eaten. However, neither mean affective ratings nor mean connotative ratings predicted actual food intake in the popcorn task. Perhaps individuals struggling with weight are characterized by strong health awareness as it relates to food, but at the same time, when it comes to actual consumption the predominant factors that controls intake are not the cognitive health goals. The situation may be similar to trying to teach a child that candy is bad: you may be able to make the child automatically associate '*bad*' with encountering sweets, but that connotation would be cognitive and perhaps relatively ineffective in terms of influencing intake. In fact, we think that this kind of learning of cognitive connotations has already been demonstrated experimentally in the manikin task (Moors & De Houwer, 2001). It is, of course, possible that if instead of using mean ratings for all foods as predictors, we had ratings for popcorn specifically, then relationships between connotations and intake, as well as between affect and intake might have surfaced. This is speculation, however, and leaves the role of health associations open, while such cognitive goals seem to be characteristic markers in themselves, are they at the same time ineffective in terms of guiding food intake in overweight individuals, or do they perhaps have other important influences on behaviour not specified here? We regard the functional parsing of connotative consequences versus consequences of affect an important avenue to explore.

In summary, this study found that highly affective or motivational stimuli do not potentiate approach responses and do not suppress withdrawal responses. Furthermore, these findings highlight that the affective Simon task may actually be a non-affective task, even though we and others have mistakenly treated it as providing important information about affective processing. Instead, the task appears to be sensitive to the connotative properties of stimuli, which may possibly be used to study these types of strong cognitive associations in special populations, such as in individuals attempting to lose weight. Perhaps the affective Simon task should be renamed to the connotative Simon task?

This chapter established that affective stimuli do not modulate fast approach and withdrawal reactions, but since affective ratings of food words are more prone to reflect *motivational* properties of these stimuli, then we did not answer the question whether the genuine *hedonic reactions* or *pleasure* from stimuli modulates such responding. The latter question will need to be answered with further research.

On the basis of the confounding of connotative and affective properties with symbolic food-related stimuli (i.e. words), we decided to use real foods in the following investigations of the effects of food *pleasure*. The two upcoming chapters assess the role of the affective properties of real foods as mediated by the two main types of event relationships: stimulus-outcome and action-outcome relationships. The next chapter will study the first type of relationship, which is a facet of *pleasure* sometimes called *development of liking*. Namely, we will examine what happens to neutral stimuli that co-occur with pleasurable stimuli, or to be more precise, what happens to neutral stimuli that co-occur with the *pleasure* stemming from the hedonic stimuli.

IV. Learning of New Likes

Food intake is influenced by the hedonic evaluation of both the to-be-eaten food and food-associated stimuli. In other words, people do not only eat the food they like, but are also biased by affective cues related to the foods. The affective potency of such cues is largely learned through experience and one form of experiential learning comprises evaluative conditioning. Evaluative conditioning is the process of learning to like (or dislike) objects and features of the environment as a result of their association with attractive (or aversive) events. For instance, when potential homebuyers visit a property in California, some agents apparently bake bread in the house before the client arrives, thereby filling the rooms with highly pleasant scents from the oven, in the hope that the liking will transfer to the property itself. Such examples of evaluative conditioning depend on successful pairing of two stimuli – the initially neutral conditioned stimulus (CS), the property, and a hedonic unconditioned stimulus (US), the smell of baking bread. Although such evaluative conditioning resembles standard Pavlovian conditioning procedurally, a number of authors (e.g. Baeyens & De Houwer, 1995; Martin & Levey, 1978) have argued that different learning processes mediated these forms of conditioning. The purpose of the present studies was to investigate whether evaluative conditioning is sensitive to one of the major determinants of Pavlovian conditioning, blocking.

Flavour liking can be acquired in many ways. Firstly, through *flavour-flavour learning* (*FFL*; e.g. Yeomans, Leitch, Gould, & Mobini, 2008), whereby initially neutral flavours become liked as a result of pairing with already pleasant flavours (or disliked when paired with unpleasant flavours). Secondly, through *flavour-nutrient* or *flavour-consequence learning* (*FCL*; e.g. Gibson & Brunstrom, 2007), which produces changes in liking as a result of pairing novel flavours with ingestive consequences, which may be positive or negative. In a subtype of *FCL* of *conditioned taste aversion* learning (*CTA*; Garcia & Koelling, 1966), the consequences are negative (e.g. nausea) and the flavours become disliked, but *FCL* also produces learning through pairing with positive consequences, such as the satisfaction derived from reduction of nutrient deficiency or from relief of caffeine deprivation (e.g. Yeomans, Gould, Leitch, & Mobini, 2009). '*Cognitive learning*' due to disgust elicited from mental imagery may be a separate learning model involved in flavour liking (e.g. Eertmans, Baeyens, & Van den Bergh, 2001). Thirdly, flavour liking can be acquired through *mere exposure effects* (e.g. Pliner, 1982), whereby liking for a flavour is increased simply as a function of exposure to the flavour i.e. the more you experience a flavour, the more you start to like it.

Evaluative conditioning or evaluative learning fits into the liking acquisition processes as a general form of *FFL*. In other words, *FFL* is a specific form of evaluative conditioning involving flavours rather than pictures of beaches or other stimulus types. Increases in liking have been observed with sweet-paired flavours (e.g. Brunstrom & Fletcher, 2008), as well as with a multitude of other positive stimulus types (see De Houwer, Thomas, & Baeyens, 2001). Similarly, pairing with bitter or soapy tastes has been shown to decrease flavour liking (e.g. Yeomans, Mobini, & Chambers, 2007). Evaluative conditioning does not always produce changes in liking, however, and the investigation of boundary conditions for liking to change is an active research area (see e.g. Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010; Yeomans, 2010).

A cardinal feature of Pavlovian conditioning is that only surprising or unexpected USs support learning, which is most succinctly illustrated by the blocking effect (Kamin, 1969). Blocking is observed when the amount learned about a cue is attenuated or blocked by the presence of another cue that has been pretrained as a predictor of the same outcome. This cue competition effect can be illustrated by imagining drinking a novel and refreshingly palatable soft drink, Mezzo (US), which has a distinctive logo on the bottle (target CS), which itself has a shape that is similar to that of an established, attractive soft drink (pretrained CS), for example Pepsi. If blocking were to take place, then the presence of the Pepsi-shaped bottle would predict the positive affective reaction to the drink US and therefore block the acquisition of liking (evaluative conditioning) to the novel Mezzo logo.

Although blocking has been demonstrated in a number of human conditioning paradigms, such as electrodermal (Hinchy, Lovibond, & Terhorst, 1995), and eyeblink conditioning (Martin & Levey, 1991), the evidence for blocking in appetitive evaluative conditioning is mixed. When Dickinson and Brown (2007) pretrained the colour of a drink as a predictor of whether it would taste sweet or soapy, the amount of evaluative conditioning to a flavour added to the drink was unaffected by whether its taste was predicted by its colour. In other words, prior colour-taste learning failed to block flavour-taste learning. By contrast, in a procedure in which visual icon CSs were paired with fruit juice USs, Tobler, O'Doherty, Dolan, & Schultz (2006) reported blocking of the conditioning of a positive evaluation of the icons. Although there are many procedural differences between these two studies, one of the most notable concerns the modality of the CSs and USs. Tobler and colleagues (2006) used an across-modality procedure, in which the CSs were visual and the USs were gustatory, whereas Dickinson and Brown (2007) used a flavour-flavour, within-modality procedure. Given this difference, the purpose of the present study was to re-examine whether blocking occurs in across-modality evaluative conditioning of the type envisaged by the hypothetical competition between the shape and logo of soft drink bottle.

Therefore, similarly to Tobler and colleagues (2006), we employed visual CSs and gustatory USs. However, as our procedure differed from that employed by Tobler and colleagues in a number of respects, Experiment 1 established that this procedure supported evaluative conditioning to the visual CSs before Experiment 2 investigated whether this form of conditioning was subject to blocking.

Exp 1. Evaluative Conditioning

A problem with employing gustatory USs is that participants vary greatly in their liking for such stimuli. In an attempt to minimize such variation, we developed a novel procedure in which the participants selected their own highly-palatable hedonic foods to act as USs. At the time of recruitment, the participants were asked to identify their most liked foods in a number of categories and the two that were most liked were chosen to act as the hedonic USs. During conditioning, the opportunity to consume each of these hedonic foods were then signalled by a different CS, which were visual logos (H), before the participants were finally asked to rate their liking for the CSs.

The second change concerned the control CS against which evaluative conditioning is assessed. Tobler and colleagues (2006) compared the ratings for a CS paired with a hedonic US to one paired with no US. However, this control confounds the hedonic value of the outcome associated with each CS with whether or not the CS is associated with any US. To minimize this confound, we assessed evaluative conditioning by contrasting the change in the liking for the H logos from the initial, preconditioning ratings with those for another pair of neutral CSs (N logos) that signalled neutral USs during conditioning. Evaluative conditioning would have occurred if the positive change in liking was greater for the H logos than for the N logos.

The use of the neutral CS control also allowed us to address a further concern. In addition to assessing evaluative conditioning, we also measured contingency learning by asking the participants to predict on each trial which specific food was associated with each logo CS. The importance of assessing contingency learning lies with the interpretation of any difference in the post-conditioning evaluative ratings for the H and N logos. An interpretation of such a difference in terms of evaluative conditioning attributes the effect to the hedonic valence of the US rather than to a difference in the ability of the particular USs to engage learning processes per se. An assessment of contingency learning therefore allowed us to assess the extent to which any evaluative conditioning was mediated by the impact of the US valence on general learning.

Finally, Tobler and colleagues (2006) also reported an implicit, reaction time (RT) measure of conditioning by asking their participants register by spatially differentiated responses the location of the CS during training and found faster responding to CSs associated with a hedonic US. As this implicit measure goes someway to validating the explicit evaluative ratings, we also included a spatial RT measure during the assessment of evaluative status of the CSs.

Participants, Stimuli and Apparatus

Adult volunteers, mainly undergraduates (females: 3; males: 7), were recruited from the Cambridge area and were asked to have a light morning or afternoon meal and then to fast for at least 4 h before the experimental session. This was essentially a pilot study, so the sample size was chosen to be small. Participants were tested individually in an experimental room in which they sat at a table facing a computer screen (PC with a 1280x1024 display; *Figure* 5). The program controlling the experiment was written in VB.NET 2008. The volunteers were paid for their participation at the end of the session.

Ethical approval for this study was attained from the Psychology Research Ethics Committee of the University of Cambridge (see *Appendix E*). Information about the study was provided to the participants through the recruitment website (see *Appendix F*), and through the consent form when the participant arrived, as well as the study tutorials themselves (*Appendix C*). A written consent form was given to each participant to read and to sign at the start of the session (see *Appendix G*). In addition, the participant was asked if they have any questions, or if anything is unclear before the experiment commenced. All data was recorded anonymously using anonymous participant IDs, and the volunteers were free to stop the experiment at any time without having to give a reason. Although participants chose their own favourite foods, any participant who reported a food allergy was excluded from taking part in the study. At the end of the session, an interview was conducted with each participant, in which they were debriefed about the experimental hypotheses, and asked to give feedback about the study, with emphasis on any discomfort the study might have caused (see *Appendix H*). None of the participants reported discomfort, but reported rather enjoying their favourite foods.

Abstract Brand Logos (CSs). Four abstract pictures selected from a set constructed by (Kuwayama, 1973) served as CSs. This source contains a collection of commercial brand logos that are likely to be unfamiliar to the general population and that are utilised in marketing research (Henderson & Cote, 1998). The original black and white images of different shape categories were digitally coloured for this experiment to enhance the discriminability of individual images. The CSs were 400 by 400 pixels in size and presented in either the top left- or right-hand side of the screen. The assignment of the pictures to the roles of the H and N logos were counterbalanced across participants.

Food Unconditioned Stimuli (USs). The hedonic USs were established using a web-based questionnaire during initial recruitment of participants (see http://tinyurl.com/fabfood). The participants specified six of their most favourite foods from different food categories and then ranked the list, allowing us to pick the two most liked foods to act as hedonic USs. Examples of the hedonic USs are Belgian chocolates, strawberries or different cheeses. The neutral USs, oats and miniwheats, were picked from a pilot study as dry and bland foods that the participants generally rated as moderately disliked. The unit sizes are visible in *Figure* 5, as well as the total amount consumed. Relative nutritional values and energy densities were not controlled, but determined by the nature of the favourite foods chosen by the participants. As illustrated in *Figure* 5, the two hedonic USs and the neutral USs were placed on the table with the computer on each side of the participant. The positions of the individual USs with respect to each other were rotated across participants.

Fig 5. Food Placements

Both the hedonic and neutral foods were placed on each side of the computer that presented the brand logo CSs. The arrows were used as US indicators to point to the participants, which food they need to self-administer with a given brand logo. The arrows also represented the four different foods on the surfaces when the participant had to predict, which food a given brand CS was followed by – to measure contingency knowledge.

Procedure

Participants were asked to sit behind the computer and to follow the instructions on the screen. Before each stage instructions appeared describing to the participant step by step what they should do, which was always followed by 2 practice trials.

Initial Evaluation Test. To provide baseline evaluative ratings, initially the four CSs and four USs were rated on the Labelled Affective Magnitude (LAM) scale (Schutz & Cardello, 2001), which is claimed to have ratio properties (Cardello & Schutz, 2004). The scale presented the following (negative) positive scale points: (-)80-60: (dis)like extremely; (-)60-40: (dis)like very much; (-)40-20: (dis)like moderately; (-)20-0: (dis)like slightly; 0: neither like nor dislike. Each CS was presented individually once on either the left or right side of the screen together with the LAM scale and the participants were required to rate this stimulus by moving a cursor along the scale using the mouse. To encourage immediate evaluations, the participants had no more than 7 s to make each rating. An additional spatial reaction time (RT) measure was also taken during CS evaluations. This measure was the RT to press the marked G and H keys on the keyboard to register whether CS appeared on the left or right side of the screen, respectively. These keys were chosen to make the spatial position of the CS and the response compatible. In each CS evaluation test, the trial started with the RT measure and was then followed by the LAM measure. The USs were also rated on the LAM scale while the participants actually tasted the food but without the RT component.

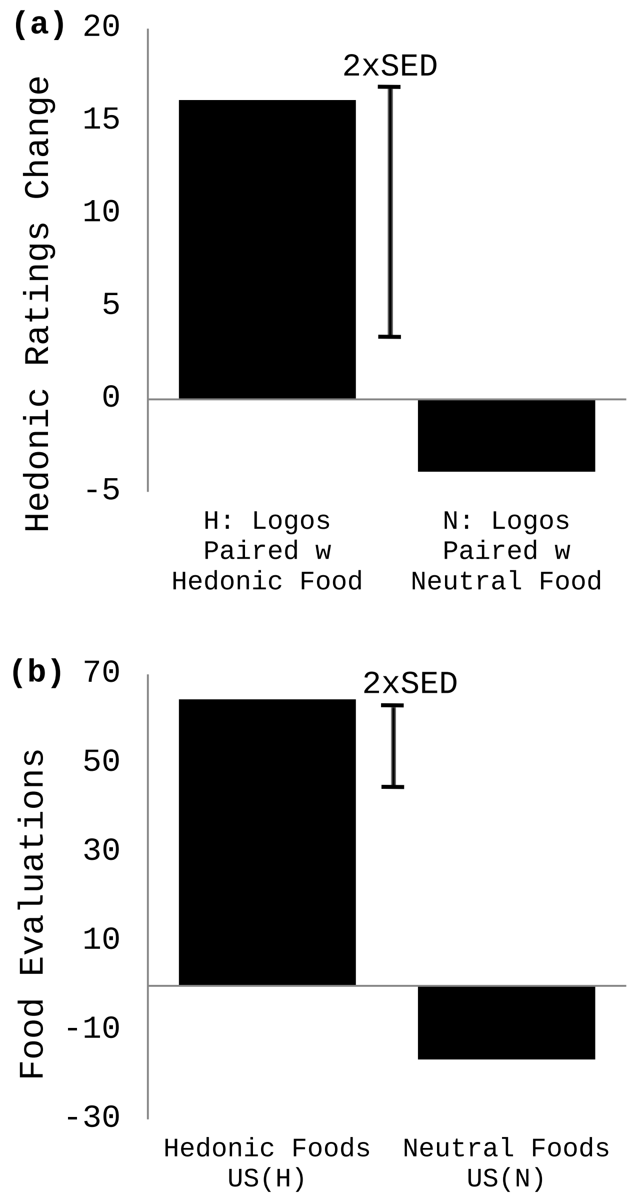
Evaluative Conditioning. After the initial evaluations, each participant received six trials with each of the four CSs presented in a random order that varied across participants. In the initial instructions the participants were told to self-administer a given food whenever one of the US indicators (arrows) appeared on the screen. One H logo consistently signalled consumption of one of the hedonic USs, and the other H logo the consumption of the other hedonic US. Similarly, each of the N logos signalled consumption of one of the two neutral USs. In order to assess contingency learning, each conditioning trial started with the presentation of one of the CSs and a centrally placed panel displaying four arrows indicating the locations of the four USs and an instruction to predict which of the four foods was signalled by the logo CS. The participants then decided which US indicator arrow to click to indicate which food they thought they would be eating next and were instructed to hold down the mouse button longer if they were more confident about their prediction. Having predicted the location of the food paired with the CS, the correct US arrow flashed on the screen indicating to the participant which of the four USs to consume. During the 16-s period while the particular US was being eaten, the CS flickered randomly every 1-4 s, and the participants had been instructed to count the total number of CS flickers. Then, immediately after this consumption period, they reported the number of flashes by highlighting the appropriate number with a click of the mouse in a list of numbers from 0-9. The purpose of this task was to ensure that the participants attended to the CS during consumption of the US. The trial then terminated with a request to take a sip of water from a glass on the table in order to neutralize the taste of the food before the next trial started. The next trial was started by the participant by clicking a button, which was preceded by a 1-s inter-trial interval (ITI).

Final Evaluation Test. The experiment concluded with a repetition of the procedure used in the baseline evaluation phase. Note that our design enabled the use of change in evaluations between initial and post-conditioning scores rather than post-conditioning scores on their own, which de-confounds the currently uninteresting visual aesthetic evaluation from that of conditioning related evaluation i.e. not confusing how ‘pretty’ a visual attribute of an image is with food pairing related changes in evaluation.

Exp 1. Results and Discussion

The evaluative ratings for the USs shown in *Figure* 6 (Panel B) confirm that the individual selection of the USs on the basis of the questionnaire responses did in fact yield hedonic USs with a higher evaluative ratings than those for the neutral USs, acquired at the start of the session, $t(1, 9) = 12.4$, $p < .01$. More importantly, *Figure* 6 (Panel A), which displays the difference between the initial and final evaluation ratings for the CSs, illustrates that the hedonic USs supported more evaluative conditioning to their associated CSs than did the neutral USs. The H logos showed a positive increase from an initial mean rating of 7, whereas the N logos, if anything, decreased from an initial mean rating of -4. The reliability of this differential evaluative conditioning was confirmed by a significant interaction between the effects of the evaluation test (initial vs. final) and CS type (H logo vs. N logo), $F(1, 9) = 5.54$, $p = .04$.

Fig 6. Evaluative Conditioning



The top panel shows the main evaluative conditioning result, comparing the evaluations of H brand logos (paired with hedonic food) with evaluations of N brand logos (paired with neutral food).
The bottom panel shows that the participants liked the hedonic food USs more than the neutral USs. The error bars represent double Standard Error of the Difference (SED), for the depicted comparisons.

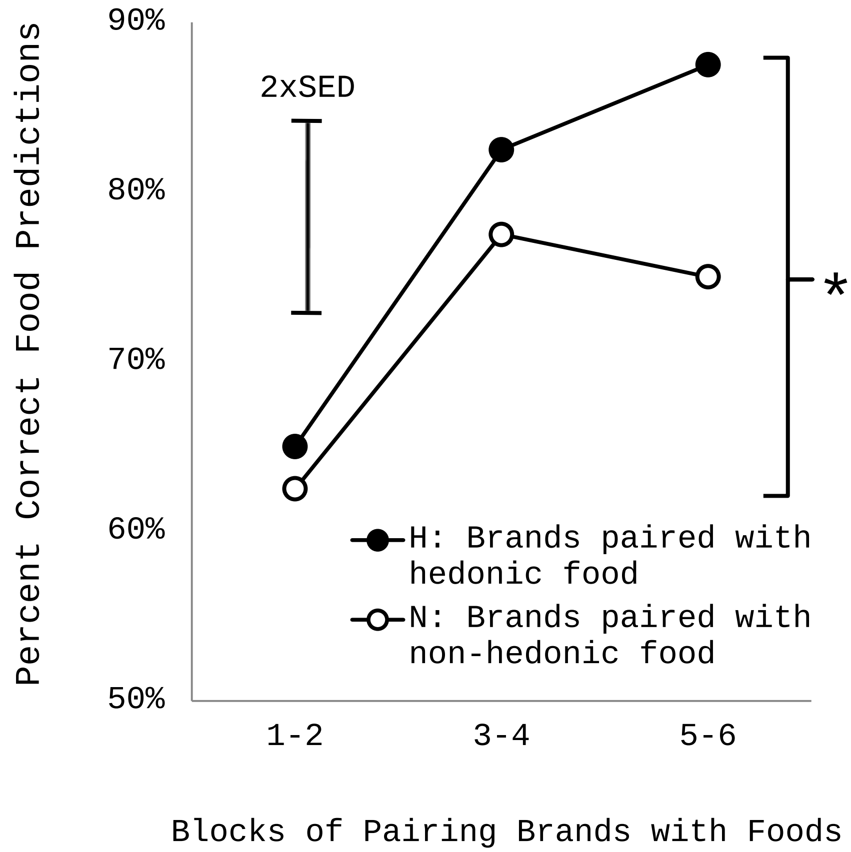
We also assessed Tobler and colleagues (2006) observation that evaluative conditioning was accompanied by implicit learning as assessed by the RT to register the side on which the CS was presented. This RT increased by 130 ms for the H logos, but decreased by only 5ms for the N logos, an effect that is substantiated by a significant Test X CS Type interaction, $F(1, 9) = 6.02$, $p = .04$.

The percentage of trials on which the participants predicted the correct food was pooled across two-trial blocks for analysis and presentation in *Figure* 7 of contingency learning. The percentage of correct predictions of the next food increased with training, $F(2, 18) = 5.37$, $p = .01$, illustrating that contingency learning occurred with our paradigm. Although the graphic data suggests that less learning may have occurred to the N logo CSs than to the H logo CSs, we doubt whether a general learning deficit with the neutral USs contributed to the differential evaluative conditioning. Neither the effect of CS type nor the interaction with trial block approached significance, both Fs < 1.

Exp 1. Discussion

We replicated the evaluative conditioning with visual CSs and food USs observed by Tobler and colleagues (see also Johnsrude, Owen, Zhao, & White, 1999; 2006). It is not clear why Baeyens, Eelen, Van den Bergh, & Crombez (1990) failed to find such cross-modal evaluative conditioning, although it may be significant that they used uniformly coloured CSs, whereas the successful procedures, including the present one, used more complex visual CSs.

Fig 7. Non-Evaluative Predictive Learning



The figure shows how the participants learnt to predict which food US was paired with a given brand CS, in Experiment 1. With more conditioning pairings of the brands with the foods, the percentage correct predictions increased significantly for the brand logos. Participants provided more accurate predictions for brands that were paired with hedonic food (H) compared to predictions for brands paired with non-hedonic food (N), although the difference was not significant. * indicates $p < .05$

In summary, this experiment established that our procedure employing self-selected food USs established cross-modal evaluative conditioning, both in terms of the explicit hedonic ratings and the more implicit spatial RT measure. Moreover, this differential evaluative conditioning was observed in the presence of significant contingency learning for both CS types. Therefore, we employed this procedure to investigate whether blocking occurs in this form of evaluative conditioning in the next experiment.

Exp 2. Blocking

Table 4 illustrates the design of the second experiment and *Appendix C* provides screenshots of the interactive tutorial guiding the participant through the procedure. After the initial hedonic evaluations of the CSs and USs, the pretraining stage was identical to the training given in Experiment 1. The H logos were established as predictors of hedonic USs, whereas the N logos signalled neutral USs. This basic training regime continued into the compound training phase, except for two changes. First, a second novel logo was also presented on each trial with the B logos being presented in compound with the H logos and the C logos in compound with the N logos. Second, these cue compounds consistently signalled a hedonic US. Finally, the hedonic evaluations of the cues were reassessed.

Table 4. Design of Blocking Experiment

Condition	Initial Evaluations	Pre-Training (Conditioning)	Compound Training (Conditioning)	Final Evaluations
Blocking	H	$H \rightarrow US_H$	$BH \rightarrow US_H$	H
	B			B
Control	N	$N \rightarrow US_N$	$CN \rightarrow US_H$	N
	C			C
Neutral	X		$XY \rightarrow US_N$	X
	Y			Y

Cues H, B, N, C, X, Y: brand logo CSs;
US_H: hedonic food US; US_N: neutral food US

The critical evaluations for assessing blocking are those of the B and C logos. The B logos were trained in compound with the H logos, which had been previously associated with a hedonic US. Consequently, if blocking occurs in this form of evaluative conditioning, relatively little conditioning should have accrued to the B logos during compound training because the occurrence of the hedonic USs on these trials would have been predicted by the presence of the pretrained H logos. By contrast, the C logos were trained in compound with CSs, the N logos, that had been previously associated with neutral USs so that the occurrence of the hedonic US on the compound trials in this control condition should have been unpredicted and surprising, and therefore capable of supporting evaluative conditioning to the C logos. In summary, the critical contrast for assessing blocking is that between the final evaluative ratings for the B and C logos - relative to their initial ratings – and blocking would have occurred if the ratings for the B logos were lower than those for the C logos.

Although the interpretation of a blocking effect with this design is straightforward, the theoretical significance of a failure to observe blocking is more problematic. Therefore, we included two further elaborations on the basic design to strengthen interpretation of similar evaluative ratings for the B and C logos. First, blocking can only be observed if the compound training stage actually supports some evaluative conditioning to be blocked. Therefore, a compound of two further sets of logos, X and Y, were paired with the neutral USs (see Table 4). A comparison between the relative final evaluations of the C logos with those for the X/Y logos established whether or not the compound training supported evaluative conditioning to the C logos as well as showing that the measurement technique is sensitive enough to discriminate between the conditions.

The second modification was to include a test of contingency knowledge following the assessment of the final evaluative ratings. A failure to observe evaluative blocking could only be of theoretical significance if our design supported the basic conditions for blocking to occur. As it is well established that contingency learning is subject to blocking (e.g. Aitken, Larkin, & Dickinson, 2000; G. B. Chapman & Robbins, 1990; Dickinson, Shanks, & Evenden, 1984), a demonstration that less had been learned about the contingency between the B logo and the hedonic US than about the C logo-hedonic US relationship during compound training would establish that our procedure was capable of supporting blocking.

Participants, Stimuli and Apparatus

Adult human volunteers (females: 8; males: 8) were recruited as in Experiment 1 and tested under the same conditions with the same apparatus. The sample size for this experiment was chosen to be slightly above that of *Experiment 1* given that the first experiment produced significant results with a small number of recruits. However, this was not sufficient to yield a powerful design with respect to the measurement of blocking: in order to be able to detect a small effect, the sample size should have been approximately 200; about 35 participants would have been needed to detect a medium effect (d = 0.5). The sample size was sufficient to detect large effects (d = 0.8; approximately 15 participants needed). Nevertheless, we were as interested in small and medium effects, as large effects, because of the theoretical implications of any effect size, so this study was under-powered. We employed the same type of brand logo CSs, but included an additional four pairs of logos to play the roles of the B, C, X and Y logos. The assignment of actual brand logos to the different CS conditions was counterbalanced between participants, such that any given physical brand logo for one participant was trained under a different contingency for another participant. Again, the hedonic USs were selected for each participant using the web-based questionnaire as in Experiment 1 and the neutral USs were the same as before.

Procedure

Initial Evaluation Test. The procedure for assessing the baseline evaluative ratings for the CSs and USs using the LAM scale, was the same as in Experiment 1 except that the additional CSs were also rated.

Pretraining. The procedure during the pretraining was identical to that employed during the evaluative conditioning of Experiment 1. In summary, each H and N logo predicted a hedonic and neutral US, respectively, for 6 trials.

Compound Training. The pretraining procedure was continued into the compound training stage with three changes. First, each trial presented two CSs, one in the top left hand corner of the screen and the other in the top right hand corner. The H logos were presented in compound with the B logos and the C logos in compound with the N logos. The identity of the individual logos comprising each BH and CN compound remained consistent across trials, although spatial location of the CSs within the compound was varied randomly across trials. Second, both the BH and CN compounds signalled the consumption of a hedonic US with identity of the US paired with a logo compound remaining consistent across trials. Moreover, the specific hedonic US paired with a particular BH compound was the same as the hedonic US that was paired with that H logo during pretraining. Finally, trials were also included in which a compound of the X and Y logos signalled consumption of a neutral US. Seven presentations of each compound were given in a random order that varied across participants. In all other respects, the procedure was identical to that employed during evaluative conditioning in Experiment 1.

Final Evaluation and Contingency Knowledge Test. The experiment concluded with a repetition of the procedure used in the initial evaluation test, followed by a contingency knowledge test. The participants were asked to report their contingency knowledge for B and C as well as X and Y. Contingency knowledge was measured the same way as during the conditioning stages except that no feedback and no self-administrated US followed.

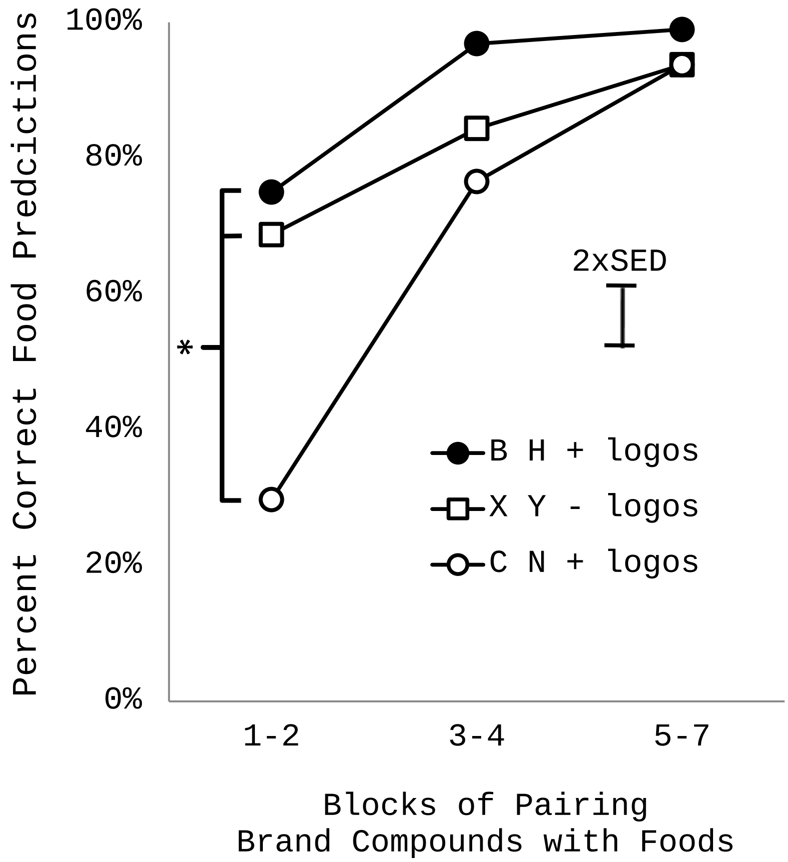
The final measure of contingency knowledge utilised two components. First, whether the participants correctly identified the hedonic food US as the food US paired with the brands, yielding a score of 1 if the participant correctly predicted B or C to be paired with hedonic food and -1 if the participant incorrectly predicted B or C to be paired with neutral food. For the brands X and Y, which were paired with neutral food, the opposite assignment was made, 1 if the participant correctly predicted X or Y to be paired with neutral food and -1 if the participant incorrectly predicted X or Y to be paired with hedonic food. Even though our analyses sought to determine whether the participants had knowledge with regard to the valence of the food (pleasant or not) rather than knowledge about the specific food identity (e.g. strawberries), the participants were nevertheless asked to predict the specific foods (and thereafter the valence prediction was extracted from their specific predictions, for analyses).

The second component of the contingency knowledge measure was the confidence rating determined by how long the participant held the mouse button to indicate how sure he or she was about the correctness of the prediction. As individual baselines of confidence rating varied between participants and the participants used the range of the scale to varying degrees, the raw confidence scores were converted into z scores, where the mean and standard deviation were calculated based on all non-practice confidence ratings for each individual. In computing the individual z-scores the values for B, C, X and Y CSs for any given participant were always assessed against the same mean and standard deviation. The final measure of contingency knowledge was then calculated by multiplying the correctness of prediction (1 or -1) by the confidence z score. Consequently, when a participant correctly predicted the valence of the US and was confident about the prediction being correct then the contingency knowledge index was high and positive. Conversely, when a participant incorrectly predicted the incorrect food valence, but was not confident about the prediction, the index would have had a low and negative score.

Exp 2. Results

Acquisition of Predictive Response. The profile of contingency learning during pretraining was similar to that observed in Experiment 1 in that the participants rapidly learned to predict which US to consume. The growth in percentage correct predictions for the H stimuli with increasing blocks of trials was from 83.3 % (SEM = 4.6) to 90.6 % (SEM = 4.4) to 98.4 % (SEM = 1.5). The growth for N stimuli was from 45.8 % (SEM = 5.5) to 85.9 % (SEM = 4.5) to 95.3 % (SEM = 3.3). As in *Experiment 1*, predictive elemental learning was confirmed by main effect of block in RM-ANOVA with block and stimulus-type as within-subject factors, $F(2, 30) = 31.63$, $p < .01$. However, there was also an effect of stimulus-type, as well as an interaction of the factors, $F(1, 15) = 36.2$, $p < .01$ and $F(2, 30) = 10.74$, $p < .01$, respectively. The latter effects stemmed from the low percentage correct score in the first block of N trials / or from the high percentage correct score in the first block of H trials, even though participants were mostly guessing what the outcome was in that first block. The reason for this difference is likely to be that participants had an initial bias to pick their favourite foods when guessing the outcome / before they had any information to base their predictions on. *Figure* 8 illustrates the acquisition of the prediction response across compound training. The prediction response to the BH compound was maintained across compound training in the blocking condition. By contrast, in the control condition, with the change in US the participants initially made the wrong predictions before rapidly learning the new correct predictive response. Concurrently, they also rapidly learned the correct prediction in the neutral condition. There was a significant Condition X Trial interaction for the percentage correct prediction responses during compound training, $F(4, 60) = 6.81$, $p = .01$, and simple main effect analysis showed that performance in the blocking and neutral conditions was superior to that in control condition in blocks 1-2, $F(1, 15) = 56.53$, $p < .01$.

Fig 8. Compound Predictive Learning



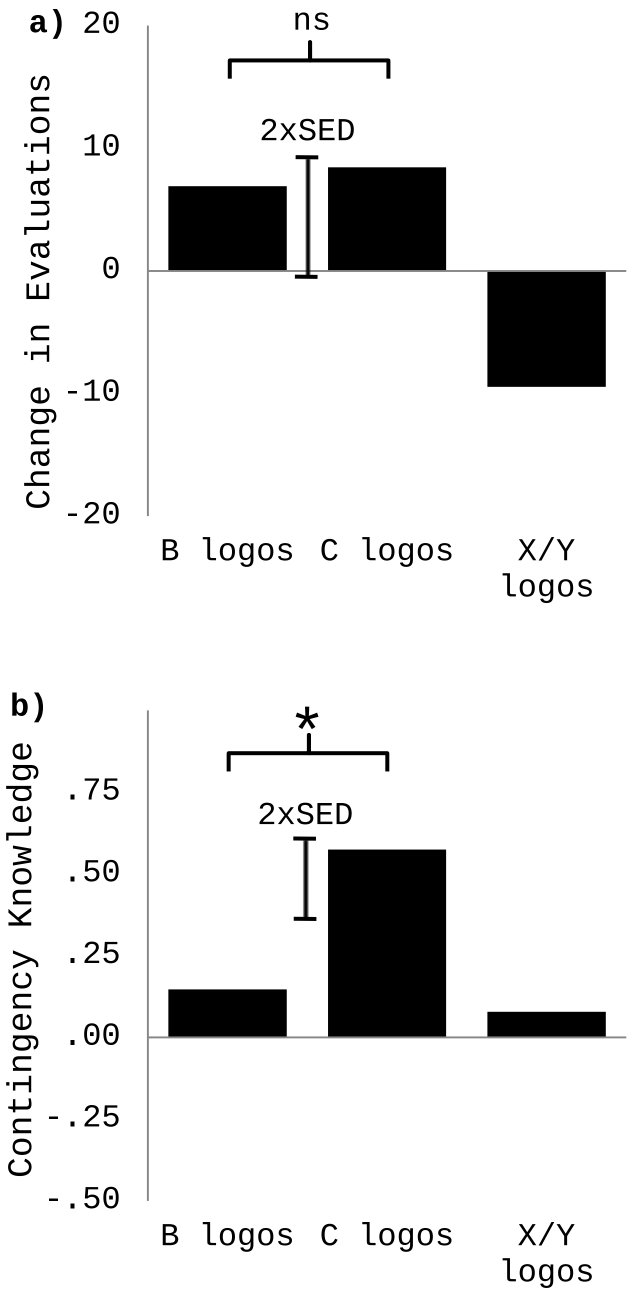
This figure exhibits how the participants continued to predict, which food US was paired with the given brand CS compounds, in compound training of Experiment 2. Initially the predictions were poor for the control CN brand compound as they were now unexpectedly paired with hedonic food compared to the blocking BH brand compound, which continued to be rated as predictors of hedonic food. See Table 4 for the compound (and elemental) training conditions used in this blocking paradigm.

Cue Competition

Evaluative Ratings. The top panel of *Figure* 9 displays the mean differences between the initial and final evaluative ratings for the CSs introduced during compound training. There was no evidence for evaluative blocking in that the ratings for the B logos were similar to those for the control CSs, the C logos. However, the fact that the ratings for these CSs were higher than those for the CSs trained with the neutral US, logos X/Y, established that compound training supported evaluative conditioning. An analysis of the evaluative ratings yielded a reliable interaction between the evaluation test (initial versus final) and the type of CS, $F(1, 15) = 5.05$, $p=.04$. The source of this interaction was determined by a set of orthogonal contrasts between the difference between the initial and final ratings for each CSs type. There was no significant difference between these evaluative change scores for logos B and C, $F < 1$, although the combined evaluative score for these CSs were significantly higher than for logos X/Y, $F(1, 15) = 7.01$, $p = .02$.

Contingency Knowledge. The bottom panel of *Figure* 9 shows the contingency knowledge scores. In contrast to the evaluative scores, blocking was observed for contingency knowledge in that the B logos obtained lower scores than the C logos, $F(1, 15) = 6.16$, $p = .02$. Unexpectedly, however, the participants showed little knowledge about the contingency between the X/Y logos and the neutral USs in that the contingency knowledge for these CS, were significantly lower than those for the C $F(1, 15) = 4.54$, $p = .05$.

Fig 9. Lack of Evaluative Blocking



No competition between brands for liking (a), in contrast to blocking in predictive learning (b). The top graph shows the evaluative blocking comparison, where the B to-be-blocked brand logo CSs were, however, not liked significantly differently from the C control CSs. The bottom graph shows the equivalent results for non-evaluative predictive learning, the results differing from first graph in that the participants were significantly less knowledgeable about which foods the B to-be-blocked pictures were paired with, as compared to the higher knowledge of what food the C control pictures were paired with. *ns* indicates non-significance above threshold alpha 0.05. X/Y brand scores are provided for control comparisons (see text).

Discussion

In summary, we found that the visual CSs, which were paired with hedonic food, were evaluated higher than the logos paired with neutral food USs, thereby replicating the cross-modal evaluative conditioning observed in the first experiment. More importantly, however, we found no evidence for blocking of evaluative conditioning. The strength of evaluative conditioning accruing to a CS as a result of compound training with a hedonic US was unaffected by whether or not the other element of the compound had been pretrained with a hedonic or neutral US.

Our failure to find blocking was not due to the absence of evaluative conditioning during compound training because the visual CSs paired with the hedonic US were more liked than those paired with neutral CSs at the end of this training. Nor was the absence of evaluative blocking due to the failure of our paradigm to support blocking because the participants failed to learn as much about the predictive relationship between a CS and the particular US, if the other element of the compound had been pretrained as a signal for this US. In other words, our procedure supported blocking of predictive or contingency learning. This being said, it must be acknowledged that the failure to find evaluative blocking is a null result, and it is always possible that a more sensitive measure of liking would have detected a difference in evaluative conditioning as a function of the pretraining of the other element of the compound. Furthermore, our study is more under-powered than that of Tobler and colleagues (2006). That is, retrospective power analysis showed we had power of .46 to detect a medium effect, making lack of power a considerable alternative interpretation to the lack of evaluative blocking. In other words we may ascertain with sufficient confidence that evaluative conditioning does not exhibit strong blocking (with a difference of more than 0.8 standard deviations), but the same cannot be said about medium or small effect sizes. This alternative interpretation needs to be tested in future studies with increased sample sizes, achieving power of at least .8 for medium effects, and perhaps even endeavouring to detect smaller effects. It remains noteworthy, however, that we did observe parallel blocking of predictive learning.

Our results stand in contrast to those of Tobler and colleagues (2006) who reported blocking of “pleasantness” ratings for a visual CS paired with fruit juice. Although there are many differences between the procedure that they employed and our paradigm, one of potential importance concerns the control condition against which the blocking was assessed. In Tobler and colleagues (2006) the pretrained element of the control compound was presented alone without any outcome during the pretraining, and consequently it is possible that their participants stopped attending to this CS during the pretraining, a decrement that then transferred to compound training. As a result, the control pretrained CS would not have competed with the added CS for visual attention, thereby enhancing conditioning to the added CS. By contrast, the pretrained CS in the blocking condition, having been paired with the US, would have competed with the added CS for attentional resources and so blocked conditioning to this CS. In summary, it is possible that the blocking observed by Tobler and colleagues (2006) reflected attentional competition between pretrained and added CSs.

It is unlikely that such attentional competition would have exerted a differential effect in our procedure. First, during pretraining the control pretrained CS (N – see Table 4) was paired with a neutral US which the participants had to learn to predict, a task requirement that should have maintained visual attention to this CS. It could be argued, however, that such a neutral CS may not provide an adequate control for the role of attentional processes. Although the participants clearly learned about the relationship between neutral CSs and the neutral USs during conditioning (see Figures 3 and 4), they showed little evidence of contingency knowledge about X and Y in the final test. We suspect, however, that a failure to learn about the relationship between neutral CSs and USs is not the reason why the contingency knowledge acquired during XY compound training did not transfer to the final test in which X and Y were assessed alone. It is well established that human participants often fail to show cue-competition effects, such as blocking, because they tend to adopt a configural strategy when processing compound stimuli, such as the XY compound, so that little learning accrues to the elements of the compound (e.g. Williams, Sagness, & Mcphee, 1994). The pretraining to the H and N logos in the blocking and control conditions (see Table 4) may well have prevented such configural processing of the BH and CN compound logos, respectively, thereby enabling cue competition to function.

In summary, we doubt whether attentional competition differentiated our control and blocking conditions. Consequently, the absence of evaluative blocking in our procedure suggests that this form of conditioning, in contrast to contingency learning, is not modulated by whether or not the US is surprising or unexpected when attentional competition is minimised. This conclusion accords with Dickinson and Brown (2007) finding that evaluative conditioning was not affected by whether or not the US was predicted or unexpected using a colour/flavour-flavour paradigm in which there was no within-modality attentional competition.

What is also clear from the present results is that the blocking of contingency learning does not necessarily depend upon attentional competition, because we observed reliable blocking of this form of learning in spite of maintaining attention to the pretraining CS in both the blocking and control conditions. Dickinson and colleagues (1984) suggested that such learning depends upon whether or not the occurrence of the US generates a prediction error, which in turn governs learning either directly (Rescorla & Wagner, 1972) or indirectly (Mackintosh, 1975; Pearce & Hall, 1980). Alternatively, others have argued that blocking of contingency learning reflects the operation of causal inference processes (e.g. De Houwer, 2009).

Whatever the merits of these various accounts, blocking joins other effects that have been claimed to differentiate evaluative conditioning from predictive learning manifest in standard forms of Pavlovian conditioning. For example, it has been claimed that evaluative conditioning is abnormally resistant to both extinction (Vansteenwegen, Francken, Vervliet, De Clercq, & Eelen, 2006) and conditional control by occasion setters (Baeyens, Crombez, De Houwer, & Eelen, 1996; Baeyens, Hendrickx, Crombez, & Hermans, 1998). These dissociations have led Baeyens & De Houwer (1995) to endorse Martin & Levey's (1994) original claim that evaluative conditioning is mediated by a form of referential or holistic learning that is distinct from the process underlying standard Pavlovian conditioning and other forms of contingency learning. The differential impact of the blocking procedure on these two forms of learning observed in the present experiment reinforces this claim. Another interesting way of looking at evaluative conditioning is to regard it as a form of second-order conditioning. Second-order conditioning refers to the pairing of two CSs, where one of these CSs has been previously paired with a US. For example, associating a bell with a light, while the light has been previously associated with food reward. In evaluative conditioning, this interpretation is supported by the notion that the food USs themselves are really CSs, which have already undergone learning. That is, food stimuli may need to be involved in learning processes that associate the food CS with the accompanying reward USs. Referring to food stimuli as USs is then a short-hand for referring to this learnt association of food CSs with the reward elements as USs. Therefore, we are really pairing food CSs with the brand logo CSs, as a form of second-order conditioning.

Human food consumption may be shaped by a lack of evaluative blocking. In particular, consumption may be enhanced for foods that are associated with liked brands, but brands that do not actually cause positive affect, which nevertheless are liked as if they were the causes of liking. This implication will now be explained step-by-step. Consider a situation in which you (1) drink a pleasant soft drink, and at the same time notice both (2) a novel Mezzo brand logo, and (3) an already liked Pepsi visual CS. Before learning then, the Pepsi stimulus is already associated with a positive affective state due to past learning, but the Mezzo stimulus is not yet able to trigger a liking reaction. In accordance with our key finding, when the pairing of the pleasant drink and the two visual stimuli occurs, the already-liked Pepsi brand does not block the learning of liking for the Mezzo logo. The Mezzo logo becomes liked without competition from Pepsi. At this stage two effects have arisen. Firstly, Mezzo became liked despite Pepsi already predicting positive affective state, which occurred despite the redundancy of Mezzo as an affective stimulus. In other words, the lack of evaluative blocking implies a lack of competition from Pepsi, and enables contiguity-based learning instead of contingency-based learning; this is in line with the referential account of evaluative conditioning (see Baeyens & De Houwer, 1995). The second key effect was that Mezzo produced superstitious liking. As indeed Mezzo is not the actual cause of positive affect, attribution of causality to this stimulus represents misattribution. Therefore, as a consequence of Pepsi not having decreased the liking for Mezzo, Mezzo will be preferred to another neutral brand and the Mezzo drink consumed more (other things being equal), even though it is not the actual cause of positive affect.

However, evaluative learning does not necessarily give brands the ability to induce a genuine pleasurable reaction per se: instead evaluative learning associates brands with an abstracted or cognitive representation of positive affect. As Russell (2003a) explained “A stimulus can be perceived as to have affective quality with no change in core affect … as when a depressed patient admits that the sunset is indeed beautiful but is still not able to alter a persistently depressed mood” (p. 149). In our example, seeing the Mezzo logo on its own after evaluative learning, need not make you feel pleasure as such, instead you could value the brand more highly for having felt good in its presence. This model does not propose, however, that the process of learning evaluative likes is deliberative or highly explicit and rule-based in its nature. In fact, development of likes is posited to be automatic in the sense that you ‘cannot easily help it happening’. For example, when pleasantly intoxicated with wine you tend to attribute liking to any stimuli you encounter, or similarly, when you are having a ‘bad day’, you are inclined to automatically dislike the most salient stimuli co-present with your negative mood. Therefore, the concluding assertion is that the lack of evaluative blocking may lead to automatic liking, in a non-pleasurable evaluative sense, of brands and other targets as if the stimuli were the causes of positive affect, even when such causality is not present.

This chapter found that *pleasure* has the capacity to attribute *value* of some kind to stimuli that co-occur with the *hedonic reactions*. I shall discuss the nature of that *value* in the concluding chapter; just point out now that the nature of that *value* seems to *not* be a propagation of *pleasure reactions* themselves from the hedonic stimuli to the initially neutral stimuli. Next I shall explore what perhaps are the most important consequences of *pleasure*, which are its effects on our choices and on our motivation.

V. Hedonic Consumption and Motivation

Have you ever found yourself reaching for chocolate just before passing the till or perhaps even going out for the sole purpose of buying chocolate? You will likely have seen people linger around the doughnut/bakery section in the supermarket; or you will have snacked on grapes (rather than Brussels sprouts) before dinner was ready. Have you been unable to stop eating before a packet of crisps you like was empty? Perhaps you can find room for dessert even though you are full; or find yourself regularly going to the fridge looking for tasty snacks. Hedonic consumption, whereby the more pleasurable the food the more it is chosen and consumed, is a well-established phenomenon. For instance, Nisbett (1968) used a basic taste manipulation by either adding or not adding bitter tastant quinine to ice cream, and found that more grams of the *'good'* ice cream were eaten than the *'bad'* ice cream. Bellisle and colleagues (1984) found that highly-palatable sandwich snacks were consumed in a larger amount and for a longer duration than the less-palatable sandwich snacks. They also observed a higher eating rate for the high preference meal, including faster chewing per food unit in the first quarter of the meal, measured with strain gauges on a headset. Spiegel and colleagues (1989) also used preferred and non-preferred foods in the form of *solid food units* (*SFUs*) - custom-made sandwiches with different fillings - and similarly found that the more palatable test *SFUs* were consumed in larger amount, for a longer time. Additionally, more *SFUs* (of standard bite-size) were eaten per minute, in the beginning of the eating session. Bobroff and Kissileff (1986) used a different approach, whereby yoghurt was either adulterated or not adulterated with a flavouring cumin, making it less palatable, while not changing the macro-nutrient content of the yoghurts. Again, they found that the more palatable / unadulterated yoghurt was eaten in larger quantity, for a greater length in time and at a faster initial rate, measured using a hidden weighing scale under the drinks. The initial eating rate was calculated as the linear coefficient (slope) in a quadratic model of the cumulative intake curve (see more at Kissileff & Guss, 2001). There are many more reports of hedonic consumption, for example de Graaf and colleagues (2005) and Yeomans and colleagues (1997); for reviews of this literature see Sorensen and colleagues (2003) and Yeomans (1998), for instance.

This literature showcases hedonic consumption, the profiling of which we were targeting. Demonstrating this effect is an important part of the relation of these studies to our work. In terms of the designs and methods used, our work both shares some similarities and has some distinct differences compared to the studies carried out in the past. For instance, unlike many of these studies (e.g. Bobroff & Kissileff, 1986; Nisbett, 1968), we also targeted hedonic motivation in addition to hedonic consumption (motivation was perhaps indexed by chewing rate in Bellisle et al., 1984). Similar to e.g. Spiegel and colleagues (1989), and de Graaf and colleagues (2005), we compromised controlling for macronutrient composition and energy density in favour of incorporating a number of different foods with different hedonic qualities. We also employed actual food consumption rather than anticipated consumption, or replacing food with pictures of food (as did Yeomans et al., 1997 and many others). In contrast to e.g. Bobroff and Kissileff (1986), we aimed to profile these phenomena without the help of unpleasant foods (they used adulteration producing more unpalatable food rather than more palatable food); further pros and cons of our approach are highlighted later.

The impact of food pleasure on intake can become pathological, and so it would be clinically highly relevant to find specific ways to control the impact of this pleasure on intake (e.g. Halford, Boyland, Blundell, Kirkham, & Harrold, 2010; Nathan & Bullmore, 2009). In a substantial proportion of cases, food pleasure, through its impact on intake, is a primary factor that leads to over-consumption and obesity (e.g. Blundell & Finlayson, 2004; Erlanson-Albertsson, 2005; Schultes, Ernst, Wilms, Thurnheer, & Hallschmid, 2010). Although the mechanisms of over-consumption are not entirely clear, effects that occur near the end of meals are important. However, meal termination effects need not be the only critical mechanisms. In addition to the *'dessert stomach'* or *'pudding tummy'* phenomenon (Lowe & Butryn, 2007), food palatability influences how much is eaten in the midst of a meal (in the maintenance phase; Yeomans et al., 1997). Hedonic aspects also predict whether consumption is initiated in the first place, and how frequently, as well as which foods are preferred (Berteus-Forslund, Torgerson, Sjostrom, & Lindroos, 2005; Drewnowski & Hann, 1999; Rosas-Nexticapa, Angulo, & O'Mahony, 2005). Given that food pleasure is a considerable determinant of overeating, interventions against hedonically driven over-consumption would seem sensible. Intervening against hedonic over-consumption requires measurement of hedonic consumption, which in turn obviates the need for a relevant methodology.

Yet, we are not aware of any procedures specifically designed to model the impact of pleasure on food intake. Existing paradigms, such as various ad libitum intake or preload test-meal designs serve multiple useful purposes, while focusing primarily on factors influencing inhibition and termination of eating. The picture task developed by Finlayson and colleagues (2007a) involves rating pictures of foods, but does not measure actual consumption of food. Alternatively, the *Universal Eating Monitor* (*UEM*; Kissileff, Klingsberg, & Van Itallie, 1980) comes close as a tool for current purposes. The *UEM* consists of a highly accurate and precise weighing scale that is normally hidden under the food to be eaten: as the food is eaten, readings from the scale are monitored programmatically such that continuous information is available as to the amount of food eaten, as well as the eating rate. This covers the dependent variable of consumption. Pleasure and motivation are indexed using *Visual Analogues Scales* for pleasantness and appetite, respectively, presented to the participant on a computer screen at regular intervals during the eating session. However, the main issues in using this general-purpose instrument for profiling hedonic consumption and motivation specifically, are: 1) that the *UEM* allows incorporation of a relatively narrow sample or range of the independent variable to be assessed i.e. relatively few foods of different hedonic values can be given to any participant, often studying only two different levels of palatability, which is far from ideal for gauging into hedonic consumption. 2) If no cover story is built into the setup, task demand is more likely to alter the ingestive behaviour under study – even though the weighing scale is concealed, it is rather obvious to the participant that the main foci of the studies with *UEM* are about how much food is eaten, because that is all the participants are doing, sitting in a room with a food plate in front of them and filling in questionnaires. Ideally, there would be a plausible cover story that draws the participant's attention away from hedonic consumption. 3) *UEM* uses self-report scales to assess both palatability and appetite, which may produce cross-contamination of the measures (e.g. Booth, 2009; but see also Yeomans, 2000); given the serious potential for confusion when measuring both liking and wanting together, it would be very useful to index these phenomena through more independent means. Therefore, a laboratory procedure that specifically targets the profiling of hedonic consumption and motivation per se, is missing. The current study aimed to fill that important niche by providing a much wider set of hedonic experiences as the independent variable (by incorporating more foods); by providing a plausible cover story of taking part in a physiology experiment where the main focus is on the effect of food on the '*micro-sweating'* in the fingers of the participant; and by measuring motivation with a non-self-report technique. Our procedure aimed to incorporate the measurement of motivation by modelling the *'drive'* effects of incentive, as exemplified by starting to walk faster to a food-store when motivated to attain food, compared to walking more slowly if you were not as motivated to attain the food. Operationally, the implicit measurement of force exerted was an appropriate technique: participants had to press a hand-grip in order to get food without knowing that any forces were being measured.

In order to design an optimal procedure for assessment of hedonic consumption and motivation, three additional features were incorporated. Firstly, a laboratory tool should possess high ecological validity, in terms of employing familiar foods and actual eating. Otherwise, there is a real danger of studying arbitrary effects that actually have little relevance to the behaviour claimed to be under study. To reduce this risk, the current study incorporated primary rewards themselves rather than their symbolic representations, such as pictures of foods. Pictures of food, and food itself, *might* produce equivalent effects in participants, at least in every important respect. But, that equivalence needs to be explicitly established in order to equate effects obtained with pictures to effects obtained with foods. A strong explicit link has not yet been established between choosing from pictures of foods as a valid model of choosing from actual foods. In order to avoid the high impact risk of this link being weak, we opted for the use of common foods. Secondly, most existing paradigms involve negative feedback satiety signals. Such signals confound clear measurement of the impact of food palatability on intake. Thus, minimal fullness is the second feature incorporated in our dedicated hedonic assessment technique. As a final key feature, we incorporated automated rather than manual delivery of foods. Such a feature made the procedure convenient to use. This is particularly important given that the utilization of real foods made it somewhat less convenient and inconvenience beyond a certain threshold can become a critical handicap for the adoption of a procedure (see e.g. Blundell et al., 2009, pp. 308-309). Automated delivery also minimizes observer or experimenter biases (Hetherington, Anderson, Norton, & Newson, 2006).

In summary, there is a critical need for a procedure specifically designed to assess the impact of pleasure on food motivation and intake. In order to achieve this aim, such a procedure would preferably possess high ecological validity, as well as not be confounded by satiation factors and provide automated delivery of the foods used. The current study proposes a procedure meeting all these criteria. We have named this procedure the *Jaffa Cake task*.

In addition to developing a novel procedure for testing hedonic consumption and motivation, another, separate core aim for this study was to provide an analogue of a dose-response curve between pleasure and intake. While other investigations, e.g. Bobroff and Kissileff (1986) and Yeomans and colleagues (1997), have quantified the relationship between food palatability and consumption, we aimed to elucidate that function in more detail by assessing the relationship across a large selection of different foods for each participant. This study provided data from more than 15 different foods from each participant, compared to the use of 2 different foods per participant in most previous studies. Therefore, based on a comprehensive within-subject dataset, the second independent aim of this study was to derive equations that best describe hedonic consumption by quantifying this relationship (Zandstra, de Graaf, van Trijp, & van Staveren, 1999), beyond simply establishing the presence of an identifiable effect. Furthermore, by taking advantage of a technique called linear mixed modelling, the study aimed to incorporate individual differences parameters into the function. Establishing such a formula enables accurate and useful predictions, such as how many marshmallows Bob would consume based on how pleasant he found marshmallows to be.

The aim of *Experiment 1* was to validate the laboratory procedure, the *Jaffa Cake task*, which models the impact of food pleasure on food intake, in order that this tool could be used to assess interventions that would give control over this impact. The aim of *Experiment 2* was to establish the impact of pleasure on motivation in the *Jaffa Cake* *task*. Finally, data from both *Experiment 1* and *2* was used to quantify the impact of food pleasure on food intake, resulting in best-fit equations of hedonic consumption.

Exp 1. Hedonic Consumption

Participants self-administered a series of different food snacks with the option of deciding when to change the snack, while giving hedonic ratings of each snack. The main outcome measures in *Experiment 1* were hedonic liking ratings of the snacks and the corresponding amounts of snacks consumed.

Participants, Apparatus and Stimuli

Sample. 27 student volunteers (17 female) were included in this experiment through university-wide e-mail recruitment. The students received an invitation linking to a web-based recruitment questionnaire at http://tinyurl.com/JaffaCakeStudy that served as a common introduction to the study. Any candidates acquainted with the first author, or reporting psychology as their main specialty, were excluded from taking part of the study to minimize familiarity with study aims and to minimize highly analytical task performance. Participants were also required to be native speakers or fluent in English, and have no food allergies. For the participants that were selected, absence of food allergies was confirmed verbally at the start of the study. In addition, a silenced mobile phone was given to the participant with a direct line to the experimenter / first-aider seconds away, in the unlikely event that an emergency would have arisen. The sample size was chosen based on rule-of-thumb for psychology experiments. The actual sample size was below the detection threshold for large effects of hedonics, as approximately 40 participants would have been needed to achieve that ($f^2 = 0.35$). We were not interested in smaller effects, because the aim of the *Jaffa Cake task* was to isolate and profile the effects of hedonics, and a task that produces small effects would lack in these characteristics. Recruits were provided free food and received 7 GBP (approx. 12 USD) for participation in a 75-minute session.

Experimental Setup. As *Figure* 10 illustrates, participants were tested individually in a test room in which they sat at a table facing a computer screen (PC with a 1280x1024 resolution display). In addition, a dispenser containing all the snacks for the session was positioned to the left of the participant. This dispenser was built using standard Lego bricks and conveyor belts, Lego Mindstorms motors and sensors, and was controlled wirelessly over Bluetooth connection in order to allow user-initiated automated delivery of snacks. Unlike in *Figure* 10, however, the dispenser was concealed in a cardboard enclosure throughout the experimental sessions with only the food plate visible in front of the participant. A force hand-grip was also placed to the right of the participant (see *Figure* 10). This BIOPAC hand dynamometer (model TSD121C) had to be squeezed to trigger delivery of snacks by the dispenser. Before all experimental sessions, the hand-grip was calibrated using standards with fixed mass. The output units of these devices are set by the manufacturer to be in kg force rather than Newtons. Additionally, a filled non-drip water-bottle was placed in front of the participant. Finally, skin conductance sensors were used in this experiment. This GSR (Galvanic Skin Response) sensing system consisted of EL250 reusable electrodes, GSR100C amplifier and MP150 psycho-physiological data acquisition system (all BIOPAC equipment). The software package controlling the Lego and Biopac device communications as well as delivering instructions and rating scales to the computer screen, was custom-coded for this experiment in Visual Basic 2008 (.NET 3.5), and utilizing IONET.dll and NXT# libraries.

Fig 10. Jaffa Cake Task

Participants squeezed the hand-grip (1a) to deliver snacks one by one (1b). The pleasantness of each snack was rated on the LAM scale while eating the snack (2). After each snack the participants had a choice to deliver more of the snack they had just eaten or alternatively to move on to snack on a different food (4). Unlike the depiction in the image, during experimental sessions the food apparatus was covered, so the upcoming snacks were not visible to the participants.

Food Stimuli. 17 separate foods were selected from a pilot study. The pilot established which foods did not evoke aversive disgust evaluations while instead eliciting a range of hedonic ratings on tasting. The foods used were *Tesco Whole Food Apricots*, *Oatland Mini Jaffa Cakes*, *Co-Operative Malt Crunchies*, *McVitie's Mini Cheddars*, *Tesco Whole Food Cranberries, Fiddes Payne Pearl Swirls*, *Schneider German Rye Bread*, *Nestle Milkybar White Chocolate Buttons*, *Arnott's Barbecue Shapes*, *Nutberry's Yoghurt Coated Raisins*, *Jacob's Cheeselets*, *WeightWatchers Cheese Puffs*, *Tesco Whole Food Black Cherries*, *Tesco Butter Pastry Cases*, *Tesco Chocolate Flavour Cornflake Cakes*, *Weetabix Crisp Minis* and *Fazer Tutti Frutti Original*. See *Table 5* for details of the energies and macronutrient compositions of the stimuli used in the study (data given per 100 grams of each food). The practice food was always the same (the apricots) and was not re-used in test trials. The order of all the other foods was randomized by the software and pre-loaded onto the dispenser according to the random sequence given. Each food was available as 6 individual snacks, as visible in *Figure* 10. The individual snacks were cut to approximately uniform sizes, weighing about 2 grams each.

Table 5. Food Energies and Macronutrients Per 100g

Stimulus	**Energy /kJ (/kcal)**	**Protein /g**	**Carbohydrate /g (Sugars /g)**	**Fat /g (Saturates /g)**	**Fibre /g**
Tesco Whole Food Apricots	705 (165)	3.9	36.0 (36.0)	0.6 (0.4)	6.3
Oatland Mini Jaffa Cakes	1623 (385)	4.2	72.2 (52.4)	8.8 (4.8)	2.2

Co-Operative Malt Crunchies	1461 (344)	11.7	69.3 (0.7)	2.2 (0.5)	11.8
McVitie's Mini Cheddars	2160 (516)	11.2	51.2 (4.8)	30.0 (12.0)	2.4
Tesco Whole Food Cranberries	1380 (325)	0.4	79.0 (78.4)	0.8 (0.2)	4.7
Fiddes Payne Pearl Swirls	1210 (289)	0.0	77 (77)	0.0 (0.0)	0.0
Schneider Rye Bread	788 (186)	5.8	37.7 (0.8)	1.3 (0.3)	8.4
Nestle Milkybar White Buttons	2283 (546)	7.5	58.1 (57.7)	31.6 (20.0)	0.0
Arnott's Barbecue Shapes	2221 (520)	0.0	63.2 (1.6)	25.2 (11.6)	0.0
Nutberry's Yoghurt Raisins	1833 (429)	3.3	66.0 (62.7)	16.5 (13.2)	3.3
Jacob's Cheeselets	2053 (491)	9.5	55.1 (1.9)	25.8 (15.2)	2.3
WeightWatchers Cheese Puffs	1759 (417)	7.8	72.4 (3.2)	10.7 (1.4)	2.2
Tesco Whole Black Cherries	1480 (350)	0.2	84.3 (66.6)	1.1 (0.4)	2.1
Tesco Butter Pastry Cases	2005 (480)	7.8	65.3 (20.0)	20.5 (8.6)	2.4
Tesco Chocolate Cornflake Cakes	2093 (500)	7.5	75 (48.8)	22.5 (13.8)	3.75
Weetabix Crisp Minis	1563 (369)	9.5	70.9 (21.6)	5.3 (2.5)	9.4
Fazer Tutti Frutti Original	1480 (355)	1.5	84.0 (56.0)	0.2 (0.0)	0.9
Ryvita Crackerbread	1612 (380)	10.3	76.9 (1.5)	3.5 (0.5)	3.5
Taj Cassava Chips	2093 (500)	0.0	73.3 (0.0)	23.3 (6.7)	10
Mars Maltesers	2112 (505)	7.9	61.9 (53.3)	25.0 (15.2)	1.1

Tesco Free From White Bread	1140 (270)	3.6	47.6 (0.0)	7.2 (0.8)	4.0
Kallo Organic Rice Cakes	1578 (372)	8.0	78.7 (2.2)	2.8 (0.6)	5.1
Whittard Marshmallows	1404 (330)	3.1	79.5 (64.5)	0.0 (0.0)	0.0

Procedure

The procedure was carried out according to a written Standard Operating Procedure to maximize accurate and consistent execution of experimental protocol.

Preparation. Sessions were scheduled to start at 09.00, 10.45, 12.30, 15.45 or 17.30. Recruitment confirmation emails asked the participants to either have a light morning/afternoon meal before the session (at a time they would normally have it) or to skip that meal altogether if the meal would have been eaten 3 hours or less before the session. A day before a given session a reminder email was sent which asked the participants to avoid snacking and excessive drinking within the 3 hours leading to the start of the session. Snacks were cut fresh and set up on the dispenser half an hour before each session.

On arrival, the participant was asked to wash their hands with warm water but no soap. In order to ensure that the participants were aware of a plausible purpose for the study, the experimental aim from the recruitment web-page was repeated as the assessment of the effect of different foods on micro-sweating in their fingers. On entry to the test room the experimenter explained that the foods were hidden inside the cardboard enclosure in order to minimize any expectation effects on the physiological GSR measure. BIOPAC GEL101 was then applied and the GSR sensors slid onto the index and middle finger of the left hand.

Main Trial Structure. An interactive tutorial of the main task explained each part of the procedure to the participant, by way of step by step instructions that led the participant through their first snack (see *Appendix D*). As the arrow *1a* indicates in *Figure* 10, the participants were first instructed to squeeze the food grip*: "Whenever you are ready press and hold the food grip, to move a piece of food in front of you."* As a consequence of pressing the food grip, the dispenser responded by delivering a unit of food (a snack) onto the food plate in front of the participant (1b in *Figure* 10; the snack for the tutorial was a piece of apricot). The force that participants exerted to earn a snack was recorded, but the participants were not informed about this measurement until debriefing. In this experiment, little effort was required to cause food delivery, such that any single press that reached above 3 kg force[f] initiated food delivery. Although pressing stronger did not deliver the food faster in this experiment, differential sound feedback was given to the participant depending on the strength of the press: i.e. a Lego Mindstorms motor hidden inside the dispenser produced a slow rotating noise if the participant pressed with a force above 3 kg and below 8 kg force; the hidden motor produced a fast rotating noise if the participant pressed above 13 kg force; and a noise in-between the fast and slow for forces between 8 and 13 kg.

[f] Units of the hand-grip device we used were set by the manufacturer as kg force rather than Newtons.

The second screen instructed the participant to eat and rate the food*: "Now please eat the food and rate how much you like it. Please remember this sequence: 1) Put food in your mouth 2) Rate how much you like the food. For ratings, please do not focus on any other aspect of the food - we want to see if the physiological measure correlates with how much you like the food at this moment in time. Therefore, we need your rating to be honest and to not be about anything other than how much you like the food at this moment in time."* To provide evaluative ratings, the hedonic reactions to the foods were rated on a digital version of the Labelled Affective Magnitude (LAM) scale (Schutz & Cardello, 2001). The LAM scale is a Visual Analogue Scale (VAS) that displays the following (negative) positive semantic anchors: (dis)like extremely; (dis)like very much; (dis)like moderately; (dis)like slightly; neither like or dislike. The positioning of the labels is not uniform on the LAM scale, however, but has been derived through magnitude estimation to yield ratio properties (for further details see Cardello & Schutz, 2004). On the third screen, the participants were then instructed to sip a bit of water to neutralize the taste in their mouth.

At the end of each snack, the participants were given a choice to either have the snack again they had just tasted, or alternatively to switch to a different food thereby starting a new trial, by means of two buttons on the screen*: "Press More of Same if you want to have the food that you just had, again. Or press Stop Same, if not."* Four practice snacks followed that were presented without the concurrent written instructions of the tutorial. Before the participant embarked on test trials the experimenter prompted for any questions and clarified the procedure, if necessary, and then left the experimental room until debriefing. The participants then carried through with the learned procedure with the remaining 16 trials, each composed of snacks of different foods. A minimum of two snacks had to be eaten before the participants had the opportunity to terminate the trial by switching to a new food on the next trial. Participants were free to choose to consume from three to six snacks of the same food type in succession. If the participant chose to eat all the six snacks of a given food, the program automatically switched to the next trial with snacks of a new food type.

A hunger / fullness scale called Satiety Labelled Intensity Magnitude (SLIM) scale (Cardello, Schutz, Lesher, & Merrill, 2005) appeared on the computer screen immediately after the last snack of the 17^{th} food trial. Participants then rated their hunger / fullness on this scale. The SLIM scale was also presented to the participants at the start of the session, after practice snacks and before test trials, so we obtained hunger / fullness ratings from both the start and end of the session.

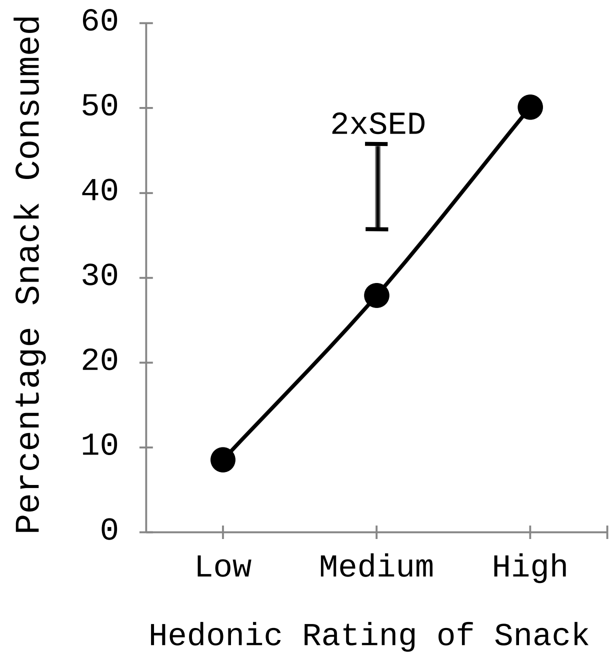
Data Analysis. Raw force scores from Biopac AcqKnowledge data files were transformed into percentage maximal force scores using the peak force from all test trials as the per participant maximal force. The percentage maximal force scores were averaged over 1 second from the start of pressing the hand-grip. All data points where a participant rated a snack below -15 on the hedonic LAM scale were excluded from all analyses, in order to study positive hedonic influences on motivation and consumption. Number of snacks consumed was transformed into percentage available consumption scores whereby the minimum number of snacks per trial (2) corresponded to 0 % and the maximum number of available snacks per trial (6) corresponded to 100 %. Data and statistical analyses were carried out using Microsoft Excel 2010 and SPSS 19 software packages, except for Cohen's *d* effect size values, which were retrieved from http://www.uccs.edu/~faculty/lbecker/

Exp 1. Results and Discussion

In order to determine whether effort was exerted preferentially for obtaining highly-palatable over bland snacks, we compared the forces applied for high- versus medium- versus low-hedonic snacks. Firstly, the forces for the different hedonic snacks were calculated from trials when the participant knew what snack they were working for: we included only responses for a snack that was the same as the snack that the participant had just eaten. Secondly, these trials provided the hedonic ratings to classify a given force trial hedonically into the low-hedonic (-15 < LAM < 25), medium-hedonic (25 <= LAM <= 50) and high-hedonic (LAM > 50) categories. Thirdly, the force was averaged over the 1-sec time window that the hand-grip was squeezed. Finally, this force was calculated as the percentage of the maximal force: maximal force was the largest force the participant applied throughout the test trials of the whole session. In this analysis the low-hedonic snacks attracted a mean force of 20.7 % (SEM = 1.0), the medium-hedonic snacks a force of 19.3 % (SEM = 1.1) and the high-hedonic snacks a force of 19.8 % (SEM = 1.0). There was no evidence of a difference between the low-, medium- and high-hedonic forces, $F(2, 52) < 1$.

Next we determined whether higher hedonic ratings were associated with higher amounts of consumption. First, for each participant each food was assigned to one of the three hedonic categories based on the mean of the first two LAM ratings, which was used as the independent variable. The hedonic categories were then plotted against the percentage of snacks consumed as the dependent variable. As *Figure 11* illustrates, high-hedonic foods were consumed in larger amounts than medium-hedonic foods, which, in turn, were consumed in larger amounts than low-hedonic foods. This difference in percentage of available snacks consumed was confirmed by a Repeated Measures ANOVA, with a main effect of hedonic rating at the three hedonic levels, $F(2, 54) = 42.78$, $p < .01$. An overall three-point linear relationship was then confirmed with pairwise comparisons: low-hedonic versus medium-hedonic, $t(26) = 4.55$, $p < .01$, $d = 0.72$, and medium-hedonic versus high-hedonic, $t(26) = 4.90$, $p < .01$, $d = 0.78$.We included other factors in the above ANOVA as well: 1) Time of day for when the sessions took place as a covariate. 2) Energy density of the foods (as energy in kilocalories per 100 grams of each stimulus), with a third of the foods classed as high-energy foods (more than 500kcal per 100g), a third as low-energy (less than 350kcal per 100g), and a third in-between. 3) Food presentation order within each session as another covariate. 4) Mean fullness ratings of each participant as a final covariate. In this experiment, the time of day covariate had a significant effect on overall consumption, $F(1, 26) = 7.56$, $p = 0.01$. The parameter estimate of -0.34 (SEM = 0.01) showed that the participants consumed less food in evening sessions compared to afternoon sessions, and even less in the morning sessions. Although there appears to be order in the consumption of foods with respect to their energy densities – 22.1 % (SEM = 5.5) for low-energy foods, 25.6 % (SEM = 4.6) for medium-energy and 34.8 % (SEM = 5.1) for high-energy foods - the effect of energy density was nevertheless not significant, $F < 1$. The remaining covariates, food order and fullness, did not produce significant effects in this experiment, all $Fs < 1$.

Fig 11. More Pleasure More Intake



Mean percentage of snacks consumed as a function of hedonic ratings in *Experiment 1*. As expected, more pleasure was associated with more consumption. This demonstrates that *Jaffa Cake task* is sensitive to hedonic consumption and an ecologically valid procedure specifically designed to assess and compare the impact of pleasure on consumption. SED is Standard Error of the Difference

As intended, these participants were predominantly *'hungry'* rather than *'full'*. Mean fullness ratings were -11.0 (SEM ±5.9), which was significantly lower than *'slightly full'* on the SLIM scale, $t(26) = 7.21$, $p < .01$. When the mean fullness ratings were separated into individual ratings at the start of the session and individual ratings at the end of the session, both were still significantly lower than *'slightly full'*, at both the start -23.1 (SEM ±6.3), $t(26) = 8.69$, $p < .01$, and at the end 0.9 (SEM ±6.6), $t(26) = 4.63$, $p < .01$ (all one sample *t* tests).

In summary, *Experiment 1* established an association between food hedonic ratings and amount of food consumed. It was hypothesized that the lack of association between food hedonic ratings and force was due to a limitation of the procedure: participants were only required to make a short single press to obtain the food. Therefore, this force parameter was changed in *Experiment 2*.

Exp 2. Hedonic Motivation

Experiment 2 required a long and continuous press to obtain snacks instead of the short single press required in *Experiment 1*. This manipulation would determine whether the single press in *Experiment 1* was too brief and insensitive to detect an association between hedonic ratings and force applied. Otherwise the basic design was equivalent, and thus provided further data to quantify and predict consumption based on food hedonic ratings. The main outcome measures in *Experiment 2* were hedonic liking ratings for the snacks that participants tasted and the corresponding forces applied for the snacks, as well as the corresponding amounts of snacks participants chose to consume.

Participants, Apparatus and Stimuli

The sample for *Experiment 2* was 25 student volunteers (16 female) recruited through http://tinyurl.com/JaffaCakeStudy2, using the same sampling procedure as in *Experiment 1*. The apparatus used in *Experiment 2* was also the same as in *Experiment 1* (see *Figure* 10). The food stimuli were changed to serve an additional experimental aim discussed in a following chapter: Nestle Milkybar Buttons, Ryvita Crackerbread, Taj Cassava Chips, Mars Maltesers, Tesco Free From White Bread, Nutberry's Yoghurt Coated Raisins, Kallo Organic Rice Cakes and Whittard of Chelsea Marshmallows.

Procedure

The basic procedure for *Experiment 2* was the same as for *Experiment 1*. As in *Experiment 1*, we attached GSR sensors to the participant fingers under the pretext of measuring physiological response to different foods as part of the cover story for the study. The basic trial structure was also the same in *Experiment 2* (see *Figure* 10): First the participants squeezed a hand-grip to make the dispenser deliver a piece of food (a snack). Second, the participants ate and rated the pleasantness of the snack, followed by a sip of water. Finally, the participants chose whether to have more of this snack or switch to a different trial with new snacks. The second snack had to then be earned by pressing the hand-grip again, followed by eating the snack while rating the stimulus on the hedonic LAM scale and so forth.

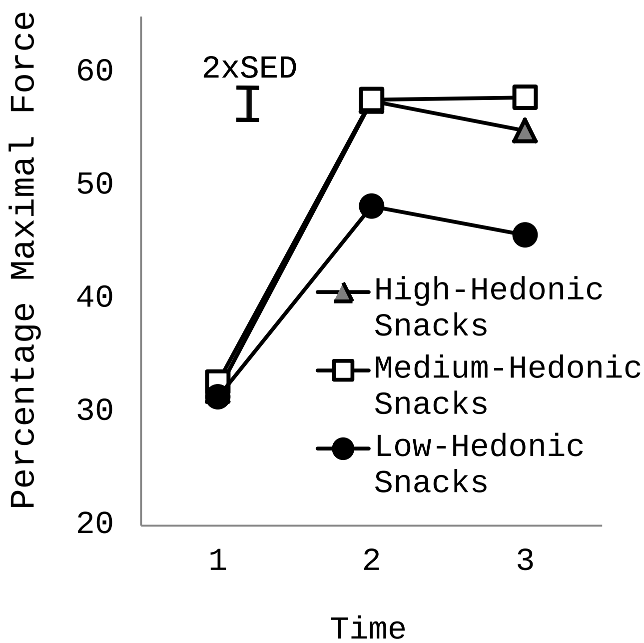
Experiment 2 was critically different from *Experiment 1*, however, in terms of hand-grip force parameters. In this experiment a single press was not sufficient to trigger food delivery and, instead, a squeeze was required that produced a total effort of at least 21 kg force seconds. Again, the output units of the force measuring devices were set by the manufacturer to be in kg force rather than Newtons. A total effort of 21 kg s was achieved on average with a 5 kg press held for about 4 seconds. The thresholds for sound feedback were slightly lower than in *Experiment 1* for the Lego Mindstorms motor hidden inside the dispenser, which created rotating noise as if part of the dispensing process, giving an impression how fast the food machine was working in delivering the participant the food. In *Experiment 2*, the motor produced a slow rotating noise if the participant pressed above 1.5 kg and below 5.5 kg force; the hidden motor produced a fast rotating noise if the participant pressed above 10.5 kg force; and a noise in-between the fast and slow for forces between 5.5 and 10.5 kg. *Experiment 2* was also different from *Experiment 1* in that the first snacks in each trial were compulsory, so the participants had no choice to change the foods in the first three snacks of each trial. These three compulsory snacks were always different from the following snacks (snacks 4 to 6). This pre-exposure manipulation was used to investigate an additional question posed by this experiment, the details for which are available in the subsequent chapter. For the purposes of the current investigation, a minimum of one snack (the fourth snack) had to be eaten before the participants had the opportunity to terminate the trial, which the participant could do by switching to a new food of the next trial. Participants were free to choose to consume from one to three snacks of the same food type in succession (snacks 4 to 6).

Data Analysis. Raw force scores were transformed into percentage maximal force scores as in *Experiment 1.* The percentage maximal force scores were then, however, allocated into 1.2 second time windows, because the squeeze lasted for many seconds in this experiment. These time bins were then normalized, because participants varied in terms of how long they pressed the hand-grip from as short as a 2-second duration to as long as 12 seconds. The time bins were normalized such that by definition food delivery always occurred in the fourth time bin. Number of snacks consumed was transformed into percentage available consumption scores. The minimum number of test snacks per trial, which was one snack, corresponded to 0 % and the maximum voluntary test snack number of three per trial corresponded to 100 %.

Exp 2. Results and Discussion

In order to determine whether effort was exerted preferentially for obtaining highly-palatable over bland snacks, we compared the forces applied for high- versus medium- versus low-hedonic snacks. The forces were analysed in an equivalent manner to *Experiment 1*, with the exception that there was the additional factor of time. The forces are conventionally shown as time traces, although our main interest was the mean difference between the forces regardless of time bins. As *Figure 12* illustrates, participants exerted more force for the high-hedonic and medium-hedonic snacks than for the low-hedonic snacks. The difference between percentage maximal force means was confirmed by a Repeated Measures ANOVA, as a main effect of hedonic rating on effort, $F(2, 48) = 7.01$, $p < .01$. The main effect of time was also significant, $F(2, 48) = 67.00$, $p < .01$, with no interaction of hedonic rating and time, $F(2, 48) = 1.21$, $p = .30$.

Fig 12. More Pleasure More Force



Hedonic motivation in *Experiment 2*. Unbeknownst to the participants, the forces they exerted on the hand-grip to deliver the snacks were recorded. Mean percentage maximal force applied was associated with the hedonic ratings of the snacks, such that the participants worked more for the high- and medium-hedonic than for the low-hedonic snacks. Food delivery always started at the fourth time bin.

Next we determined whether higher hedonic ratings were associated with higher amounts of consumption. The high-hedonic snacks were consumed in larger amounts at

39.3 % (SEM = 7.4), than the medium-hedonic snacks at 28.1 % (SEM = 8.4) which, in turn, were consumed in larger amounts than low-hedonic snacks at 6.9 % (SEM = 2.4). The difference in percentage of available snacks consumed was confirmed by a Repeated Measures ANOVA, as a main effect of hedonic ratings at the three hedonic levels, $F(2, 48) = 19.81$, $p < .01$. Identically to the analysis in *Experiment 1*, we included more factors in this analysis than just the hedonic levels: time of day, energy density (low, medium and high), food order and fullness ratings. In Experiment 2, however, time of day was not a significant predictor of consumption, $F < 1$, whereas fullness ratings were, $F(1, 24) = 6.52$, $p = .01$. The parameter estimate for fullness ratings, -0.21 (SEM = 0.08), indicated that the fuller the individual felt, the smaller the amount of food eaten. Energy density did not predict consumption reliably, with 26.1 % (SEM = 7.2) consumption for low-energy foods, 16.3% (SEM = 3.7) for medium-energy, and 25.1 % (SEM = 4.7) for high-energy foods. That is, energy density and food order did not reach significance again, all *F*s < 1.

As in *Experiment 1* and according to our intentions, these participants were predominantly *'hungry'* rather than *'full'*. Mean fullness ratings were -12.3 (SEM ±4.7), which was significantly lower than *'slightly full'* on the SLIM scale, $t(24) = 9.29$, $p < .01$. When the mean fullness ratings were separated into individual ratings at the start of the session and individual ratings at the end of the session, both were still significantly lower than *'slightly full'*, at both the start -32.0 (SEM ±3.7), $t(24) = 16.86$, $p < .01$, and at the end 7.2 (SEM ±7.2), $t(24) = 3.38$, $p < .01$ (all single sample t tests).

Modelling Hedonic Consumption

Combined Data Analysis

We employed specialized analysis techniques on data combined from *Experiment 1* and *2* to derive quantitative best-fit equations for hedonic consumption. Linear mixed model analyses and model selection were carried out in the freely available R software (version 2.10.1; http://www.r-project.org/). The package used within R was *lme4* with analytical practice procedures adopted from Bates (2010). Starting with a linear mixed model with most components, stepwise regression with backward elimination was then used to identify models with components that possessed significant predictive power while retaining parsimony. The starting model (with most components) consisted of a general hedonic component as a fixed factor regressor, in addition to two random factors of personal hedonic component and a personal consumption baseline (e.g. *Equation 2* in *Results* below). Different versions of the starting model were tested in parallel, with either linear or exponentially transformed hedonic components (the non-linear transformation used was $^{100}/_{(1+160\ \exp\ (-0.06\ x))}$; see more below). Model selection then consisted of excluding models with non-significant fixed factors. Non-significant random factors were removed as well, except those required for repeated measures modelling. Finally, amongst the models with only significant factors, the best fitting model with the highest overall predictive power surfaced based on overall R^2 values.

Combined Results

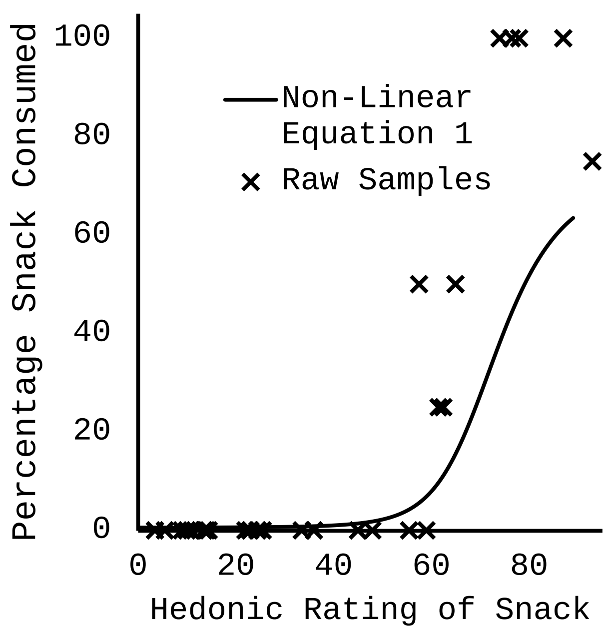
To describe the relationship between hedonic ratings and amount consumed in more detail, we employed curve-fitting on data combined from both *Experiment 1* and *2*. As presented in *Figure 13*, visual inspection of data that was not averaged into one of the three hedonic categories suggested that the high hedonic ratings were associated with a disproportionally large increase in consumption when compared to low hedonic ratings. In fact, the hedonic ratings appeared to be linked to consumption only after reaching a certain threshold hedonic rating. Thus closer analysis revealed that a linear function was not an accurate model of the relationship. Instead, an appropriate function had to model a disproportional increase in consumption. An additional constraint was that the output values could never exceed 100 % consumption, irrespective of hedonic ratings. The mathematical nature of the logistic function is able to satisfy these criteria. Specifically, this exponential transformation was employed: ${}^{100}/_{(1+160 \exp(-0.06\, x))}$.

Curve-fitting with this exponential transformation produced the overall function with the highest predictive power compared to all the other linear and non-linear models tested, R = 0.76 (see above for details of model selection procedure). The exponential component of the best-fitting model is illustrated by the curve in *Figure 13,* which yielded the following relationship:

$$\textit{Percentage snacks consumed} = \frac{0.6 * 100}{1 + 160\, e^{-0.06\, \textit{Hedonic LAM rating}}} \qquad (1)$$

Applying *Equation 1* estimates that a 20 point increase in hedonic rating on the LAM scale, from food *'neither liked or disliked'* to food that is *'liked slightly'*, is associated with a 1 % increase in available snacks consumed. By contrast, from food *'liked very much'* to food *'liked extremely'*, that same hedonic rating increase of 20 points is associated with an approximate 20 % increase in available snacks consumed.

Fig 13. Non-Linear Effect of Pleasure



In-depth analyses revealed that the effect of pleasure on consumption is not linear. Raw data illustrates how most of the snacks that were at the bottom half of the liking scale were consumed in minimal amounts. By contrast, for the rarer extremely liked snacks, consumption increased disproportionally above this apparent hedonic threshold. *Equation 1* was found to be the best model describing average percentage consumed based on hedonic ratings of snacks.

Equation 1, however, does not take individual differences between participants into account. We were able to determine the size and relative importance of individual differences by using mixed models (see Data Analysis for details on this technique). *Equation 2* presents the full model whereby consumption is predicted not just for an average person, but for specific individuals.

% consumed = General Hedonics ± Personal Hedonics ± Personal Baseline (2)

= *Equation 1* ± b**Hedonic LAM rating* ± c

A completely average person from the population would be predicted to consume food according to just *Equation 1* i.e. the personal components in *Equation 2* have values of 0 for a completely average person. However, in non-average participants, the personal hedonic function and the personal baseline components in *Equation 2* allowed for a more accurate individual prediction of amount consumed, as a deviation from the average person, or as added personal components to *Equation 1*. Accordingly, any given individual was found to have an individual hedonic relationship to consumption that deviated more or less from the general hedonic relationship of the average person (General Hedonics ±Personal Hedonics). Any given individual also had a non-hedonic consumption baseline (Personal Baseline; c), which reflected their level of consumption regardless of how pleasant the food was. Specifically, each individual had their own weight (b) for the personal hedonic function e.g. Mary's personal hedonic function was -0.1**Hedonic LAM rating* and Bob's personal function was 0.5**Hedonic LAM rating*. The standard deviation of all the personal hedonic functions was ±0.4**Hedonic LAM rating*, providing an estimate for how differently hedonic ratings impacted upon consumption relative to the average person (see *Equation 3*). The personal consumption baselines changed *Equation 1* by ±17.1, standard deviation, as an indicator of the size of individual baseline differences across participants. When there is no individual participant information available, *Equation 1* predicts the consumption of an average person and is able to account for about 41 % of the modelled variability observed in consumption (r^2 = 0.41). By knowing the personal hedonic component and the personal consumption baseline for a given individual (*Equation 2* for a given individual), the predictive power added is 59 % to the total modelled consumption.

$$\textit{\% consumed} = \textit{Equation 1} \pm 0.4 * \textit{Hedonic LAM rating} \pm 17.1 \qquad (3)$$

Using mixed models analysis allowed us to also determine the relative predictive power of hedonic versus non-hedonic influences on consumption. The hedonic components in the form of the general and personal hedonic components together predicted 56 % (r^2 = 0.62) of the modelled variability in consumption in contrast to the non-hedonic influence of personal consumption baseline adding 44 % (r^2 = 0.44). Furthermore, we were able to contrast the importance of the general hedonic component with the personal hedonic component: the relative proportion of variance explained by the general hedonic function alone (*Equation 1*) was 55 % in contrast to the personal hedonic function that constituted the remaining 45 % of the hedonic predictive power.

Jaffa Cake Task Discussion

The current study established and validated a laboratory procedure for the assessment of the impact that food pleasures have on food intake. Specifically, *Experiment 1* demonstrated the sensitivity of the procedure to hedonic consumption, which at the same time was not confounded by satiation factors, while possessing high ecological validity and incorporating automated delivery of the foods used. This *Jaffa Cake task* also allowed the assessment of hedonic motivation. In *Experiment 2*, participants exerted more effort to attain highly palatable foods compared to the lower effort exerted in order to obtain low-hedonic snacks, which occurred despite participants not being informed that forces were measured. We also established a quantitative hedonic consumption function (*Equation 1*) that turned out to be non-linear and that allows the amount of foods consumed to be predicted from food pleasantness. Using mixed models analysis we were able to increase the predictive power of the hedonic consumption function further by incorporating person-specific estimates of the amount to be consumed (*Equation 2*). Overall, the results of this study demonstrated that the *Jaffa Cake task* worked, allowing highly quantified and comparative profiling of hedonic consumption and motivation.

The single short press required to obtain food in *Experiment 1* appeared to not be sufficient to differentiate the forces applied based on the hedonic values of the target foods. By contrast, the longer continuous squeeze in *Experiment 2* was sensitive to the hedonic properties of the snack outcomes. The latter is possibly the first quantification of primary reward driven motivation, as opposed to cognitively driven motivation, in humans. The differentiation of motivation originating from primary rewards versus cognitively originating motivation is important (e.g. S. de Wit & Dickinson, 2009; Finlayson, King, & Blundell, 2008), because food is a primary reward and therefore the main aim is to measure this non-cognitive type of motivation that primary rewards trigger. As an example of cognitively initiated motivation, participants would exert more force when a blue square rather than a green square appears on the screen, if working for the otherwise arbitrary blue squares had been cognitively set up as the goal (Anderson, 1936). Such cognitively specified motivations are different from primary reward initiated motivations. The force results of this study are potentially the first true reflection of human motivation originating from primary rewards, because our participants were neither informed that forces were being measured nor explicitly instructed to use more force to obtain the rewards. Furthermore, the hand-grip was naturally presented, without any special emphasis, as a necessary part of the experimental setup that was simply required to deliver the food without the experimenter being present. Thus, the hand-grip was presented as a practical means to an end rather than as any unnecessary, out-of-place addition, which might have aroused attention and suspicion. Altogether, these precautions should have minimized cognitively initiated motivations. Designs in existing literature, on the contrary, have not used such implicit measurement and often incorporate explicit instructions that are conducive to cognitive motivations, and therefore confound measurement of primary reward driven motivation (e.g. Talmi, Seymour, Dayan, & Dolan, 2008). Furthermore, the demonstration of sub-conscious priming of a motivation (Aarts, Custers, & Marien, 2008) does not necessarily constitute measurement of primary reward motivation. That is, once a motivation has been established, either through primary or cognitive means, it can be primed or activated by implicit or explicit methods. On the basis that only non-implicit designs have been previously employed, only cognitively induced motivation has been subconsciously primed (Pessiglione et al., 2007).

Beyond the fact that pleasure affects intake, we do not know the specific mechanism that explains how this occurs. It is possible that at least in healthy volunteers the palatability we measure might work through appetite or desire for food, which in turn determines whether more or less is consumed. A fitting mechanism detailing how this process might occur is instrumental incentive learning (Dickinson & Balleine, 2002), which involves the assignment of motivational value to outcome snack representations due to experiencing the hedonic reactions from the food. Therefore, if pleasure effects are mediated through motivation, pleasure may have non-linear effects on motivation, instead of having non-linear effects on consumption directly (consistent with force findings in *Figure 12*). Hedonic consumption is not explained by the concept of *alliesthesia* (Cabanac, 1971), whereby pleasure derived from a stimulus is determined by the degree to which the stimulus satisfies an internal homeostatic state such as nutrient deficiency. Alliesthesia does not apply here, especially in *Experiment 1*, because the internal state indexed through fullness did not change between the different foods while the different foods still produced different pleasantness scores. The different hedonic ratings could not have therefore primarily have been determined by *alliesthesia*. Furthermore, the effect of pleasure on consumption is likely to have not been mediated by satiety, because we know that palatability does not affect satiety, while it does affect satiation or the termination of a meal (see e.g. Benelam, 2009; De Graaf, De Jong, & Lambers, 1999). Given that the *Jaffa Cake task* captures hedonics, motivation and consumption all-in-one, then this procedure could also be used to investigate potential dissociations of pleasure and motivation, or liking and wanting (Finlayson et al., 2007b; Mela, 2006). In that regard, the *Jaffa Cake task* would be a complement to the development of a liquid reinforcer / ratio schedule procedure, which currently is not yet sensitive to measurement of wanting (Gondek-Brown et al., 2007). The picture task developed by Finlayson and colleagues (2007a) would also be complemented by the *Jaffa Cake task*, with the measurement of actual food intake. A general concern with regard to distinguishing liking from wanting (see e.g. Kringelbach & Berridge, 2009) needs to be raised here, however. Namely, as discussed before, a pleasure rating scale does not necessarily index pleasure, but it may be an index of wanting instead, or at least be influenced by wanting as well as liking. It might be possible to test this alternative interpretation in future studies employing objective measures of pleasure, instead of self-report ratings (see *Chapter I*).

Equation 1 and *2* allow the prediction of consumption based on pleasure. Such predictions may be of practical use in many situations and can be made at group-level (*Equation 1*) or if the person-specific coefficients are determined, at the level of specific individuals. The magnitude of this predictive power demonstrates that food palatability is a critical influence on intake. However, the non-linearity of the relationship between pleasure and consumption is not necessarily a reflection of true non-linearity between these phenomena, but potentially a reflection of the variables being non-linear themselves. Firstly, consumption was measured with a discrete number of units per food and as such was not a continuous variable. Furthermore, if there was a floor effect such that participants would have actually consumed the less-hedonic foods in smaller amounts than was allowed, then that would also contribute to apparent non-linearity. Secondly, pleasure was indexed with a LAM scale, which is based on magnitude estimation and which in turn is known for producing exponential scales rather than linear scales. The latter concern is, however, alleviated by the fact that the development of the LAM scale took into account the exponential nature of magnitude estimation and actually corrected for it, such that the LAM scale itself is not exponential. This was achieved through: "*Since magnitude estimates have been shown to be log-normally distributed … the data were analyzed by equalizing the magnitude estimates across subjects … and then calculating the geometric means of the normalized magnitude estimates across subjects for each phrase*" (Schutz & Cardello, 2001, p. 123). Finally, the non-linear nature of the relationship needs to be treated with caution, because sensory specific satiety may have contributed to it.

However, hedonics is not the only influence on consumption. Consumption is also influenced by multiple non-hedonic factors (Drewnowski, 1997). For instance, even if foods were neither liked nor disliked, people tend to clean their whole plate once the foods and quantities of food have been chosen (Wansink & Cheney, 2005). In parallel to highlighting the complexity of consumptive decision-making, this observation emphasizes the importance of how much food is chosen at the start of the meal in determining food intake (Brunstrom & Shakeshaft, 2009). Therefore, as it stands, our unitary hedonic model of consumption fails to take into account a plethora of important observations regarding non-hedonic factors influencing consumption and therefore substantially reduces the explanatory power of the model (see e.g. West, 2005, pp. 21-22). Factors such as dietary motives, boredom, frustration and novelty seeking should all be incorporated into a future model. For example, at times participants will be pressing a button to have less of a food not because it is less pleasant, but because they want to get through the experiment faster. As we saw in *Experiment 1*, time of day also plays a role in food-choice, which is likely to result from choosing to eat less breakfast-food types, such as cereals, in the evening. Such contextual effects were not detected in *Experiment 2* probably because it incorporated fewer breakfast foods. *Experiment 2*, however, witnessed an effect of satiety such that less hungry participants ate less. *Experiment 1* did not produce that effect likely because the participants were more hungry in that experiment. Interestingly, the participants in *Experiment 2* were far from being full as such, demonstrating that satiety is a continuous variable that can have effects before feeling fully bloated. Although energy density and food ordering did not yield effects in this study, these factors do influence intake in different designs (e.g. Drewnowski, 1998), and a complete picture of food intake would be incomplete without them. All-in-all, in addition to predicting specific consumption more accurately, a fuller model of consumption would facilitate a more comprehensive understanding of food intake. In the process of advancing the unitary hedonic model into a broader multi-componential model, it is likely that parts of the person-specific random factors (see *Equation 2* and *3* and mixed models analyses) will be absorbed into fixed trait and state variables such as novelty seeking.

The *Jaffa Cake task* provides an opportunity to assess hedonic consumption profiles against variables such as varying degrees of Body Mass Index (BMI) or the propensity for binge-eating. Having been specifically designed to assess the impact of food pleasure on intake, our procedure is perhaps the only tool available for such a purpose. In fact, we postulate that it is not just food pleasure that increases food intake, but that pleasure from any stimulus type enhances the extent of exposure to those hedonic stimuli. Such a general pleasure mechanism would yield desirable consequences in terms of amplifying exposure to many different kinds of rewarding stimuli. However, at times pleasure may play a critical role in leading to escalations in contact with stimuli that have undesirable effects or side-effects: in addition to the over-consumption of palatable foods, sexual pleasure driving use of pornographic materials (Delmonico, 1997), excessive engagement with video games (Klimmt, Schmid, & Orthmann, 2009) or encounters with euphorigenic drugs in substance abuse (Fischman & Foltin, 1991), and so forth. Perhaps the same hedonic consumption relationships hold for such non-food stimuli, *Equations 1* and *2*.

In summary, this study presents a special-purpose laboratory tool which allows for the assessment of hedonic motivation and consumption. We plan to further develop this *Jaffa Cake task*, so that the relevant apparatus could be built easily and inexpensively in any laboratory. We welcome any modification or feature requests to incorporate into this upgrade process. Additionally, this study provides formulae that allow the prediction of food consumption based on the hedonic value of that food.

This chapter observed large effects of *pleasure* on consumption, as well as effects of *pleasure* on primary motivation. We suggested that the two are linked by incentive learning i.e. the effect of *pleasure* on consumption is mediated by the effect of *pleasure* on motivation. This is the role of pleasure in behaviour that we regard to have critical influences in health and disease, which we will elaborate on in the last chapter. Before that, we will, however, study another effect of *pleasure*, which is its effect on itself.

VI. Habituation of Affective Evaluations

Can you have too much of a good thing? In particular, what if you start to enjoy snacks less after snacking on a variety of pleasant foods. For instance, you might try a selection of different delicious cheeses at a cocktail party, followed by a few great-looking marshmallows, but which you would actually enjoy less because of having experienced the mouth-watering cheeses beforehand. If this example is true, it would represent a phenomenon by which the hedonic experience derived from a stimulus decreases as a result of repeated pleasurable experiences. Critically for this investigation, the reduction in pleasure would be caused by preceding pleasures rather than any other aspect of the preceding experience. We term this possible phenomenon hedonic habituation. Determining whether food stimuli exhibit hedonic habituation was the key aim of the current study. To clarify, we regard hedonic contrast (e.g. Yeomans, Chambers, Blumenthal, & Blake, 2008) as one possible form of hedonic habituation, but hedonic habituation is a broader umbrella effect that may also take the form of decreases in pleasure that occur regardless of expectancy effects, or that are independent of perceptual processes and interpretations of situations. An example of such non-cognitive and non-perceptual affective after-reactions is opponent processes (see Mauro, 1988 for more about the distinction). That is, hedonic habituation is a decrease in hedonic ratings caused by preceding pleasures, independent of what the underlying mechanisms of the decrease might be.

A number of studies have explored contrast effects. Some of these focus on expectancy effects, whereby hedonic evaluations are manipulated by providing information about the test stimuli prior to experiencing them. For instance, Zellner and colleagues (2004) found both assimilation (affective ratings biased towards the prior expectations) or contrast (affective ratings biased away from prior expectations), depending on how certain and different the expectations were from the test experiences. This and other studies of this type utilised prior descriptive information and labelling to alter these expectations e.g. telling the participants beforehand that other people strongly disliked the foods, or that they will be eating candy. However, this study focuses on the effect of actual prior experiences, specifically on the effect of hedonically laden pre-exposures. The contrast literature has employed this approach as well, whereby prior exposure to hedonic context stimuli is used instead of providing prior information. For example, test paintings were rated higher after viewing unpleasant paintings (positive hedonic contrast; Zellner et al., 2010), also fruit juices became less hedonically discriminable after being exposed to pleasant fruit juice (hedonic condensation; Zellner, Allen, Henley, & Parker, 2006).

To our knowledge, hedonic habituation has not been addressed for taste stimuli. Related works exist on a phenomenon called *Sensory Specific Satiety* (Rolls, Rolls, Rowe, & Sweeney, 1981), which similarly to hedonic habituation involves decreasing pleasure from food, but in *Sensory Specific Satiety* the cause of the reduction in food pleasure is attributed to the sensory rather than hedonic properties of the preceding foods. The term *Sensory Specific Satiety* should not be confused with decreases in sensory intensity of tastes. In both *Sensory Specific Satiety* and hedonic habituation the result is a decrease in food pleasure rather than food taste intensity. In *Sensory Specific Satiety (SSS)*, however, the cause of this decrease in food pleasure is due to repeated exposure to the same foods with the same sensory properties, whereas the cause of the decrease in pleasure in hedonic habituation is repeated exposure to pleasant experiences. As an example of *SSS*, the hedonic evaluation of a chocolate was reduced when the chocolate had been eaten having the same colour, but the hedonic evaluation was not reduced when the same chocolate had been previously eaten having a different colour (Rolls, Rowe, & Rolls, 1982). The same study also showed that eating pasta of shape A reduced the pleasantness of shape A pasta, but did not reduce the pleasantness of the same pasta in shapes B or C. Furthermore, generalisation can be found in *SSS*, such that pre-exposure to cheese and crackers not only reduced their hedonic ratings, but also reduced hedonic ratings of potato chips and sausages, while not reducing hedonic ratings of bananas and yogurt (Rolls, Van Duijvenvoorde, & Rolls, 1984). A concept similar to *SSS*, but broader, is *habituation* (Epstein, Temple, Roemmich, & Bouton, 2009). *Habituation* also aims to explain decreases in eating, but goes beyond liking, encompassing measures of salivation, acoustic startle etc, as well as employing different experimental designs and wider variety of independent variables such as distractions and stress. Although *habituation* does sometimes involve decreases in hedonics, these hedonic decreases are not the focus of *habituation* (see Epstein et al., 2009). For instance, *habituation* as measured through salivation is not predicted by concurrent decreases in liking (Epstein, Caggiula, Rodefer, Wisniewski, & Mitchell, 1993). Given this related but different focus, *habituation* does not directly pertain to hedonic habituation. Another related phenomenon, termed affective habituation, has also been investigated (e.g. Beebe-Center, 1929; Cain & Johnson, 1978; Dijksterhuis & Smith, 2002; Leventhal, Martin, Seals, Tapia, & Rehm, 2007). Studies of affective habituation involve decreasing hedonic experiences as well, but without specifying a specific source as the cause of these reductions. Well-being literature uses yet more labels: hedonic adaptation or hedonic desensitization (see e.g. Frederick & Loewenstein, 1999), but again these terms and investigations are general in the sense that they do not pinpoint the cause for decreasing hedonic experiences to be the preceding pleasures per se. Perhaps the most directly related research has been carried out by Grabenhorst and Rolls (2009) using the label relative reward, but they utilised odours as stimuli, so the question whether taste stimuli exhibit hedonic habituation has not been addressed.

In order to determine whether having a pleasant snack now makes you less able to enjoy a subsequent snack, participants first ate either three pleasant snacks or three bland snacks, followed by a fourth test snack (see *Table* 6). The preceding snacks were either all different foods or all the same food (while also being pleasant or all being bland). The key dependent variable was the hedonic rating of the fourth test snack, after the *varied-pleasant* compared with the *varied-bland* snacks. The *same-pleasant* pre-exposure condition, in which all the preceding snacks were the same food as the test snack, served as a control. This *same-pleasant* pre-exposure condition determined whether a decrease in the hedonic rating of the fourth test snack was due to the hedonic rather than the sensory properties of the preceding foods. That is, we expected the hedonic ratings for the test snack to be lower on the *pleasant-same* trials than on *bland-same* trials. However, such a reduction could be due to *Sensory Specific Satiety* and/or hedonic habituation. Insofar that there was a contribution from hedonic habituation, as opposed to *Sensory Specific Satiety*, we expected the decrease to be similar for both *same-pleasant* and *varied-pleasant* pre-exposures (see *Table* 6).

Table 6. Pleasant or Bland x Varied or Same

Trial Type	**Pre-Exposure**	**Effect on Rating (and Consumption)**
Pleasant-Varied	Hed1 Hed2 Hed3	Test Rating of Same Snacks Across All Conditions (+choose to eat 1-3 pieces)
Pleasant-Same	Hed4 Hed4 Hed4	
Bland-Varied	Low1 Low2 Low3	
Bland-Same	Low4 Low4 Low4	

Hed: a snack of a high hedonic rating
Low: a snack of a low hedonic rating

Auto-Inhibition Experiment

Participants, Apparatus and Stimuli

Sample. 25 student volunteers (16 female) were included in this experiment through university-wide e-mail recruitment. These are the same participants that generated the data for the previous study. The students received an invitation linking to a web-based recruitment questionnaire at http://tinyurl.com/HedHabitStudy that served as a common introduction to the study. Any candidates acquainted to the first author, or reporting psychology as their main specialty, were excluded from taking part in the study to minimize familiarity with study aims and to minimize highly analytical task performance. Participants were also required to be native speakers or fluent in English, and have no food allergies. Session slots were otherwise allocated on a first come first served basis; no further exclusion criteria were applied. For the participants that were selected, absence of food allergies was confirmed verbally at the start of the study. In addition, a silenced mobile phone was given to the participant with a direct line to the experimenter / first-aider seconds away, in the unlikely event that an emergency would have arisen. The sample size was chosen based on rule-of-thumb for psychology experiments. In order to detect large within-subject effects between pre-exposure type and hedonicity a sample size of approximately 20 was needed. This design was sensitive to detect large effects, but not medium or small ones. Given that a priori detectability of smaller effects was desirable as well, however, this study is under-powered in that regard. As advertised on the web-page, recruits were provided free food and received 7 GBP (circa 12 USD) for participation in a 75-minute session.

Experimental Setup. Participants were tested individually in a test room in which they sat at a table facing a computer screen (PC with a 1280x1024 display). In addition, a dispenser containing all the snacks for the session was positioned to the left of the participant. The dispenser was concealed in a cardboard enclosure throughout the experimental sessions with only the food plate in front of the participant. Further procedural details are in the previous chapter. The results of that chapter also demonstrated that participants did not become full during this experiment, but were mostly hungry instead.

Food Stimuli. Foods were selected from a pilot study. The pilot established which foods did not evoke aversive disgust evaluations while instead eliciting hedonic reactions at the bland and highly pleasant extremes of the spectrum: *Nestle Milkybar Buttons, Ryvita Crackerbread*, *Taj Cassava Chips*, *Mars Maltesers*, *Tesco Free From White Bread*, *Nutberry's Yoghurt Coated Raisins*, *Kallo Organic Rice Cakes* and *Whittard of Chelsea Marshmallows*. The foods were divided into groups of three snacks that constituted either the *bland* versus *pleasant* pre-exposure conditions combined with *same* snack versus *varied* snack conditions, described in more detail under the procedure. The order of the conditions consisting of different snack sequences was randomised by our software and pre-loaded onto the dispenser according to the random sequence given. The individual snacks were cut to approximately uniform sizes, weighing about 2 grams each.

Procedure

The procedure was carried out according to a written Standard Operating Procedure to maximize accurate and consistent execution of experimental protocol.

Preparation. Sessions were scheduled to start at 09.00, 10.45, 12.30, 15.45 or 17.30. Recruitment confirmation emails asked the participants to either have a light morning/afternoon meal before the session (at a time they would normally have it) or to skip that meal altogether if the meal would have been eaten 3 hours or less before the session. A day before a given session a reminder email was sent that also prohibited snacking and excessive drinking within the 3 hours leading to the start of the session. Snacks were freshly cut and set up on the dispenser half an hour before each session.

In order to ensure that the participants were aware of a plausible purpose for the study, the experimental aim from the recruitment web-page was repeated as an investigation into the effect of different foods on micro-sweating in their fingers. On entry to the test room the experimenter explained that the foods were hidden inside the cardboard enclosure in order to minimize any expectation effects on the physiological Galvanic Skin Response (GSR) measure.

Main Trial Structure. An interactive tutorial of the main task explained each part of the procedure to the participant, by way of step by step instructions that led the participant through their first snack (see *Appendix D*). Details of these instructions are reported in the previous chapter. To provide evaluative ratings, the hedonic reactions to the foods were rated on a digital version of the Labelled Affective Magnitude (LAM) scale (Schutz & Cardello, 2001). The LAM scale is a Visual Analogue Scale (VAS) that displays the following (negative) positive semantic anchors: (dis)like extremely; (dis)like very much; (dis)like moderately; (dis)like slightly; neither like or dislike. The positioning of the labels is not uniform on the LAM scale, however, but has been derived through magnitude estimation to yield ratio properties (for further details see Cardello & Schutz, 2004). After eating a snack participants were then instructed to sip some water to neutralize the taste in their mouth. Finally, the participants were given a choice to either have the snack they tasted again or alternatively to switch to a different food thereby starting a new trial, by means of two buttons on the screen*: "Press More of Same if you want to have the food that you just had, again. Or press Stop Same, if not."* Before the participant embarked on test trials the experimenter requested questions and then clarified the procedure, if necessary, before leaving the experimental room until debriefing.

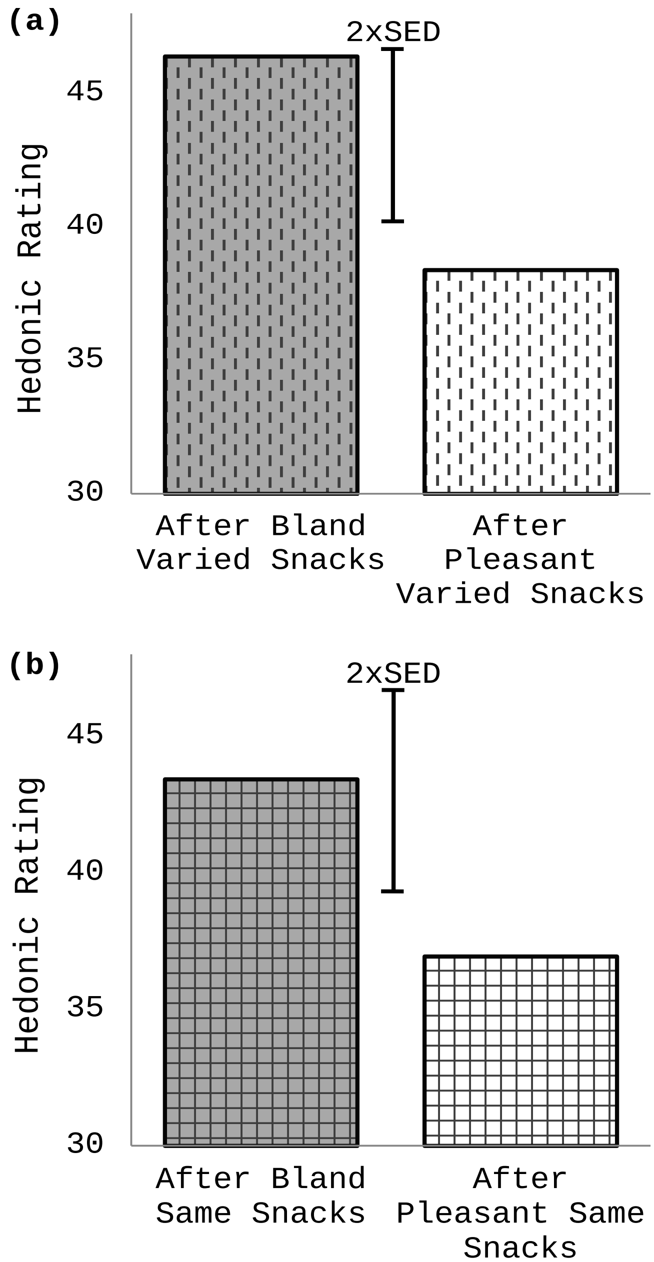
The participants then completed the test trials, which consisted of 3 snacks as the pre-exposure condition, followed by a minimum of 1 test snack and a maximum of 3 test snacks. Each trial started with 3 snacks that were either 3 pleasant snacks or 3 bland snacks. These two types of pre-exposure snacks constituted the critical manipulations as the *pleasant* pre-exposure and the *bland* pre-exposure conditions. The first 3 snacks in each trial were compulsory: the participants had no choice but to continue with the snack given for the first three snacks in a given trial. Additionally, the *pleasant* pre-exposure condition was split into two sub-types: one in which the three pleasant pre-exposure snacks were all the same foods (and the same as the test food); and the other in which the three pleasant pre-exposure snacks were all different foods (and different from the test food as well). Following the three pre-exposure snacks, the trial ended with test snacks, where the participant was free to choose to consume either 1, 2 or 3 further snacks. If the participant chose to eat all the 3 test snacks of a given food, the program automatically switched to the next trial with another pre-exposure condition. The two conditions were crossed (*bland* versus *pleasant* combined with *same* versus *varied*), and the resulting trials were all repeated twice per participant. See *Table* 6 for summary of the different trial types.

Data Analysis. Number of snacks consumed was transformed into percentage consumption scores whereby the minimum number of voluntary snacks per trial (1) corresponded to 0 % and the maximum number of available snacks per trial (3) corresponded to 100 %. Data and statistical analyses were carried out using Microsoft Excel 2010 and PASW 18.

Results

Figure 14 presents the hedonic ratings given to test snacks depending on what snacks were eaten beforehand, and whether or not those snacks were varied. Test snacks were rated as less pleasant following a sequence of *pleasant* snacks compared with *bland* snacks. This appeared true regardless of whether the pre-exposed snacks were *varied* or *same* (*1a* and *1b*). These effects were confirmed by a two-way ANOVA with pre-exposure hedonicity (*pleasant* versus *bland* snacks) and pre-exposure type (*varied* versus *same*) as within-subject factors: there was a main effect of pre-exposure hedonicity, $F(1, 24) = 8.42$, $MSE = 155.62$, $p < .01$, $\eta^2_p = 0.26$, whilst there was no evidence of an effect of pre-exposure type, $F(1, 24) < 1$, nor interaction, $F(1, 24) < 1$. The above results replicate the classic finding that hedonic ratings decrease after exposure to *same* foods (*Figure 14b*). The emphasis, however, is on the observation that test foods were also rated as less liked when a sequence of *varied-pleasant* snacks preceded the test foods, compared to test foods that were preceded by *varied-bland* snacks. *Figure 14a* presents the hedonic ratings given to test snacks in those conditions. Furthermore, hedonic ratings were similarly reduced irrespective whether the preceding foods constituted a variety of different pleasant snacks or whether the preceding snacks were of the same kind. The reduced test ratings when a variety of pleasant snacks preceded the test (*Figure 14a*) were similar to the reduced test ratings when the preceding pleasant foods were all the same snack (*Figure 14b*), as reflected by the aforementioned lack of main effect of pre-exposure type and lack of interaction of pre-exposure type with pre-exposure hedonicity.

Fig 14. Hedonic Habituation



Mean hedonic ratings of the test snacks after consumption of *pleasant* and *bland* snacks, which were either (a) *varied* or (b) all the *same*. Snacks were rated lower after a series of *pleasant* snacks compared to after a series of *bland* snacks; snacks were rated lower not only after *same-pleasant* snacks, but also after *varied-pleasant* snacks.

The difference in hedonic ratings after *pleasant* versus *bland* snacks reflected a reduction in hedonic ratings after *pleasant* snacks rather than an enhancement of hedonic ratings after *bland* snacks. Snacks after *pleasant* pre-exposure were rated at a mean of 37.6 down from an initial baseline of 44.6 . The initial baseline rating was for the first snack of each *pleasant* pre-exposure trial. In contrast to the decrease from baseline after *pleasant* snacks, snacks after *bland* pre-exposure remained similar to baseline at 44.9. Within-subject variability for the baseline versus *pleasant* pre-exposure test scores was SED[g] = 2.7 and SED for the baseline versus *bland* pre-exposure test conditions was 2.5. The significance of the reduction in the *pleasant* pre-exposure condition was confirmed by a one-way Repeated Measures ANOVA, as a reduction in *pleasant* pre-exposure test compared to initial baseline level, $F(1, 24) = 6.52$, $MSE = 94.20$, $p = .01$, $\eta^2_p = 0.21$. In contrast, there was no evidence that the *bland* pre-exposure test ratings differed from initial baseline, $F(1, 24) < 1$.

In order to determine whether test foods were consumed differentially depending on which snacks were consumed beforehand, percentage available snacks consumed following *pleasant* snacks were compared with the percentage following *bland* snacks. The percentage of snacks consumed was 27.6 % when a variety of *pleasant* snacks preceded the test, and was 42.1 % when the preceding variety of snacks was *bland*. Within-subject variability for this comparison was SED = 8.8 %. However, consumption after *pleasant* snacks was not significantly lower than consumption after *bland* snacks, as

[g] SED is Standard Error of the Difference (for uses of SED see Cardinal & Aitken, 2006, pp. 95-101)

determined by lack of main effect of pre-exposure hedonicity, $F(1, 18) = 1.91$, $MSE = 964.91$, $p = .18$. There was also no significant interaction between pre-exposure hedonicity and pre-exposure type (*same* versus *varied*), $F(1, 18) < 1$.

Discussion

This study found that snacks were rated lower after a series of *pleasant* snacks compared to after a series of *bland* snacks. The test snacks were rated lower not only after *pleasant* snacks that were all the same, but test snacks were also rated lower after *pleasant* snacks that were all different snacks.

The reduction in pleasantness observed may have resulted solely from sensory similarity of test foods to the preceding snacks. This interpretation becomes less likely, however, because both *same* and *varied* pre-exposure were associated with a non-differing decline in pleasantness, which is similar to what Grabenhorst and Rolls (2009) found with odour stimuli.

The difference in hedonic ratings observed after *pleasant* snacks relative to post-*bland* snacks may have arisen from the snacks being valued more after *bland* snacks rather than the snacks being valued less after *pleasant* snacks. In opposition to this positive contrast effect interpretation, the ratings after *bland* snacks were not higher than baseline ratings for these foods. Furthermore, ratings after *pleasant* snacks were found to be lower than baseline ratings.

The direction of effect on consumption of foods reflected the decline in food ratings after *pleasant* snacks, but the effect on consumption was not statistically significant. We interpret this result to suggest that the difference in hedonic ratings was not large enough to elicit a parallel consistent difference in number of snacks chosen for consumption, perhaps because the pre-exposure was not sufficiently extended for an effect on consumption to surface. Similarly, the measure of consumption may have been too insensitive to detect an effect because it only measured three possible levels of consumption. Alternatively, hedonic ratings may have a non-linear effect on consumption, so the lack of effect on consumption may reflect the finding that for any food below a high pleasure threshold, consumption is relatively unaffected by hedonic changes (see previous chapter).

Despite the lack of effect on consumption, this study constitutes the first demonstration of hedonic habituation with food stimuli. Equally, as a first demonstration, the results of this study are hardly generalizable to different circumstances and populations and as such await for further research to complement this investigation. The current findings of hedonic habituation may, however, explain existing research that argued intensely flavoured foods were more susceptible to *Sensory Specific Satiety* than bland foods (Vickers, Holton, & Wang, 1998), insofar that the intensity correlated with hedonicity. It must be acknowledged, however, that the conclusion is based on a no-difference between the same and varied pre-exposures, which may have arisen due to lack of power rather than due to true lack of effect. Retrospective power analysis showed we had power of .66 to detect a medium effect, making lack of power a plausible alternative interpretation. This alternative interpretation is much more substantial for small effects. We would consider power prospectively in any future investigations of hedonic habituation.

The hedonic habituation effect observed may reflect a decline in the evaluation of food, but not an actual decrease in the pleasantness of food. That is, instead of experiencing a decrease in genuine pleasurable reactions to foods, participants may rate the foods lower in terms of a cognitive representation of affective value (Russell, 2003a). The distinction is similar to rating a film very highly, because a friend you watched it with rated it very highly, while really believing in / not lying about your hedonic evaluation, in contrast to actually having enjoyed the film more. This type of evaluative judgment may be especially sensitive to immediate past experiences and the reason we observe the decline in ratings may be due to the preceding *pleasant* snacks heightening the standard against which the current snack is compared. In a similar way, Riskey and colleagues (1979) found that participants rated the sweetness of a drink as less sweet after having experienced highly sweet drinks compared to after having experienced less sweet drinks; although it is debatable whether the participants actually perceived lower sweetness in the first case or the sweet perception remained the same, but the sensory judgment and scaling changed. Furthermore, hedonic habituation may be seen because the participants treat the relatively pleasant test snacks to be in the same category as the preceding pleasant snacks; by contrast, participants may not treat the relatively pleasant test snacks to be in the same category as the preceding bland snacks, resulting in a categorisation effect. This type of categorisation effect has been found with flower experts who do not show hedonic contrast in their aesthetic judgments of orchids versus irises, because they treat these flowers as belonging to different categories, whereas novices do show hedonic contrast because they treat orchids and irises as belonging in the same category of flowers (see Rota & Zellner, 2007). Alternatively, if genuine pleasure reactions are decreased in hedonic habituation, this effect may arise as a result of hedonic opponent-processes, whereby any pleasant reaction is followed by an unpleasant counter-reaction, which lowers the actual pleasure experienced from food (Solomon, 1980). The mechanisms which may underlie hedonic habituation are, of course, a speculation, at this stage, and the focal point of this paper is on the effect rather than process of hedonic habituation. Finally, the dishabituation paradigm (Epstein, Rodefer, Wisniewski, & Caggiula, 1992) could potentially be used to study hedonic habituation if the variable under study is chosen to be hedonics rather than salivation, of course. The essence of the dishabituation paradigm consists of repeatedly presenting food stimuli such that habituation would occur, but then presenting a novel stimulus that reduces the habituation (that novel stimulus being the dishabituator).

Should you be worried about going to too many good restaurants? Not on the basis of this evidence. The size of hedonic habituation effect appears too small to be of a practical concern and may only affect evaluations rather than genuine enjoyment of food. Food hedonic habituation does not seem to be in the same league as pharmacological tolerance, for instance, whereby euphoria from drugs such as heroin is drastically reduced due to a receptor desensitization process of one kind or another. Nevertheless, if taste hedonic habituation is found to be robust and gets larger with prolonged exposure, then the finding should have serious consequences for everyday choices and behaviour. To speculate further, hedonic habituation may occur for any type of pleasurable stimuli. For example, if you have just listened to three great songs, will this exposure to three highly enjoyable and different songs make you enjoy a fourth song less? As another instance, from the realm of euphorigenic drugs, snorting one line of cocaine after another would also produce a reduction in the rushes and highs elicited by each subsequent snorting. Importantly, this reduction would not occur because of general pharmacological tolerance, but due to the recent hyper-stimulation of pleasure reactions. For now, however, based on this study, food pleasure appears to remain an accessible and renewable daily joy of life, which does not undermine itself at a practical level.

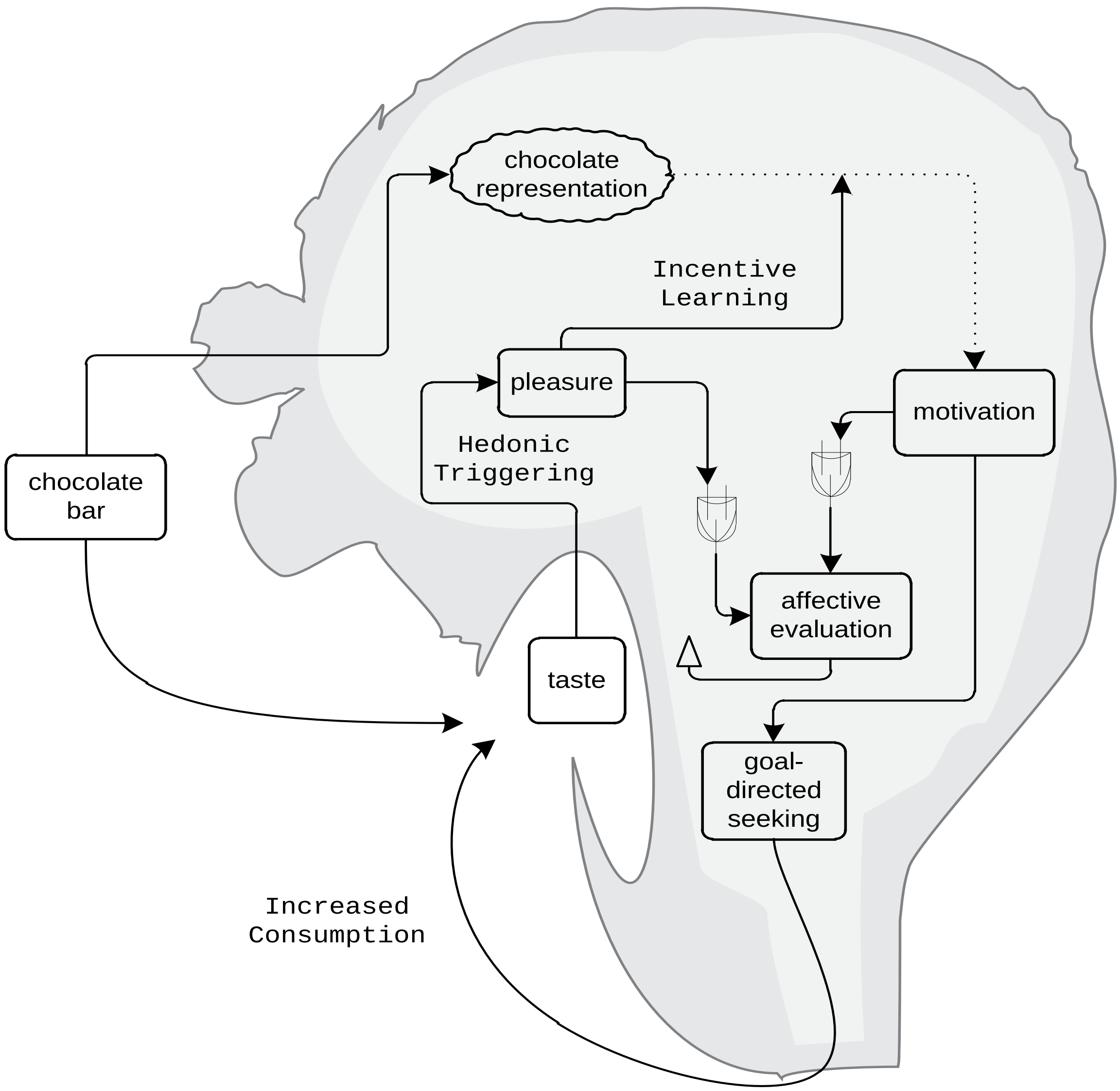
This chapter found that we give lower affective ratings after a series of pleasurable experiences. We interpret this effect to primarily reflect the process of *affective evaluation* rather than any change in true *pleasure reactions* per se i.e. the preceding pleasures make us feel '*rich*' and being '*rich*' we assess the additional '*pounds and pennies*' we earn as less valuable, even though the absolute amount of '*money*' we receive is the same as before. This chapter was the last empirical chapter and next we conclude with a contextualisation of our findings into a framework that highlights the overall impact and importance of *pleasure*.

VII. Roles and Importance of Pleasure

Firstly, a short summary of our findings: 1) It appears that there are at least 17 different ways to induce pleasure, such as with highly palatable flavours or through positive self-image; 2) Highly motivational stimuli do not make your approach and withdrawal reactions faster; 3) When you pair pleasurable experiences with novel neutral stimuli (e.g. unfamiliar brand logos), then you start indiscriminately *'liking'* them through a learning process that involves just the simple pairings of the stimulus with a pleasurable event; 4) We exert more force to obtain foods that are pleasant rather than bland, even though we appear to be unaware of doing so. We also consume more of tasty foods; in fact, we can predict exactly how much more with empirically-derived equations; 5) Pleasure seems to inhibit itself, or to be more accurate, we evaluate foods to be less pleasant if they are preceded by a series of pleasant snacks … Now how do these findings fit together?

Figure 15 presents an illustrative model of the key roles of *pleasure* in behaviour, which I will now explain with our findings linked to some of its structure. Firstly, certain types of triggers have the power to elicit *pleasure* (centre of *Figure 15*), in this instance it is the *taste* of the *chocolate bar*. The plethora of ways by which this *pleasure* state can be heightened is described in the *Causes* chapter and is by no means restricted to '*sensory pleasures'* only. Furthermore, the *Hedonic Triggering* arrow is a gross simplification of the processes by which pleasure may be triggered i.e. different core causes of pleasure will have their own mechanisms by which they elicit hedonic reactions, which differ fundamentally from each other.

Fig 15. Pleasure-Driven Incentive Learning



Pleasure from *tasting chocolate* provides an illustration of the general process of pleasure-driven incentive learning by which *hedonic reactions* assign *motivational value / desire* to co-occurring stimulus *representations*. That *desire or craving* then translates into *increased choice and consumption* of the *chocolate*, next time it is seen. Arrows represent spreading activation, dependent on how many *'holes'* there are in the path connecting the nodes. These paths become strengthened with more learning and weakened by time. *Affective evaluation* is a comparison of either the current *pleasure* level with some *reference*, or a comparison of the current *motivation/craving* with a *reference*, which can be output as evaluative self-report (*hollow arrow*).

For example, some pleasure sources are more homeostatic, such as temperature normalisation, while others are more cognitive or rooted in appraisals, such as fulfilment of expectations. For illustration purposes I will use the *taste* of *chocolate* as the trigger, however.

The *chocolate bar* is also a visible object that is perceived as a kind of a *representation of chocolate* in the brain (from here and after *italics* refer to components in the figure). During the elicited *pleasure* (from the *taste*), any *representations* that are active *at the same time* as the *pleasure* acquire *motivational value* through the process of *incentive learning*. This is conceived as the strengthening of the *path* from the *chocolate representation* to the state of *motivation*. *Motivation* can be manifest as a state of desire or craving, but not necessarily one of large overwhelming magnitude. When you are *motivated* to do something then you have a tendency to allocate your resources towards the outcome, such that your actions are likely to be directed towards the outcome, and you are likely to pursue the outcome with more vigor, compared to another outcome you are not *motivated* to attain. The state of *motivation* does not mean you actually realise those actions, however, you might not have the opportunity to act on your *motivation*, but the *motivation* is nevertheless there, as might be the case with a thirsty individual lost in a desert. As such, *motivation* is related to concepts of incentive, appetite, wanting, enthusiasm and so on. Our force findings give credence to the face-valid idea that pleasure affects motivation (*Hedonic Motivation Experiment*). Furthermore, I argue that the *Blocking Chapter* concurs within this model as well. This is a novel interpretation of this type of learning of new likes and such a modelling suggests that *incentive learning* does not exhibit the blocking phenomenon, which means that we attach *motivational* potency to any and all stimulus *representations* that are active during a *pleasure* episode. In this instance, the *chocolate representation* does not become capable of eliciting true *pleasure* as a result of pairing it with the *pleasure* from the *taste* of *chocolate*, instead the *chocolate* acquires incentive *motivational value* as we already described. The reason participants deem the *chocolate representation ‘liked’* - on its own, after one or more paired *tastings* - is because of the sensitivity of *affective evaluation* not just to true *pleasure* but also to *motivational* properties of stimuli. *Affective evaluation* is basically evaluative self-report (and it is verbalisable), and our findings with food words in the second empirical chapter support the idea that *affective evaluation* is sensitive to the motivational values of stimuli.

So the next time we come across that *chocolate bar* we are more likely to prefer it and taste it, because the *chocolate representation* has become *motivating* (the path between the *representation* and *motivation* has become stronger), and because *motivation* triggers *goal-directed seeking* leading to *increased consumption* when possible. The hedonic consumption experiments corroborate such a link. In fact, we have established quantitative formulae for the relationship between pleasure and intake (*Equations 1, 2* and *3*).

Going back to *pleasure* being more than just the peaks, but the background *core affect* as well, then *desires* would constantly be born when the baseline *pleasure* is enhanced as well e.g. when we are sufficiently merry from alcohol and take in the world around ourselves, or in the case of any other less stimulus-bound *pleasure*-level increase.

According to this model, this would lead to *'Increased Consumption'* later as well, of whatever *representations* became *motivationally* enhanced. The observation that pleasure appears to inhibit itself is posited to occur at the stage of *affective evaluation* while not influencing the true *pleasure* reactions themselves: *affective evaluation* is not a direct reading of the pleasure level, but a comparison of the current *pleasure* with a *reference* that can be influenced by various factors (Zellner, Mattingly, & Parker, 2009). In this model, the preceding pleasurable snacks heighten the status of the *reference* (the *comparator* between *pleasure* and *affective evaluation*), thus decreasing the *estimation* of the current *pleasure*. The *hollow arrow* going out of *affective evaluation* indicates not only that such evaluations can be verbalised, but also that such *affective evaluations* may be used by higher-order deliberative *'thinking-type'* processes. Finally, as we have already discussed, *motivational* stimuli do not seem to produce fast automatic potentiation of approach reactions, which is why such responses are not specified in this model. In summary, our findings fit well with the *pleasure-incentive model* and provide evidence for the majority of the links and components specified in the figure.

Next I give a short overview of how this *pleasure-incentive model* relates to existing models covering similar ground. Firstly, the *pleasure-incentive model* is directly based on the incentive learning model of Dickinson and Balleine (1994), except for one notable exception. The *pleasure-incentive model* does not differentiate between Pavlovian and instrumental types of *incentive learning*. That is, animal literature provides evidence for distinguishing the acquisition of *motivation* to stimuli such as a chocolate wrapper (which predicts likely presence of a chocolate bar; the Pavlovian type) against learning the motivational significance of stimuli that are the outcomes themselves, which is the chocolate bar in this case (the instrumental type). In the *pleasure-incentive model*, however, both a *representation of chocolate* and *representation of chocolate wrapper* could become more strongly associated with *motivation* through the same *incentive learning* process: if paired with pleasure, and allowing for the *chocolate wrapper* to acquire a less strong link to motivation if needed, as long as the process itself is the same. I argue for this non-splitting simply on the basis that we do not have human evidence to support splitting the *incentive learning* process into the Pavlovian and instrumental types, at this stage.

Secondly, the *pleasure-incentive model* can in principle accommodate *Hedonic Interface Theory* (*HIT*; Dickinson & Balleine, 2010), whereby the *pleasure* has to be conscious *pleasure* for it to be able to determine *incentive value*. That is, the possibility that *subconscious pleasure* could drive *incentive learning* (see the general *Introduction*), goes against *HIT*, and the *pleasure-incentive model* does not currently commit to either scenario: the *pleasure* in the model might have to be conscious or could also be subconscious.

Thirdly, the current model is not a drive model, whereby pleasure is intimately linked to motivating homeostatic balance (e.g. Wells, 1924). According to such theories, pleasure results from only satisfying needs that restore our *internal milieu* to a stable biological state e.g. sufficient nutrients in the blood, attainment of osmo-regulation set-points etc. In the *pleasure-incentive model*, there are indeed determinants of *pleasure* that are homeostatically-driven as exemplified through increased *pleasure* from food when deficient in nutrients or *pleasure* from temperature normalisation (not depicted in Figure 2; often related to a term alliesthesia; Briese & Quijada, 1979; Pfaff, 1982). But the causation of these *pleasures* is not necessarily directly related to homeostasis and there a lot of *pleasure* triggers that are non-homeostatic (see *Causes chapter*). That is, some but not all of the *hedonic triggers* in the *pleasure-incentive model* are linked to homeostasis.

Fourthly, while incorporating behavioural, cognitive and phenomenological elements, this model is clearly a psychological model - i.e. we have not informed the model from the biological / neuroscientific perspective, comprising the brain substrates that implement such mental processes (Kringelbach & Berridge, 2009). Such a level of analysis, with identification of accompanying *'bridging laws'* (Nagel, 1961), is an avenue awaiting to be integrated with the current psychological analysis. That is, understanding the neural networks that make such *pleasure*- and *motivation*-related phenomena happen would help to determine what exactly happens, as long as we have valid rules to translate neuroscience results into psychological results; the same is true about conversion of psychological findings and models into neurobiological frameworks. For a full understanding and cross-validation both are ultimately needed (Barrett, Mesquita, Ochsner, & Gross, 2007).

Lastly, multiple entities and interactions are not specified in this model e.g. that *displeasure* - the negative side of *pleasure* - reduces *incentive motivation*, or that *motivation* is critically influenced by non-pleasurable factors as well. In fact, *incentive value* appears to be the common currency by which very different things - e.g. going out vs preparing for exams - can be compared and ranked for action, rather than *pleasure* per se being that common currency (Cabanac, 1992). The lack of a lot of other entities and interactions in the model is not an issue, however, as my purpose was to highlight important roles of *pleasure* and I have provided a zoomed-in view of the central role of *pleasure* with its impacts on *motivation* and *intake*.

Lessons Learnt

Before applying the *pleasure-incentive* model to select real-life phenomena, I will review some of the general limitations of the work presented in this thesis in a form of lessons learnt for future work in this area. Firstly, second time around, I would conduct a priori power analyses before running experiments, in order to determine what sample sizes exactly to collect so as to be able to detect presumed effect sizes. This approach would minimise the alternative interpretations stemming from null results of under-powered experiments; a good practical protocol for a priori power analyses is available at http://www.jeremymiles.co.uk/misc/power/.

Secondly, I would pay much more attention to the proper execution of running human experiments and precisely following ethical regulations, so as to make sure to not cause any harm to study volunteers and to make sure proper fail-safes are in place, if anything were to go wrong. Experimenting with food is especially relevant in that regard, given the low probability, but high impact possibility of administering a food that triggers anaphylactic shock in an allergic individual, which dictates dire need for adequate risk management.

Thirdly, I would focus more on a better question-to-design match, or selection of most optimal designs with respect to the key questions being asked. For example, the core causes of pleasure study would have benefited from focussing less on the workplace i.e. to discover sources of pleasure outside the workplace, a more encompassing time period and location is needed. This poses its own limitations on the design, of course, and a web-based instrument may not have been suitable any more, so one of the ideas for the future is to carry out case studies with fewer individuals, but involving sessions of wider depth and breadth. Similarly for the investigation of congruency effects on approach reaction times, it would have been better to carry out the experiments outside of the larger sibutramine study. At the same time, pragmatic criteria do need to be taken into account. To somewhat work around this balancing act, however, a lesson learnt with regard to project management is to resist the demand to deliver results, in order to spend more time validating design decisions in terms of whether the design really answers the primary questions posed: as well as possible given the current opportunities.

In hindsight, I would also lean more on existing experimental paradigms in my research agenda, because new designs may not work for the smallest of reasons; I took huge risks by incorporating many novel designs. At the same time, if designing novel tasks, I would take laboratory psychology even closer to field studies (without sacrificing experimental control), so as to make sure the tests really model the real world phenomena of interest. In other words, to make sure we are not isolating and amplifying effects in the laboratory that are arbitrary with respect to the key questions asked about out-of-the-laboratory human psychology, and by doing that enhance that hard-to-measure construct validity. In addition, I would perhaps focus less on food pleasure, because finding about food pleasure are not necessarily generalisable to pleasure in general. There are many other lessons learnt, of course, e.g. I would utilize multilevel modelling / linear mixed models in most of my analyses, while still presenting the results in a readable manner; I would code the experimental tasks according object-oriented programming principles using design patterns that I have started to learn etc. I hope to incorporate all these lessons learnt into my future work.

Pleasure in Everyday Life

I will now relate the terminology of the *pleasure-incentive model* to a real-life phenomenon, the very writing of a thesis. *Pleasure* appears to critically guide the whole process from the speed of progress to the generation of content and commitment to quality (Wellington, 2010). For example, when a paragraph is perceived to have worthwhile interesting content (*Fulfilled Expectations* in *Causes chapter*), a *pleasure reaction* results, which amounts to eagerness about one’s own work, because of establishing a stronger link to *motivation* through *incentive learning*. This *motivation* then translates into ‘*practical motivation*’ through the link from *motivation* to potentiated *goal-directed seeking* (with potential induction of *flow* as well; Csikszentmihalyi & Rathunde, 1993). On the other hand, when a paragraph is perceived to read clumsily or to be unclear and confusing (*Unfulfilled Expectations*; Torrance, Thomas, & Robinson, 1992), the perceiver feels displeasure - or *pleasure*’s negative side if you agree with the bipolarity of *pleasure* - and the opposite effects are observed on *motivation* and *actual progress*. Furthermore, if your colleague or supervisor comments on your work with sincere praise (*Positive Self-Image* in *Causes chapter*), this also triggers *pleasure*, leading to the same positive effects on *motivation* and through that makes you want to *work and think more on the topic*. If the feedback is negative in style or substance, however, the opposite occurs (*Negative Self-Image*; Caffarella & Barnett, 2000; Can, 2009), with *difficulties initiating and continuing* each next step and with an obvious *dislike* for the job (*affective evaluation*). Furthermore, *avoidance* of required work tasks may result, lasting days or weeks, based on the *disincentives* that have built up, as a mechanism to avoid experiencing these *'aversive'* qualia (Boice & Jones, 1984). Similar arguments apply to caring about the work in general, because of real or illusory perceptions of doing very well and consequently wanting to base your whole future career on the topic (Robins & Kanowski, 2008): as a sum of all the different sources of *pleasure* and its repeated effects on *motivation* and *goal-directed seeking*. The other extreme would result from persistent feelings of *negative affect*: e.g. constantly missing deadlines with resulting barrages of displeasure; having null results everywhere; or the findings just being confusing and incomprehensible (all *Unfulfilled Expectations*); and from the total of such senses of inadequacy not wanting to proceed to a post-doctoral position or wanting to leave science altogether (Rennie & Brewer, 1987).

There are countless other everyday situations where *pleasure* seems ubiquitous, which can be identified, for instance, by selecting any other examples from *Table 1* in the *Causes chapter*. When applied in combination with the *pleasure-incentive model*, these central hedonic effects contribute further to the importance of *pleasure* in everyday *choices of action* and *their continuation (*as well as to the intermediary *incentive motivations*). Everywhere, where there is *pleasure* - and we are not just including large overwhelming *pleasures* - *pleasure* will be a critical influence on our *wants and desires*, and through them, on our everyday *choices and behaviour*.

Pleasure and Addictions

Next I discuss the potential importance of pleasure in addictive behaviours. At the outset, it must be made clear that addictions are syndromes rather than pathologies of a single origin and mechanism, so only a subset of compulsive behaviours are to do with positive reinforcement. However, it is argued that this type of addiction is one of the main types of dependence (Newton, La Garza, Kalechstein, Tziortzis, & Jacobsen, 2009; West, 2005). Firstly, drug addictions. As exemplified by substance abuse and contrary to popular belief, hard-core heroin addicts, for instance, get high daily despite their tolerance levels, as well as exhibit multiple behaviour patterns directed directly towards attaining the euphoria from heroin (McAuliffe & Gordon, 1974). Furthermore, one of the few approved and working treatments for opiate addictions are methadone and naltrexone, both of which decrease the pleasurable effects of the abused narcotic (e.g. Hammond, 1971; Sim, 1973). Although such pharmacological treatments have their own problems (e.g. Dougherty, 2003), they are part of a large body of evidence that hedonic reactions may play a key role in a considerable portion of addictive behaviours (H. de Wit & Phan, 2009).

When applying the *pleasure-incentive model* (*Figure 15*), however, it is not currently clear which of the entities in the process might be critical. Some of the key untested hypotheses relating the *pleasure-incentive model* to drug addiction are: 1) Addicts may derive more *pleasure* per stimulus injection than non-addicts (critical difference in *hedonic triggering* link); 2) The connection from *pleasure* to *motivation* may define an '*addictive personality*', such that the same magnitude of *pleasure* would induce a much stronger *desire* in the addict than in the non-addict (but note that the presence of *pleasure* would still be necessary); 3) *Incentive* sensitisation, such that with prolonged *incentive learning* the *motivation* trace may become over-learnt as to become almost permanent and thus independent of *pleasure* (as formalised in e.g. Robinson & Berridge, 2008). This version would be similar to vampires' immense craving for blood, as long as the assumed *pleasure* from sucking blood switched to having negligible impact on the vampire's desire; 4) There may be no differences in the operation of the *pleasure-incentive* process, instead the transition to addiction may comprise of escalating access to drugs, as well as of concurrent life-style changes, which make the highly euphorigenic agent available to an extent that most normal individuals would be locked into a '*dead circle*', due to immensely powerful triggering of a normally-functioning *incentive-pleasure* system.

Secondly, obesity and over-eating disorders are also syndromes arising from various aetiologies. The argument for sub-types of the conditions - what might be called food addictions – is, however, equivalent to the roles posited for the *pleasure-incentive* model in drug addictions (see e.g. Davis & Carter, 2009; Volkow & Wise, 2005). In cases where overweight or binge-eating arises from a positive energy balance, a necessary cause of the underlying over-eating behaviour might be 1) That the patient group derives more *pleasure* from food and therefore triggers the hedonic *motivation* and subsequent *consumption* more strongly (e.g. Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006). 2) Food may be equally *palatable* to the patient group, but the impact of that *palatibility* on *motivation* (*incentive learning*) may be more powerful in food addictions, again suggesting the existince of an *'addictive personality'* type, which would lead to amplified *engagement* with anything *pleasurable* without actually deriving more *pleasure* from stimuli (e.g. J. Feldman & Eysenck, 1986). 3) Once learnt, *motivation* for palatable food may become harder to '*erase*' and somewhat impervious to changes from further experience and learning opportunitites, this loss of plasticity being another potential way by which the *pleasure-incentive* model could lead to over-eating (e.g. Clark, Dewey, & Temple, 2010). 4) Obese individuals may not *enjoy* food more, may not find it more *motivating*, may be perfectly normal in *forgetting* or *re-adjusting* their food *motivations*; but leaving the *pleasure-incentive* process to work under certain conditions, in a microcosm where highly *palatable* foods are abundant, cheap and easily available, where eating *motivations* are not oucompeted by other activities etc, then in these circumstances according to this hypothesis anyone of us would become obese. Alternatively, if releasing the *pleasure-incentive* process in certain environments is not sufficient to lead to over-eating, it may still be necessary as a cause of obesity. It is, of course, plausible and likely that many of these hypothesis hold true at the same time i.e. they are not necessarily mutually exclusive. Finally, pleasure and *pleasure-incentive* model may have further implications in other conditions, such as in depression, in bipolar disorder and in schizophrenia. In summary, it is plausible that the *pleasure-incentive* process plays some role in compulsive behaviours. However, it is yet to be determined which components of that mechanism might be most critically afflicted.

Intrinsic Value

To conclude the importance of *pleasure*, we mustn't forget the core property of *pleasure* itself, its intrinsically *good* nature. It is for this reason that *core affect* plays a part in many constitutions and is sometimes even regarded a human right, as illustrated by this quotation from the U.S. Declaration of Independence: "*that all men … are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness*" (U.S. Constitution, 1776). The same rationale applies to the more extreme and less balanced forms of hedonistic philosophical traditions (for review, see e.g. F. Feldman, 2004). Religions are not untouched either, excluding pleasures of the flesh, of course: for example, the promise of paradise or heaven in the Bible: "*you will fill me with joy in your presence, with eternal pleasures at your right hand*" (Psalm 16:11, New International Version). Besides the sizable consequences of pleasure to motivation and behaviour then, the importance of pleasure stems from the same root as does the importance of not inflicting pain, which are respectively the intrinsically *good* and *aversive* subjective qualities of the experiences.

While pleasure is very well and easily recognised as an explanatory variable by the layman and the clinician, it is not on the research agenda of many scientists. From this millennium, the comprehensive search engine *ISI Web of Knowledge* returns about 7000 reports on *(pleasure OR hedonic)* compared to >200000 hits on *(attention)*, for instance. In my opinion, the main reason for such an imbalance is prejudice, and rejecting ideas, procedures and observations from fields outside our own paradigm. This is true not only about the laboratory scientists, but the scientists on journal boards and grant committees that have the collective power to direct research. Instead of restricting ourselves, or more importantly, restricting others to the boundaries of our disciplines, we should seek to use and review empirical work as dictated by the question being posed. That is, for most questions about human behaviour and psychology, we should critically use the relevant information from the behaviourist, cognitivist, introspectionist, biological-reductionist, and other schools of thought, and not ignore or reject one of those a priori, if the question clearly demands otherwise. Taking this position back to the current object of study, pleasure is not some immeasurable and dirty thing, but a substantial constituent of our daily lives, as well as a critical factor in some serious addictive behaviours. We should therefore desire to learn more about this explanatory variable.

References

Aarts, H., Custers, R., & Marien, H. (2008). Preparing and motivating behavior outside of awareness. *Science*, *319*(5870), 1639-1639. doi: 10.1126/science.1150432

Aitken, M. R. F., Larkin, M. J. W., & Dickinson, A. (2000). Super-learning of causal judgements. *Quarterly Journal of Experimental Psychology Section B-Comparative and Physiological Psychology, 53*(1), 59-81.

Alliger, G. M., & Williams, K. J. (1993). Using signal-contingent experience sampling methodology to study work in the field - a discussion and illustration examining task perceptions and mood. *Personnel Psychology*, *46*(3), 525-549.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders - text revision* (4th ed.). Washington, DC: American Psychiatric Publishing.

Anderson, H. H. (1936). Motivation of young children: Further studies in success and failure, praise and blame. *Child Development*, *7*(2), 125-143.

Baeyens, F., Crombez, G., De Houwer, J., & Eelen, P. (1996). No evidence for modulation of evaluative flavor-flavor associations in humans. *Learning and Motivation, 27*(2), 200-241.

Baeyens, F., & De Houwer, J. (1995). Evaluative conditioning is a qualitatively distinct form of classical-conditioning - reply. *Behaviour Research and Therapy*, *33*(7), 825-831.

Baeyens, F., Eelen, P., Van den Bergh, O., & Crombez, G. (1990). Flavor-flavor and color-flavor conditioning in humans. *Learning and Motivation*, *21*(4), 434-455.

Baeyens, F., Hendrickx, H., Crombez, G., & Hermans, D. (1998). Neither extended sequential nor simultaneous feature positive training result in modulation of evaluative flavor-flavor conditioning in humans. *Appetite, 31*(2), 185-204.

Barrett, L. F., Mesquita, B., Ochsner, K. N., & Gross, J. J. (2007). The experience of emotion. *Annual Review of Psychology, 58*, 373-403. doi: 10.1146/annurev.psych.58.110405.085709

Bartoshuk, L. M., Duffy, V. B., Hayes, J. E., Moskowitz, H. R., & Snyder, D. J. (2006). Psychophysics of sweet and fat perception in obesity: Problems, solutions and new perspectives. *Philos Trans R Soc Lond B Biol Sci*, *361*(1471), 1137-1148. doi: 10.1098/rstb.2006.1853

Basch, J., & Fisher, C. D. (2000). Affective events-emotion matrix: A classification of work events and associated emotions. In N. M. Ashkanasy, C. E. J. Härtel & W. J. Zerber (Eds.), *Emotions in the workplace: Research, theory and practice* (pp. 36-48). Westport, CT: Quorum Books.

Bates, D. M. (2010). *lme4: Mixed-effects modeling with R*. New York: Springer.

Beebe-Center, J. G. (1929). The law of affective equilibrium. *American Journal of Psychology, 41*(1), 54-69.

Beebe-Center, J. G. (1965). *The psychology of pleasantness and unpleasantness*. New York: Russell & Russell.

Bellisle, F., Lucas, F., Amrani, R., & Le Magnen, J. (1984). Deprivation, palatability and the micro-structure of meals in human-subjects. *Appetite, 5*(2), 85-94.

Benelam, B. (2009). Satiation, satiety and their effects on eating behaviour. *Nutrition Bulletin*, *34*(2), 126-173. doi: 10.1111/j.1467-3010.2009.01753.x

Berridge, K. C. (2004). Motivation concepts in behavioral neuroscience. *Physiology & Behavior*, *81*(2), 179-209. doi: 10.1016/j.physbeh.2004.02.004

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: 'Liking', 'wanting', and learning. *Current Opinion in Pharmacology, 9*(1), 65-73. doi: 10.1016/j.coph.2008.12.014

Berteus-Forslund, H., Torgerson, J. S., Sjostrom, L., & Lindroos, A. K. (2005). Snacking frequency in relation to energy intake and food choices in obese men and women compared to a reference population. *International Journal of Obesity*, *29*(6), 711-719. doi: 10.1038/sj.ijo..802950

Bitner, M. J., Booms, B. H., & Tetreault, M. S. (1990). The service encounter - diagnosing favorable and unfavorable incidents. *Journal of Marketing*, *54*(1), 71-84.

Block, N. (1995). On a confusion about a function of consciousness. *Behavioral and Brain Sciences*, *18*(2), 227-247.

Blundell, J. E., de Graaf, C., Finlayson, G., Halford, J. C. G., Hetherington, M. M., King, N., & Stubbs, J. (2009). Measuring food intake, hunger, satiety, and satiation in the laboratory. In D. B. Allison & M. L. Baskin (Eds.), *Handbook of assessment* *methods for eating behaviors and weight-related problems: Measures, theory and research* (2nd ed., pp. 283-325). London: SAGE.

Blundell, J. E., & Finlayson, G. (2004). Is susceptibility to weight gain characterized by homeostatic or hedonic risk factors for overconsumption? *Physiology & Behavior, 82*(1), 21-25. doi: 10.1016/j.physbeh.2004.04.021

Bobroff, E. M., & Kissileff, H. R. (1986). Effects of changes in palatability on food-intake and the cumulative food-intake curve in man. *Appetite, 7*(1), 85-96.

Boice, R., & Jones, F. (1984). Why academicians dont write. *Journal of Higher Education, 55*(5), 567-582.

Booth, D. A. (2009). The basics of quantitative judgment. How to rate the strength of appetite for food and its sating. *Appetite, 53*(3), 438-441. doi: 10.1016/j.appet.2009.08.003

Brant, R. (1990). Comparing classical and resistant outlier rules. *Journal of the American Statistical Association, 85*(412), 1083-1090.

Briese, E., & Quijada, M. (1979). Positive alliesthesia after insulin. *Experientia, 35*(8), 1058-1059.

Brunstrom, J. M., & Fletcher, H. Z. (2008). Flavour-flavour learning occurs automatically and only in hungry participants. *Physiology & Behavior, 93*(1-2), 13-19. doi: 10.1016/j.physbeh.2007.07.009

Brunstrom, J. M., & Shakeshaft, N. S. G. (2009). Measuring affective (liking) and non-affective (expected satiety) determinants of portion size and food reward. *Appetite, 52*(1), 108-114. doi: 10.1016/j.appet.2008.09.002

Cabanac, M. (1971). Physiological role of pleasure. *Science, 173*(2), 1103-1107.

Cabanac, M. (1979). Sensory pleasure. *Q Rev Biol, 54*(1), 1-29.

Cabanac, M. (1992). Pleasure - the common currency. *Journal of Theoretical Biology, 155*(2), 173-200.

Cabanac, M., & Ferber, C. (1987). Pleasure and preference in a two-dimensional sensory space. *Appetite, 8*(1), 15-28.

Caffarella, R. S., & Barnett, B. G. (2000). Teaching doctoral students to become scholarly writers: The importance of giving and receiving critiques. *Studies in Higher Education, 25*(1), 39-52. doi: 10.1080/030750700116000

Cain, W. S., & Johnson, F. (1978). Lability of odor pleasantness - influence of mere exposure. *Perception, 7*(4), 459-465.

Can, G. (2009). *A model for doctoral students' perception and attitudes toward written feedback for academic writing.* Doctoral dissertation, Utah State University, Logan, UT.

Cardello, A. V., & Schutz, H. G. (2004). Research note - numerical scale-point locations for constructing the LAM (Labeled Affective Magnitude) scale. *Journal of Sensory Studies, 19*(4), 341-346.

Cardello, A. V., & Schutz, H. G. (2006). Sensory science: Measuring consumer acceptance. In Y. H. Hui (Ed.), *Handbook of food science, technology, and engineering* (Vol. 2). Boca Raton, FL: CRC Press.

Cardello, A. V., Schutz, H. G., Lesher, L. L., & Merrill, E. (2005). Development and testing of a labeled magnitude scale of perceived satiety. *Appetite, 44*(1), 1-13. doi: 10.1016/j.appet.2004.05.007

Cardinal, R. N., & Aitken, M. R. F. (2006). *ANOVA for the behavioural sciences researcher*. Mahwah, NJ: Lawrence Erlbaum.

Chapman, C. R. (1996). Limbic processes and the affective dimension of pain. In G. Carli & M. Zimmermann (Eds.), *Towards the neurobiology of chronic pain* (pp. 63-81). Amsterdam: Elsevier Science.

Chapman, G. B., & Robbins, S. J. (1990). Cue interaction in human contingency judgment. *Memory & Cognition, 18*(5), 537-545.

Chen, M., & Bargh, J. A. (1999). Consequences of automatic evaluation: Immediate behavioral predispositions to approach or avoid the stimulus. *Personality and Social Psychology Bulletin, 25*(2), 215-224.

Clark, E. N., Dewey, A. M., & Temple, J. L. (2010). Effects of daily snack food intake on food reinforcement depend on body mass index and energy density. *American Journal of Clinical Nutrition, 91*(2), 300-308. doi: 10.3945/ajcn.2009.28632

Cline, B. L. (1987). *Men who made a new physics: Physicists and the quantum theory*. Chicago, IL: University of Chicago Press.

Csikszentmihalyi, M., & Rathunde, K. (1993). The measurement of flow in everyday life - toward a theory of emergent motivation. *Nebraska Symposium on Motivation, 40*, 57-97.

Dai, X. C., Brendl, C. M., & Ariely, D. (2010). Wanting, liking, and preference construction. *Emotion, 10*(3), 324-334. doi: 10.1037/A0017987

Davis, C., & Carter, J. C. (2009). Compulsive overeating as an addiction disorder. A review of theory and evidence. *Appetite, 53*(1), 1-8. doi: 10.1016/j.appet.2009.05.018

De Graaf, C., De Jong, L. S., & Lambers, A. C. (1999). Palatability affects satiation but not satiety. *Physiology & Behavior, 66*(4), 681-688.

de Graaf, C., Kramer, F. M., Meiselman, H. L., Lesher, L. L., Baker-Fulco, C., Hirsch, E. S., & Warber, J. (2005). Food acceptability in field studies with US army men and women: Relationship with food intake and food choice after repeated exposures. *Appetite, 44*(1), 23-31. doi: 10.1016/j.appet.2004.08.008

De Houwer, J. (2009). The propositional approach to associative learning as an alternative for association formation models. *Learning & Behavior, 37*(1), 1-20. doi: 10.3758/Lb.37.1.1

De Houwer, J., Crombez, G., Baeyens, F., & Hermans, D. (2001). On the generality of the affective Simon effect. *Cognition & Emotion, 15*(2), 189-206.

De Houwer, J., & Eelen, P. (1998). An affective variant of the Simon paradigm. *Cognition & Emotion, 12*(1), 45-61.

De Houwer, J., Thomas, S., & Baeyens, F. (2001). Associative learning of likes and dislikes: A review of 25 years of research on human evaluative conditioning. *Psychological Bulletin, 127*(6), 853-869. doi: 10.1037/0033-2909.127.6.853

de Wit, H., & Phan, L. (2009). Positive reinforcement theories of drug use In J. D. Kassell (Ed.), *Substance abuse and emotion*. Washington, DC: American Psychological Association.

de Wit, S., & Dickinson, A. (2009). Associative theories of goal-directed behaviour: A case for animal-human translational models. *Psychological Research-Psychologische Forschung, 73*(4), 463-476. doi: 10.1007/s00426-009-0230-6

Degner, J., Wentura, D., & Rothermund, K. (2006). Indirect assessment of attitudes with response-time-based measures - chances and problems. *Zeitschrift Fur Sozialpsychologie, 37*(3), 131-139. doi: 10.1024/0044-3514.37.3.131

Delmonico, D. L. (1997). Cybersex: High tech sex addiction. *Sexual Addiction & Compulsivity, 4*(2), 159-167 doi: 10.1080/10720169708400139

Di Lollo, V., Enns, J. T., & Rensink, R. A. (2000). Competition for consciousness among visual events: The psychophysics of reentrant visual processes. *Journal of Experimental Psychology-General, 129*(4), 481-507. doi: 10.1037//0096-3445.129.4.481

Dickinson, A., & Balleine, B. (1994). Motivational control of goal-directed action. *Animal Learning & Behavior, 22*(1), 1-18.

Dickinson, A., & Balleine, B. W. (2002). The role of learning in the operation of motivational systems. In C. R. Gallistel (Ed.), *Steven's handbook of experimental psychology: Learning, motivation and emotion* (3rd ed., Vol. 3, pp. 497-534). New York: John Wiley & Sons.

Dickinson, A., & Balleine, B. W. (2010). Hedonics: The cognitive-motivational interface. In M. L. Kringelbach & K. C. Berridge (Eds.), *Pleasures of the brain* (pp. 74-84). New York: Oxford University Press.

Dickinson, A., & Brown, K. J. (2007). Flavor-evaluative conditioning is unaffected by contingency knowledge during training with color-flavor compounds. *Learning & Behavior, 35*(1), 36-42.

Dickinson, A., Shanks, D., & Evenden, J. (1984). Judgment of act-outcome contingency - the role of selective attribution. *Quarterly Journal of Experimental Psychology Section A-Human Experimental Psychology, 36*(1), 29-50.

Diener, E. (2009). Subjective well-being. In E. Diener (Ed.), *The science of well-being* (pp. 11-58). Netherlands: Springer.

Dijksterhuis, A., & Smith, P. K. (2002). Affective habituation: Subliminal exposure to extreme stimuli decreases their extremity. *Emotion, 2*(3), 203-214.

Dolan, P., Peasgood, T., & White, M. (2008). Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology*, *29*(1), 94-122. doi: 10.1016/j.joep.2007.09.001

Dougherty, R. J. (2003). Increasing compliance with naltrexone. *Journal of Addictive Diseases, 22*(2), 128-128.

Drewnowski, A. (1997). Taste preferences and food intake. *Annual Review of Nutrition, 17*, 237-253.

Drewnowski, A. (1998). Energy density, palatability, and satiety: Implications for weight control. *Nutrition Reviews, 56*(12), 347-353.

Drewnowski, A., & Hann, C. (1999). Food preferences and reported frequencies of food consumption as predictors of current diet in young women. *American Journal of Clinical Nutrition, 70*(1), 28-36.

Eder, A. B., & Rothermund, K. (2008). When do motor behaviors (mis)match affective stimuli? An evaluative coding view of approach and avoidance reactions. *Journal of Experimental Psychology-General, 137*(2), 262-281. doi: 10.1037/0096-3445.137.2.262

Eertmans, A., Baeyens, F., & Van den Bergh, O. (2001). Food likes and their relative importance in human eating behavior: Review and preliminary suggestions for health promotion. *Health Education Research, 16*(4), 443-456. doi: 10.1093/her/16.4.443

Ekman, P. (1999). Basic emotions. In T. Dalgleish & M. Power (Eds.), *Handbook of cognition and emotion* (pp. 45-60). Sussex: John Wiley & Sons.

Engen, T., & McBurney, D. H. (1964). Magnitude and category scales of the pleasantness of odors. *J Exp Psychol, 68*, 435-440.

Epicurus. (n.d.). Menoeceus 122 - Epicurus wiki Retrieved 06/23, 2010, from http://wiki.epicurus.info/Menoeceus_122

Epstein, L. H., Caggiula, A. R., Rodefer, J. S., Wisniewski, L., & Mitchell, S. L. (1993). The effects of calories and taste on habituation of the human salivary response. *Addictive Behaviors, 18*(2), 179-185.

Epstein, L. H., Rodefer, J. S., Wisniewski, L., & Caggiula, A. R. (1992). Habituation and dishabituation of human salivary response. *Physiology & Behavior, 51*(5), 945-950. doi: 0031-9384(92)90075-D [pii]

Epstein, L. H., Temple, J. L., Roemmich, J. N., & Bouton, M. E. (2009). Habituation as a determinant of human food intake. *Psychological Review, 116*(2), 384-407. doi: 10.1037/a0015074

Erlanson-Albertsson, C. (2005). How palatable food disrupts appetite regulation. *Basic & Clinical Pharmacology & Toxicology, 97*(2), 61-73.

Fazio, R. H. (2001). On the automatic activation of associated evaluations: An overview. *Cognition & Emotion, 15*(2), 115-141.

Feldman, F. (2004). *Pleasure and the good life : Concerning the nature, varieties and plausibility of hedonism*. Oxford: Clarendon Press.

Feldman, J., & Eysenck, S. (1986). Addictive personality traits in bulimic patients *Personality and Individual Differences, 7*(6), 923-926.

Ferrand, L., Ric, F., & Augustinova, M. (2006). Affective priming: A case of semantic priming? *Annee Psychologique, 106*(1), 79-104.

Finlayson, G., King, N., & Blundell, J. (2008). The role of implicit wanting in relation to explicit liking and wanting for food: Implications for appetite control. *Appetite, 50*(1), 120-127. doi: 10.1016/j.appet.2007.06.007

Finlayson, G., King, N., & Blundell, J. E. (2007a). Is it possible to dissociate 'liking' and 'wanting' for foods in humans? A novel experimental procedure. *Physiology & Behavior, 90*(1), 36-42. doi: 10.1016/j.physbeh.2006.08.020

Finlayson, G., King, N., & Blundell, J. E. (2007b). Liking vs. Wanting food: Importance for human appetite control and weight regulation. *Neuroscience and Biobehavioral Reviews, 31*(7), 987-1002. doi: 10.1016/j.neubiorev.2007.03.004

Fischman, M. W., & Foltin, R. W. (1991). Utility of subjective-effects measurements in assessing abuse liability of drugs in humans. *British Journal of Addiction, 86*(12), 1563 - 1570. doi: 10.1111/j.1360-0443.1991.tb01749.x

Fisher, C. D., & Noble, C. S. (2004). A within-person examination of correlates of performance and emotions while working. *Human Performance, 17*(2), 145-168.

Flanagan, J. C. (1954). The Critical Incident Technique. *Psychological Bulletin, 51*(4), 327-358.

Franklin, S. (2005). A "consciousness"-based architecture for a functioning mind. In D. N. Davis (Ed.), *Visions of mind: Architectures for cognition and affect* (pp. 149-175). Hershey, PA: Idea Group.

Frederick, S., & Loewenstein, G. (1999). Hedonic adaptation. In D. Kahneman, E. Diener & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 302-329). New York: Russell Sage Foundation.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology - the broaden-and-build theory of positive emotions. *American Psychologist, 56*(3), 218-226.

Frijda, N. H. (2001). The nature of pleasure. In J. A. Bargh & D. K. Apsley (Eds.), *Unraveling the complexities of social life: A festschrift in honor of Robert B. Zajonc* (pp. 71-94). Washington: American Psychological Association.

Frijda, N. H. (2007). *The laws of emotion*. Mahwah, NJ: Routledge.

Garcia, J., & Koelling, R. A. (1966). Relation of cue to consequence in avoidance learning. *Psychon Sci, 4*, 123-124.

Gibson, E. L., & Brunstrom, J. M. (2007). Learned influences on appetite, food choice, and intake: Evidence in human beings. In T. C. Kirkham & S. J. Cooper (Eds.), *Appetite and body weight: Integrative systems and the development of anti-obesity drugs* (pp. 271-300). Burlington, MA: Elsevier.

Goetz, T., Frenzel, A. C., Stoeger, H., & Hall, N. C. (2010). Antecedents of everyday positive emotions: An experience sampling analysis. *Motivation and Emotion, 34*(1), 49-62. doi: 10.1007/s11031-009-9152-2

Goldstein, I. (1989). Pleasure and pain - unconditional, intrinsic values. *Philosophy and Phenomenological Research, 50*(2), 255-276.

Gondek-Brown, M., Sclafani, A., McNally, S., Gordon, R., Farkas, J., Torres, M., & Kissileff, H. (2007). Measuring the reward value of aspartame-sweetened yogurt shake via continuous and progressive ratio schedules in humans. *Columbia Undergraduate Science Journal, 2*(1), 53-64.

Grabenhorst, F., & Rolls, E. T. (2009). Different representations of relative and absolute subjective value in the human brain. *Neuroimage*, *48*(1), 258-268. doi: 10.1016/j.neuroimage.2009.06.045

Hager, W., & Hasselhorn, M. (1994). *Handbuch deutschsprachiger Wortnormen*. Gottingen, Germany: Hogrefe.

Halford, J. C. G., Boyland, E. J., Blundell, J. E., Kirkham, T. C., & Harrold, J. A. (2010). Pharmacological management of appetite expression in obesity. *Nature Reviews Endocrinology, 6*(5), 255-269. doi: 10.1038/nrendo.2010.19

Hammond, A. L. (1971). Narcotic antagonists - new methods to treat heroin addiction. *Science, 173*(3996), 503-&.

Hare, R. M. (1972). Pain and evil. In R. M. Hare (Ed.), *Essays on the moral concepts* (pp. 76-91). Berkeley: University of California Press.

Hein, K. A., Jaeger, S. R., Carr, B. T., & Delahunty, C. M. (2008). Comparison of five common acceptance and preference methods. *Food Quality and Preference, 19*(7), 651-661. doi: 10.1016/j.foodqual.2008.06.001

Hempel, C. G. (Ed.). (1952). *Fundamentals of concept formation in empirical science*. Chicago: University of Chicago Press.

Henderson, P. W., & Cote, J. A. (1998). Guidelines for selecting or modifying logos. *Journal of Marketing, 62*(2), 14-30.

Hermans, D., & De Houwer, J. (1994). Affective and subjective familiarity ratings of 740 dutch words. *Psychologica Belgica, 34*(2/3), 115-139.

Hetherington, M. M., Anderson, A. S., Norton, G. N. M., & Newson, L. (2006). Situational effects on meal intake: A comparison of eating alone and eating with others. *Physiology & Behavior, 88*(4-5), 498-505. doi: 10.1016/j.physbeh.2006.04.025

Hinchy, J., Lovibond, P. F., & Terhorst, K. M. (1995). Blocking in human electrodermal conditioning. *Quarterly Journal of Experimental Psychology Section B-Comparative and Physiological Psychology, 48*(1), 2-12.

Hobson, J. A. (1997). Consciousness as a state-dependent phenomenon. In J. D. Cohen (Ed.), *Scientific approaches to consciousness* (pp. 379-396). Hillsdale, NJ: Erlbaum.

Hodes, R. L., Cook, E. W., & Lang, P. J. (1985). Individual differences in autonomic response - conditioned association or conditioned fear. *Psychophysiology, 22*(5), 545-560.

Hoffmann, E., & Mata, A. (1998). Measuring working time: An alternative approach to classifying time use. *Bulletin of Labour Statistics, 3*, 1-14.

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: A meta-analysis. *Psychological Bulletin, 136*(3), 390-421. doi: 10.1037/a0018916

Hu, S. Q., & McChesney, K. A. (1999). Facial EMG is associated with taste palatability. *Psychophysiology, 36*, S62-S62.

Hu, S. Q., Player, K. A., Mcchesney, K. A., Dalistan, M. D., Tyner, C. A., & Scozzafava, J. E. (1999). Facial EMG as an indicator of palatability in humans. *Physiology & Behavior, 68*(1-2), 31-35.

Huang, C.-N., Chen, C.-H., & Chung, H.-Y. (2004). The review of applications and measurements in facial electromyography. *Journal of Medical and Biological Engineering, 25*(1), 15-20.

Hudlicka, E. (2003). To feel or not to feel: The role of affect in human-computer interaction. *International Journal of Human-Computer Studies*, *59*(1-2), 1-32. doi: 10.1016/S1071-5819(03)00047-8

Hunt, S. P., & Koltzenburg, M. (2005). *The neurobiology of pain*. Oxford: Oxford University Press.

Jacobellis v. Ohio, 378 U.S. 184 (Warren Court 1964).

Johnsrude, I. S., Owen, A. M., Zhao, W. V., & White, N. M. (1999). Conditioned preference in humans: A novel experimental approach. *Learning and Motivation, 30*(3), 250-264.

Kahneman, D., Diener, E., & Schwarz, N. (Eds.). (2003). *Well-being: The foundations of hedonic psychology*. New York: Russell Sage Foundation.

Kamin, L. J. (1969). Predictability, surprise, attention, and conditioning. In B. A. Campbell & R. M. Church (Eds.), *Punishment and aversive behavior* (pp. 279-296). New York: Appleton-Century-Crofts and Fleschner Publishing Company.

Kanis, M., Brinkman, W. P., & Perry, M. (2009). Designing for positive disclosure: What do you like today? *International Journal of Industrial Ergonomics*, *39*(3), 564-572. doi: 10.1016/j.ergon.2008.10.001

Kashdan, T. B., Uswatte, G., & Julian, T. (2006). Gratitude and hedonic and eudaimonic well-being in vietnam war veterans. *Behaviour Research and Therapy, 44*(2), 177-199. doi: 10.1016/j.brat.2005.01.005

Katz, L. D. (2006). Pleasure. In E. N. Zalta (Ed.), Stanford Encyclopedia of Philosophy. Stanford: Metaphysics Research Lab. Retrieved from http://plato.stanford.edu/entries/pleasure/.

Kissileff, H. R., & Guss, J. L. (2001). Microstructure of eating behavior in humans. *Appetite, 36*(1), 70-78. doi: 10.1006/appe.2000.0369

Kissileff, H. R., Klingsberg, G., & Van Itallie, T. B. (1980). Universal Eating Monitor for continuous recording of solid or liquid consumption in man. *American Journal of Physiology, 238*(1), R14-R22.

Klauer, K. C., & Musch, J. (1999). Eine Normierung unterschiedlicher Aspekte der evaluativen Berwertung von 92 Substantiven. [A standardization of various aspects of the evaluation of 92 nouns]. *Zeitschrift Fur Sozialpsychologie, 30*(1), 1-11.

Klimmt, C., Schmid, H., & Orthmann, J. (2009). Exploring the enjoyment of playing browser games. *Cyberpsychology & Behavior, 12*(2), 231-234. doi: 10.1089/cpb.2008.0128

Klocksiem, J. (2008). The problem of interpersonal comparisons of pleasure and pain. *Journal of Value Inquiry, 42*(1), 23-40. doi: 10.1007/s10790-008-9101-4

Krafte, D. S., & Bannon, A. W. (2008). Sodium channels and nociception: Recent concepts and therapeutic opportunities. *Current Opinion in Pharmacology, 8*(1), 50-56. doi: 10.1016/j.coph.2007.09.007

Krieglmeyer, R., & Deutsch, R. (2009). Comparing measures of approach–avoidance behaviour: The manikin task vs. Two versions of the joystick task. *Cognition & Emotion*. doi: 10.1080/02699930903047298

Krieglmeyer, R., Deutsch, R., De Houwer, J., & De Raedt, R. (2010). Being moved: Valence activates approach-avoidance behavior independently of evaluation and approach-avoidance intentions. *Psychological Science*, *21*(4), 607-613. doi: 10.1177/0956797610365131

Kringelbach, M. L., & Berridge, K. C. (2009). Towards a functional neuroanatomy of pleasure and happiness. *Trends in Cognitive Sciences*, *13*(11), 479-487. doi: 10.1016/j.tics.2009.08.006

Kringelbach, M. L., & Berridge, K. C. (Eds.). (2010). *Pleasures of the brain*. New York: Oxford University Press.

Kuwayama, Y. (1973). *Trademark and symbols*. New York: Van Nostrand Reinhold Co.

Kuznicki, J. T., Johnson, R. A., & Rutkiewic, A. F. (1982). *Selected sensory methods: Problems and approaches to measuring hedonics* (Vol. 38). Baltimore, MD: American Society for Testing and Materials.

Lang, P. J. (1980). Behavioral treatment and bio-behavioral assessment: Computer applications. In J. B. Sidowski, J. H. Johnson & T. A. Williams (Eds.), *Technology in mental health care delivery systems* (pp. 119-137). Norwood, NJ: Ablex.

Larsen, R. J., & Fredrickson, B. L. (2003). Measurement issues in emotion research. In D. Kahneman, E. Diener & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 40-60). New York: Russell Sage Foundation.

Lavender, T., & Hommel, B. (2007). Affect and action: Towards an event-coding account. *Cognition & Emotion, 21*(6), 1270-1296. doi: 10.1080/02699930701438152

LeDoux, J. (1996). *The emotional brain: The mysterious underpinnings of emotional life.* New York: Touchstone.

Leventhal, A. M., Martin, R. L., Seals, R. W., Tapia, E., & Rehm, L. P. (2007). Investigating the dynamics of affect: Psychological mechanisms of affective habituation to pleasurable stimuli. *Motivation and Emotion, 31*(2), 145-157. doi: 10.1007/s11031-007-9059-8

Lorr, M., Mcnair, D. M., & Fisher, S. (1982). Evidence for bipolar mood states. *Journal of Personality Assessment, 46*(4), 432-436.

Lowe, M. R., & Butryn, M. L. (2007). Hedonic hunger: A new dimension of appetite? *Physiology & Behavior, 91*(4), 432-439. doi: 10.1016/j.physbeh.2007.04.006

Mackintosh, N. J. (1975). Theory of attention - variations in associability of stimuli with reinforcement. *Psychological Review, 82*(4), 276-298.

Markman, A. B., & Brendl, C. M. (2005). Constraining theories of embodied cognition. *Psychological Science, 16*(1), 6-10.

Martin, I., & Levey, A. B. (1978). Evaluative conditioning. *Advances in Behaviour Research and Therapy, 1*, 57-101.

Martin, I., & Levey, A. B. (1991). Blocking observed in human eyelid conditioning. *Quarterly Journal of Experimental Psychology Section B-Comparative and Physiological Psychology, 43*(3), 233-256.

Martin, I., & Levey, A. B. (1994). The evaluative response - primitive but necessary. *Behaviour Research and Therapy, 32*(3), 301-305.

Mason, E. (2007). The nature of pleasure: A critique of Feldman. *Utilitas, 19*, 379-387. doi: 10.1017/S0953820807002646

Mauro, R. (1988). Opponent processes in human emotions? An experimental investigation of hedonic contrast and affective interactions. *Motivation and Emotion, 12*(4), 333-351.

Mayfield, D. G. (1973). Effect of intravenous methamphetamine on mood. *International Journal of the Addictions, 8*(3), 565-568.

McAuliffe, W., & Gordon, R. A. (1974). Test of lindesmiths theory of addiction - frequency of euphoria among long-term addicts. *American Journal of Sociology, 79*(4), 795-840.

Mela, D. J. (2006). Eating for pleasure or just wanting to eat? Reconsidering sensory hedonic responses as a driver of obesity. *Appetite, 47*(1), 10-17. doi: 10.1016/j.appet.2006.02.006

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks: Sage Publications.

Miner, A. G., Glomb, T. M., & Hulin, C. (2005). Experience sampling mood and its correlates at work. *Journal of Occupational and Organizational Psychology, 78*, 171-193. doi: 10.1348/096317905x40105

Mogg, K., Bradley, B. P., Field, M., & De Houwer, J. (2003). Eye movements to smoking-related pictures in smokers: Relationship between attentional biases and implicit and explicit measures of stimulus valence. *Addiction, 98*(6), 825-836.

Moors, A., & De Houwer, J. (2001). Automatic appraisal of motivational valence: Motivational affective priming and Simon effects. *Cognition & Emotion, 15*(6), 749-766.

Morin, A. (2006). Levels of consciousness and self-awareness: A comparison and integration of various neurocognitive views. *Consciousness and Cognition*, *15*(2), 358-371. doi: 10.1016/j.concog.2005.09.006

Nagel, E. (1961). *The structure of science*. London: Routledge & Kegan Paul.

Nathan, P. J., & Bullmore, E. T. (2009). From taste hedonics to motivational drive: Central mu-opioid receptors and binge-eating behaviour. *International Journal of Neuropsychopharmacology, 12*(7), 995-1008. doi: 10.1017/S146114570900039x

Newton, T. F., La Garza, R., Kalechstein, A. D., Tziortzis, D., & Jacobsen, C. A. (2009). Theories of addiction: Methamphetamine users' explanations for continuing drug use and relapse. *American Journal on Addictions*, *18*(4), 294-300. doi: 10.1080/10550490902925920

Nicolas, L., Marquilly, C., & O'Mahony, M. (2010). The 9-point hedonic scale: Are words and numbers compatible? *Food Quality and Preference*. doi: 10.1016/j.foodqual.2010.05.017

Nisbett, R. E. (1968). Taste, deprivation, and weight determinants of eating behavior. *Journal of Personality and Social Psychology, 10*(2), 107-116.

Ortony, A., & Turner, T. J. (1990). Whats basic about basic emotions. *Psychological Review, 97*(3), 315-331.

Parducci, A. (1995). Pleasure as an internal judgment. In A. Parducci (Ed.), *Happiness, pleasure, and judgment: The contextual theory and its applications* (pp. 20-33). Mahwah, NJ: Lawrence Erlbaum Associates.

Pearce, J. M., & Hall, G. (1980). A model for Pavlovian learning - variations in the effectiveness of conditioned but not of unconditioned stimuli. *Psychological Review, 87*(6), 532-552.

Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in major depressive disorder. *Journal of Abnormal Psychology, 112*(2), 203-211. doi: 10.1037/0021-843x.112.2.203

Perry, D. L. (1967). Uses of 'pleasure' and related expressions. *The concept of pleasure* (pp. 41-81). The Hague, The Netherlands: Mouton & Co.

Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., & Frith, C. D. (2007). How the brain translates money into force: A neuroimaging study of subliminal motivation. *Science, 316*(5826), 904-906. doi: 10.1126/science.1140459

Pfaff, D. W. (1982). *The physiological mechanisms of motivation*. New York: Springer-Verlag.

Pliner, P. (1982). The effects of mere exposure on liking for edible substance. *Appetite*, *3*, 283-290.

Rachels, S. (2000). Is unpleasantness intrinsic to unpleasant experiences? *Philosophical Studies, 99*(2), 187-210.

Rashdall, H. (1899). Can there be a sum of pleasures? *Mind, 8*(31), 357-382

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 190-222). Cambridge, UK: Cambridge University Press.

Rennie, D. L., & Brewer, L. (1987). A grounded theory of thesis blocking. *Teaching of Psychology, 14*(1), 10-16.

Rescorla, R. A., & Wagner, A. R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and non-reinforcement. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning ii: Current research and theory* (pp. 64-99). New York: Appleton-Century-Crofts.

Riskey, D. R., Parducci, A., & Beauchamp, G. K. (1979). Effects of context in judgments of sweetness and pleasantness. *Perception & Pscyhophysics, 26*, 171-176.

Robins, L., & Kanowski, P. (2008). Phd by publication: A students perspective. *Journal of Research Practice, 4*(2), 1-20.

Robinson, T. E., & Berridge, K. C. (2008). The incentive sensitization theory of addiction: Some current issues. *Philosophical Transactions of the Royal Society B-Biological Sciences, 363*(1507), 3137-3146. doi: 10.1098/rstb.2008.0093

Rolls, B. J., Rolls, E. T., Rowe, E. A., & Sweeney, K. (1981). Sensory specific satiety in man. *Physiology & Behavior, 27*(1), 137-142.

Rolls, B. J., Rowe, E. A., & Rolls, E. T. (1982). How sensory properties of foods affect human feeding behavior. *Physiology & Behavior, 29*(3), 409-417.

Rolls, B. J., Van Duijvenvoorde, P. M., & Rolls, E. T. (1984). Pleasantness changes and food intake in a varied four-course meal. *Appetite, 5*(4), 337-348.

Rosas-Nexticapa, A., Angulo, O., & O'Mahony, M. (2005). How well does the 9-point hedonic scale predict purchase frequency? *Journal of Sensory Studies, 20*(4), 313-331.

Roseman, I. J., & Evdokas, A. (2004). Appraisals cause experienced emotions: Experimental evidence. *Cognition & Emotion, 18*(1), 1-28. doi: 10.1080/02699930244000390

Rota, L. M., & Zellner, D. A. (2007). The categorization effect in hedonic contrast: Experts differ from novices. *Psychonomic Bulletin & Review, 14*(1), 179-183.

Rotteveel, M., & Phaf, R. H. (2004). Automatic affective evaluation does not automatically predispose for arm flexion and extension. *Emotion, 4*(2), 156-172. doi: 10.1037/1528-3542.4.2.156

Russell, J. A. (2003a). Core affect and the psychological construction of emotion. *Psychological Review, 110*(1), 145-172. doi: 10.1037/0033-295x.110.1.145

Russell, J. A. (Ed.). (2003b). *Pleasure*. Hove, UK: Psychology Press.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*(5), 805-819.

Ryan, R. M., & Deci, E. L. (2001). On happiness and human potentials: A review of research on hedonic and eudaimonic well-being. *Annual Review of Psychology*, *52*, 141-166.

Saavedra, R., & Kwun, S. K. (2000). Affective states in job characteristics theory. *Journal of Organizational Behavior*, *21*, 131-146.

Scherer, K. R. (2005). What are emotions? And how can they be measured? *Social Science Information Sur Les Sciences Sociales, 44*(4), 695-729. doi: 10.1177/0539018405058216

Schultes, B., Ernst, B., Wilms, B., Thurnheer, M., & Hallschmid, M. (2010). Hedonic hunger is increased in severely obese patients and is reduced after gastric bypass surgery. *American Journal of Clinical Nutrition*. doi: 10.3945/ajcn.2009.29007

Schutz, H. G., & Cardello, A. V. (2001). A Labeled Affective Magnitude (LAM) scale for assessing food liking/disliking. *Journal of Sensory Studies, 16*(2), 117-159.

Schwibbe, M., Rader, K., Schwibbe, G., Borchardt, M., & Geikenpophanken, G. (1981). Emotional content of substantives, adjectives, and verbs. *Zeitschrift Fur Experimentelle Und Angewandte Psychologie*, *28*(3), 486-501.

Seligman, M. E. P., & Csikszentmihalyi, M. (2000). Positive psychology - an introduction. *American Psychologist*, *55*(1), 5-14.

Shraga, O., & Shirom, A. (2009). The construct validity of vigor and its antecedents: A qualitative study. *Human Relations, 62*(2), 271-291. doi: 10.1177/0018726708100360

Sim, S. K. (1973). Methadone. *Canadian Medical Association Journal, 109*(7), 615-619.

Smuts, A. (2010). The feels good theory of pleasure. *Philosophical Studies*. doi: 10.1007/s11098-010-9566-4

Snyder, C. R., & Lopez, S. J. (2007). *Positive psychology: The scientific and practical explorations of human strengths* Thousand Oaks, CA: SAGE.

Snyder, C. R., & Lopez, S. J. (Eds.). (2002). *Handbook of positive psychology*. New York: Oxford University Press.

Snyder, D. J., & Bartoshuk, L. M. (2009). Epidemiological studies of taste function discussion and perspectives. *International Symposium on Olfaction and Taste, 1170*, 574-580. doi: 10.1111/j.1749-6632.2009.04487.x

Solarz, A. K. (1960). Latency of instrumental responses as a function of compatability with the meaning of eliciting verbal signs. *Journal of Experimental Psychology, 59*, 239-245.

Solomon, R. L. (1980). The opponent-process theory of acquired motivation - the costs of pleasure and the benefits of pain. *American Psychologist, 35*(8), 691-712.

Sorensen, L. B., Moller, P., Flint, A., Martens, M., & Raben, A. (2003). Effect of sensory perception of foods on appetite and food intake: A review of studies on humans. *International Journal of Obesity, 27*(10), 1152-1166. doi: 10.1038/sj.ijo.0802391

Spiegel, T. A., Shrager, E. E., & Stellar, E. (1989). Responses of lean and obese subjects to preloads, deprivation, and palatability. *Appetite, 13*(1), 45-69.

Staw, B. M., Sutton, R. I., & Pelled, L. H. (1994). Employee positive emotion and favorable outcomes at the workplace. *Organization Science*, *5*(1), 51-71.

Talmi, D., Seymour, B., Dayan, P., & Dolan, R. J. (2008). Human pavlovian-instrumental transfer. *Journal of Neuroscience, 28*(2), 360-368. doi: 10.1523/Jneurosci.4028-07.2008

Taylor, J. G. (1996). A competition for consciousness? *Neurocomputing, 11*(2-4), 271-296.

Tiffany, S. T., Carter, B. L., & Singleton, E. G. (2000). Challenges in the manipulation, assessment and interpretation of craving relevant variables. *Addiction, 95*(8), S177-S187.

Tobler, P. N., O'Doherty, J. P., Dolan, R. J., & Schultz, W. (2006). Human neural learning depends on reward prediction errors in the blocking paradigm. *Journal of Neurophysiology*, *95*(1), 301-310.

Torrance, M., Thomas, G. V., & Robinson, E. J. (1992). The writing experiences of social-science research students. *Studies in Higher Education, 17*(2), 155-167.

U.S. Constitution. (1776). *The Declaration of Independence*. Washington, DC: Government of the United States of America.

Vansteenwegen, D., Francken, G., Vervliet, B., De Clercq, A., & Eelen, P. (2006). Resistance to extinction in evaluative conditioning. *Journal of Experimental*

Psychology-Animal Behavior Processes, 32(1), 71-79. doi: 10.1037/0097-7403.32.1.71

Vickers, Z., Holton, E., & Wang, J. (1998). Effect of yogurt sweetness on sensory specific satiety. *Journal of Sensory Studies, 13*(4), 377-388.

Volkow, N. D., & Wise, R. A. (2005). How can drug addiction help us understand obesity? *Nat Neurosci, 8*(5), 555-560. doi: 10.1038/nn1452

Wansink, B., & Cheney, M. M. (2005). Super bowls: Serving bowl size and food consumption. *Jama-Journal of the American Medical Association, 293*(14), 1727-1728.

Watson, D. (2000). *Mood and temperament*. New York: Guilford Press.

Wegge, J., van Dick, R., Fisher, G. K., West, M. A., & Dawson, J. F. (2006). A test of basic assumptions of Affective Events Theory (AET) in call centre work. *British Journal of Management, 17*(3), 237-254. doi: 10.1111/j.1467-8551.2006.00489.x

Weiss, H. M., & Cropanzano, R. (1996). Affective Events Theory: A theoretical discussion of the structure, causes and consequences of affective experiences at work. *Research in Organizational Behavior, 18*, 1-74.

Welchman, A. E., Stanley, J., Schomers, M. R., Miall, R. C., & Bulthoff, H. H. (2010). The quick and the dead: When reaction beats intention. *Proceedings of the Royal Society B-Biological Sciences, 277*(1688), 1667-1674. doi: 10.1098/rspb.2009.2123

Wellington, J. (2010). More than a matter of cognition: An exploration of affective writing problems of post-graduate students and their possible solutions. *Teaching in Higher Education, 15*(2), 135-150. doi: 10.1080/13562511003619961

Wells, F. L. (1924). *Pleasure and behavior*. New York ; London: D. Appleton and Company.

Wentura, D., Rothermund, K., & Bak, P. (2000). Automatic vigilance: The attention-grabbing power of approach- and avoidance-related social information. *Journal of Personality and Social Psychology, 78*(6), 1024-1037.

Wesnes, K. A., Garratt, C., Wickens, M., Gudgeon, A., & Oliver, S. (2000). Effects of sibutramine alone and with alcohol on cognitive function in healthy volunteers. *Br J Clin Pharmacol, 49*(2), 110-117. doi: 10.1046/j.1365-2125.2000.00131.x

West, R. (2005). *Theory of addiction*. Oxford: Blackwell Publishing.

Williams, D. A., Sagness, K. E., & Mcphee, J. E. (1994). Configural and elemental strategies in predictive learning. *Journal of Experimental Psychology-Learning Memory and Cognition*, *20*(3), 694-709.

Yeomans, M. R. (1998). Taste, palatability and the control of appetite. *Proc Nutr Soc, 57*(4), 609-615.

Yeomans, M. R. (2000). Rating changes over the course of meals: What do they tell us about motivation to eat? *Neuroscience and Biobehavioral Reviews, 24*(2), 249-259.

Yeomans, M. R. (2010). Understanding individual differences in acquired flavour liking in humans. *Chemosensory Perception, 3*(1), 34-41. doi: 10.1007/s12078-009-9052-6

Yeomans, M. R., Chambers, L., Blumenthal, H., & Blake, A. (2008). The role of expectancy in sensory and hedonic evaluation: The case of smoked salmon ice-cream. *Food Quality and Preference, 19*, 565-573. doi: 10.1016/j.foodqual.2008.02.009

Yeomans, M. R., Gould, N. J., Leitch, M., & Mobini, S. (2009). Effects of energy density and portion size on development of acquired flavour liking and learned satiety. *Appetite, 52*(2), 469-478. doi: 10.1016/j.appet.2008.12.010

Yeomans, M. R., Gray, R. W., Mitchell, C. J., & True, S. (1997). Independent effects of palatability and within-meal pauses on intake and appetite ratings in human volunteers. *Appetite, 29*(1), 61-76.

Yeomans, M. R., Leitch, M., Gould, N. J., & Mobini, S. (2008). Differential hedonic, sensory and behavioral changes associated with flavor-nutrient and flavor-flavor learning. *Physiology & Behavior, 93*(4-5), 798-806. doi: 10.1016/j.physbeh.2007.11.041

Yeomans, M. R., Mobini, S., & Chambers, L. (2007). Additive effects of flavour-caffeine and flavour-flavour pairings on liking for the smell and flavour of a novel drink. *Physiology & Behavior, 92*(5), 831-839. doi: 10.1016/j.physbeh.2007.06.006

Zajonc, R. B. (1980). Feeling and thinking - preferences need no inferences. *American Psychologist, 35*(2), 151-175.

Zandstra, E. H., de Graaf, C., van Trijp, H. C. M., & van Staveren, W. A. (1999). Laboratory hedonic ratings as predictors of consumption. *Food Quality and Preference, 10*(4-5), 411-418.

Zellner, D. A. (2007). Contextual influences on liking and preference. *Appetite, 49*(3), 679-682. doi: 10.1016/j.appet.2007.04.008

Zellner, D. A., Allen, D., Henley, M., & Parker, S. (2006). Hedonic contrast and condensation: Good stimuli make mediocre stimuli less good and less different. *Psychon Bull Rev, 13*(2), 235-239.

Zellner, D. A., Jones, K., Morino, J., Cogan, E. S., Jennings, E. M., & Parker, S. (2010). Increased hedonic differences despite increases in hedonic range. *Atten Percept Psychophys, 72*(5), 1261-1265. doi: 10.3758/APP.72.5.1261

Zellner, D. A., Mattingly, M. C., & Parker, S. (2009). Categorization reduces the effect of context on hedonic preference. *Attention Perception & Psychophysics, 71*(6), 1228-1232. doi: 10.3758/App.71.6.1228

Zellner, D. A., Strickhouser, D., & Tornow, C. E. (2004). Disconfirmed hedonic expectations produce perceptual contrast, not assimilation. *Am J Psychol, 117*(3), 363-387.

Zhang, Y. M., & Proctor, R. W. (2008). Influence of intermixed emotion-relevant trials on the affective Simon effect. *Experimental Psychology, 55*(6), 409-416. doi: 10.1027/1618-3169.55.6.409

Appendices

Introduction to Positive Events Study

Good morning! Thank you for taking part in this study. This investigation will not take much of your time, just a few minutes every hour or so today and a short evening questionnaire at the end. We have been informed that your employer is happy for you to take part.

What Do You Need to Do

On the right side you can see the main questionnaire, where you are asked to:

- describe what exactly you were doing when the last positive feeling occurred today - events box on top (1)
- and rate the last positive feeling - the scale in the middle (2)

We ask you to enter the positive events as soon as possible after they occur, and to make sure you fill in the main questionnaire at least once every hour.

1) Describe In Detail What You Were Doing When You Felt Good

In the event field on top (1), you might enter something like "I finished filing the documents" or "my colleague said my Excel table looks good". Note that we ask you to enter all positive events in the workplace, which includes things like having a chat with a friend about shopping or reading an anecdote online etc.
Additionally, please make sure to enter events associated with weak feelings, we are just as interested when you feel slightly good as we are interested when you feel extremely good.
Then use the listbox to indicate how long ago the actual event occurred. If you forget to report a positive event, then it is perfectly fine to fill in the main questionnaire as soon as you remember.

2) Rate How Much You Liked the Moment

Use the scale (2) to indicate how much you liked the moment you described in 1). In doing so, please do not use only the numbers on the scale, but read the text labels as well e.g. Like Moderately. And note that the text labels are supposed to be non-aligned with the numbers.

Repeat 1 and 2

Once you have described the event, indicated when the event happened (1) and used the scale (2), press the Record button to save your input. Pressing the button will result in the same main questionnaire being displayed again. Remember to KEEP the main questionnaire WEBPAGE OPEN on your computer and use it as soon as a new positive event occurs! NOTE: With a maximum interval of one hour.

33) Fill in Evening Questionnaire

1) What Exactly Were You Doing

Describe in detail what you were doing and what was happening when the positive feeling occurred:

When did the positive event occur: Choose a time

2) How Good Did You Feel

Please rate how good did you feel or how much you liked the above moment, by clicking somewhere on the line:

100 - - Greatest Imaginable Like

80 -

- Like Extremely

60 -

- Like Very Much

40 -

- Like Moderately

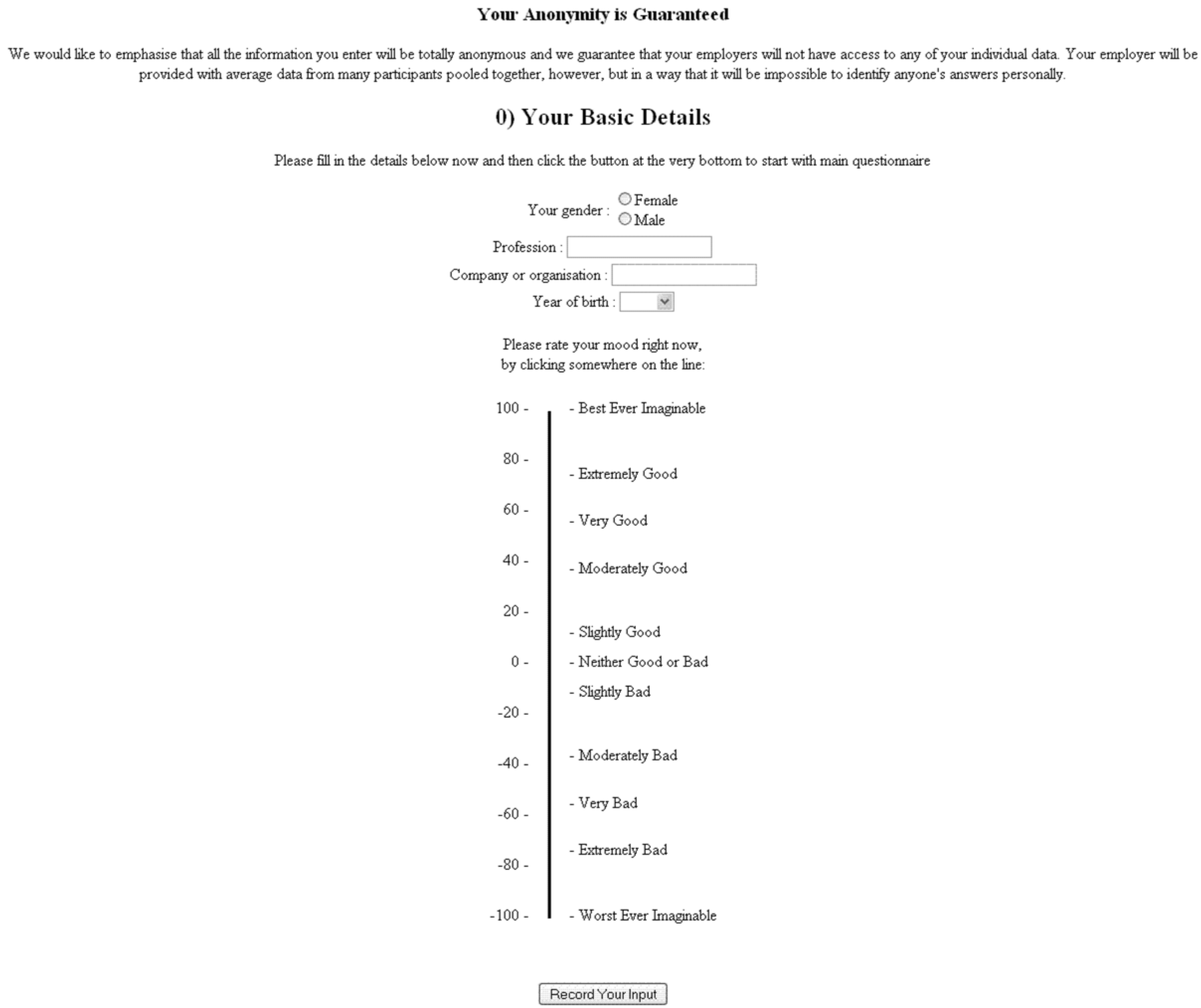
20 -

- Like Slightly

0 - - Neither Like Nor Dislike

Record Your Input OR 33) Finish the Day with Evening Questionnaire

In the evening, before leaving work, please finish the day by filling in the evening questionnaire, which you can access by clicking on the link next to the Record button.



Your Anonymity is Guaranteed

We would like to emphasise that all the information you enter will be totally anonymous and we guarantee that your employers will not have access to any of your individual data. Your employer will be provided with average data from many participants pooled together, however, but in a way that it will be impossible to identify anyone's answers personally.

0) Your Basic Details

Please fill in the details below now and then click the button at the very bottom to start with main questionnaire

Your gender : ○ Female ○ Male

Profession :

Company or organisation :

Year of birth :

Please rate your mood right now,
by clicking somewhere on the line:

100 - - Best Ever Imaginable
80 -
- Extremely Good
60 -
- Very Good
40 -
- Moderately Good
20 -
- Slightly Good
0 - - Neither Good or Bad
- Slightly Bad
-20 -
- Moderately Bad
-40 -
- Very Bad
-60 -
- Extremely Bad
-80 -
-100 - - Worst Ever Imaginable

Record Your Input

Enter What You Were Doing at Last Positive Event

1) What Exactly Were You Doing

Describe in detail what you were doing and what was happening when the positive feeling occurred:

When did the positive event occur: Choose a time

2) How Good Did You Feel

Please rate how good did you feel or how much you liked the above moment,
by clicking somewhere on the line:

100 - - Greatest Imaginable Like

80 -

- Like Extremely

60 -

- Like Very Much

40 -

- Like Moderately

20 -

- Like Slightly

0 - - Neither Like Nor Dislike

Record Your Input OR 33) Finish the Day with Evening Questionnaire

Evening Questionnaire

If you would like to enter more positive events today, please click here and come back to this evening questionnaire page at the end of your day.
As always, all entries will be totally anonymous.

1. Did you find it hard to describe the positive events or activities?
Yes: ○ No: ○ Not sure: ○

2. Did you forget to follow instructions or did you get confused at any point?
Yes: ○ No: ○ Not sure: ○

3. Do you think your work today represents a normal work day?
Yes: ○ No: ○ Not sure: ○

4. Did you use any strategies when reporting the events, activities and feelings? E.g. did you decide ahead to enter events every full hour etc
Yes: ○ No: ○ Not sure: ○

5. Did you think of previous events that you had entered before, while rating the event at hand?
Yes: ○ No: ○ Not sure: ○

6. In your own opinion, what was this study about?

7. What are your general impressions and observations from this study? What could be done better?

8. Did you find it difficult to rate how good the positive moments made you feel?
Yes: ○ No: ○ Not sure: ○

9. On the scale, did you read the text e.g. Like Moderately on the right, when making your ratings, or did you use only the numbers on the left?

10. How did taking part in the study change your day?

11. Did you come across any bugs or annoyances on the website?

Yes: ○ No: ○ Not sure: ○

12. Were your descriptions more like things you happened to be doing while you felt good or do you think they actually caused you to feel good?

Please rate your mood right now,
by clicking somewhere on the line:

100 - - Best Ever Imaginable

80 -

- Extremely Good

60 - - Very Good

40 - - Moderately Good

20 -

- Slightly Good

0 - - Neither Good or Bad

- Slightly Bad

-20 -

- Moderately Bad

-40 -

- Very Bad

-60 -

- Extremely Bad

-80 -

-100 - - Worst Ever Imaginable

More Information or Comments

Record Your Input

Dear Participant

This session takes about 20 minutes. The experimenter will be with you for the first few minutes should you have any questions, but everything should be explained on the screen here, so you can go through the experiment independently.

Press the button to get started.

I am ready, start !

UPPER and lower case Tutorial

This game will feature a stick-man, which represents a person. In the following screen you are presented with different words in either lower or UPPER case and all you should do is make the stick-man *approach* the word if the word is in UPPER case, but make the stick-man *move away* from the word if the word is in lower case.

Please press the button to go through a tutorial ...

I am ready, start !

After a short pause, a word with a stick-man is displayed like this. As soon as you see the word your task is to move the stick-man by pressing either the marked ← or → key on the keyboard.
Specifically, please make the stick-man move **away from the word** if the word is **in lower case**
and **move the stick-man towards the word** if the word is **in UPPER case**.
This time you should make the stick-man move towards the word, please do that now ...

Pleasantness Ratings

Now please rate the words according to how much you personally like these foods.

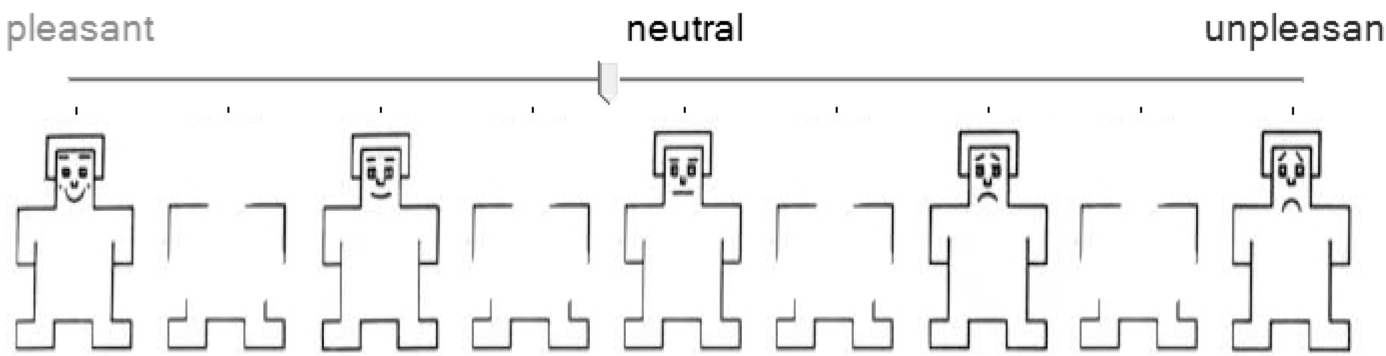
Simply rate how much you would enjoy eating each food!

Press button to start.

I am ready, start !

PRETZELS

How pleasant is this food to you ?

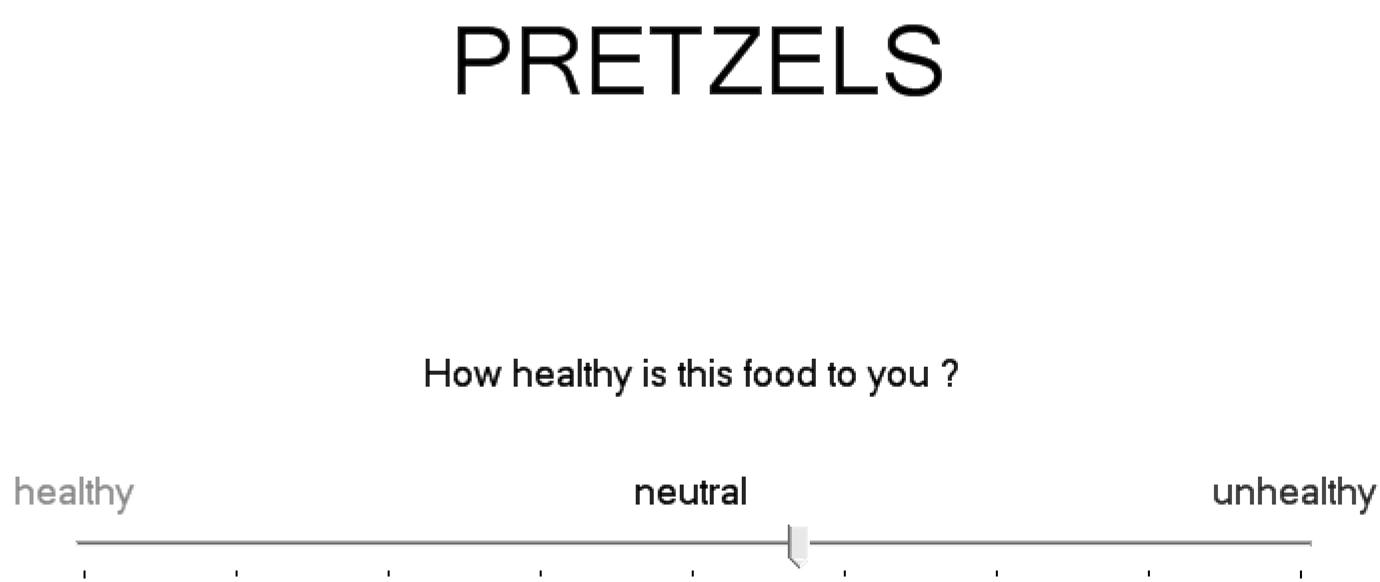


Healthiness Ratings

Now please rate the words according to how healthy you personally think they are for you.

Press button to start.

I am ready, start !


PRETZELS
How healthy is this food to you ?
healthy
neutral
unhealthy

Thank you for taking part in this experiment!

Firstly, as the aim of this experiment is to investigate physiological responding we ask you to try to not move much during the session, especially your non-dominant hand with the main sensors. But please do adjust yourself so that you feel comfortable overall, a little movement will do no harm.

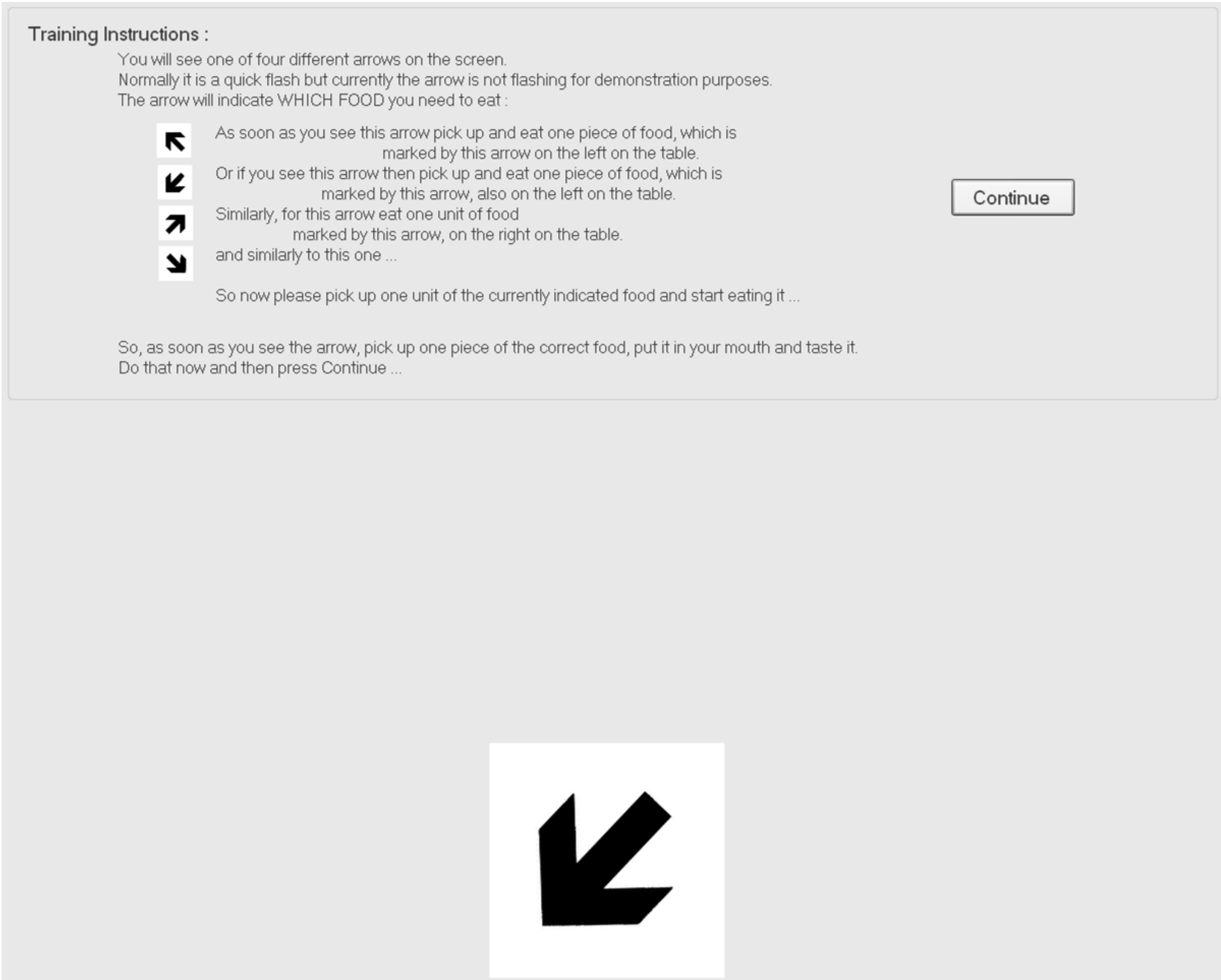
This session takes about one and a half hours involving various stages with different instructions. The experimenter will be with you for the first few phases should you have any questions, but everything should be explained on the screen here, so you can go through the experiment independently. However, in case you do get stuck or the computer crashes or similar, do not hesitate to call the experimenter.

You will be paid at the end of the session, but should you wish to stop before, you are free to withdraw at any time without giving any explanation. That said, this experiment does not involve anything painful and might be quite a pleasant experience instead.

Press the button now to go through a quick tutorial of the first phase:

☐ I have read the instructions and understand what I am supposed to do.

I am ready, start !


Training Instructions :
You will see one of four different arrows on the screen.
Normally it is a quick flash but currently the arrow is not flashing for demonstration purposes.
The arrow will indicate WHICH FOOD you need to eat :
As soon as you see this arrow pick up and eat one piece of food, which is marked by this arrow on the left on the table.
Or if you see this arrow then pick up and eat one piece of food, which is marked by this arrow, also on the left on the table.
Similarly, for this arrow eat one unit of food marked by this arrow, on the right on the table.
and similarly to this one ...
So now please pick up one unit of the currently indicated food and start eating it ...
So, as soon as you see the arrow, pick up one piece of the correct food, put it in your mouth and taste it.
Do that now and then press Continue ...
Continue


Training Instructions :
2) Now please rate the food.
How much do you like this food ?
Please give your immediate reaction ...
Done
80
60
40
20
0
-20
-40
-60
-80
LIKE EXTREMELY
LIKE VERY MUCH
LIKE MODERATELY
LIKE SLIGHTLY
NEITHER LIKE NOR DISLIKE
DISLIKE SLIGHTLY
DISLIKE MODERATELY
DISLIKE VERY MUCH
DISLIKE EXTREMELY

Training Instructions :
3)

And next you are asked to sip a bit of water.
The aim of this is to neutralise the taste in your mouth, so please make sure you rinse your mouth thoroughly.
Please do not gulp though, sip just a little water.
But most importantly please do not press next before you have put the cup down! ..... Please do all that now ...

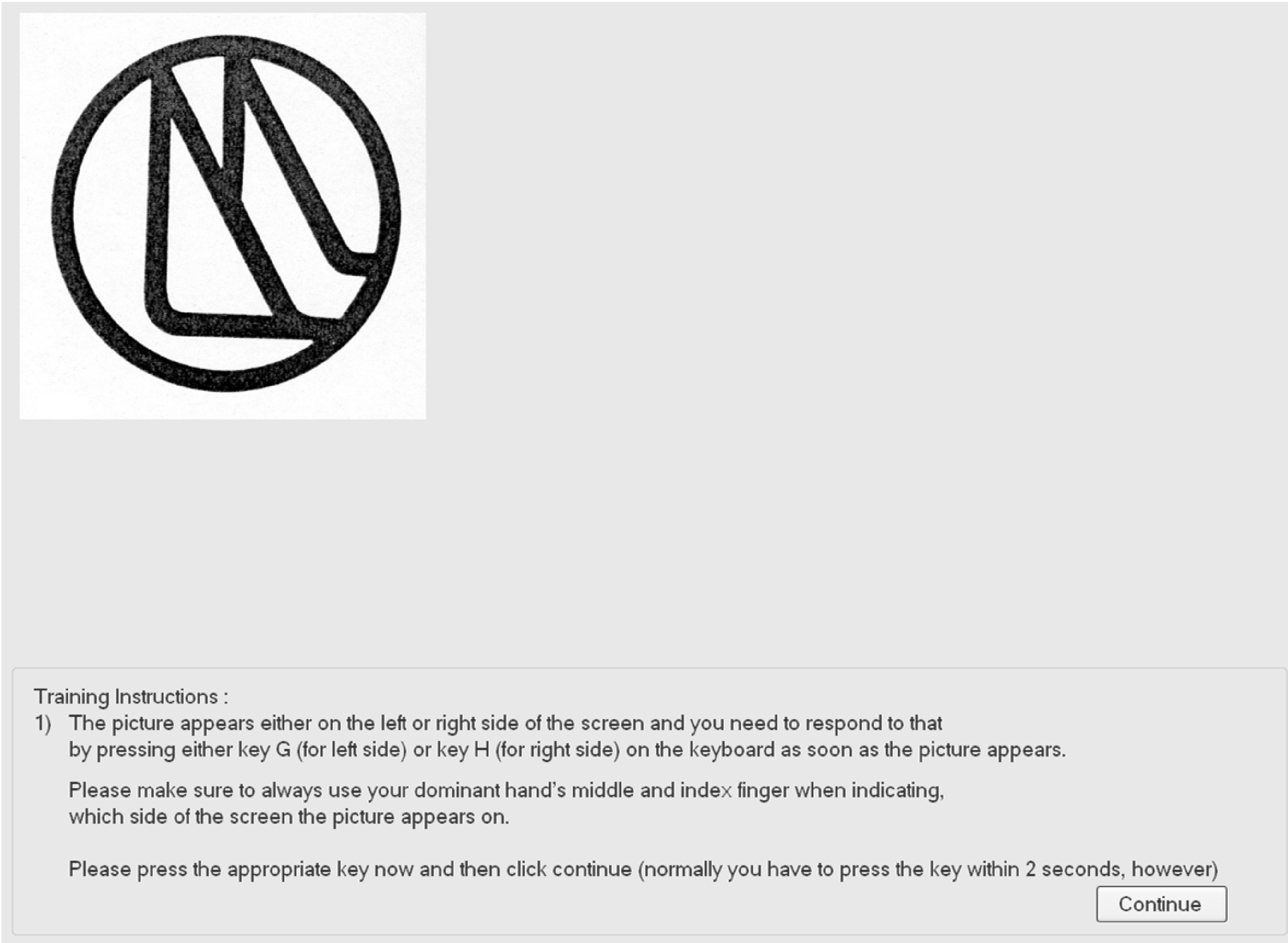
When ready pick up a drink, rinse and swallow.

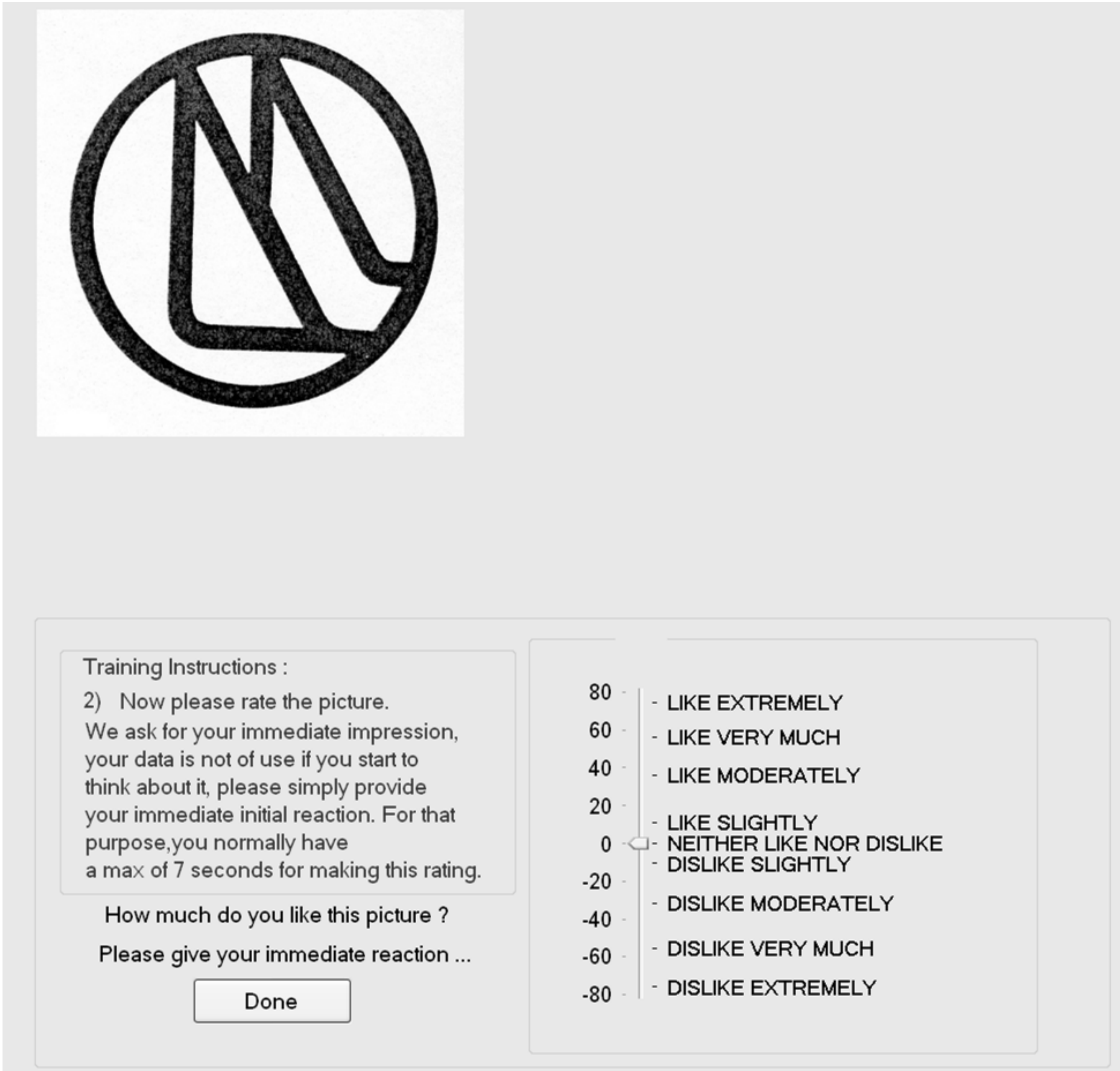
Next

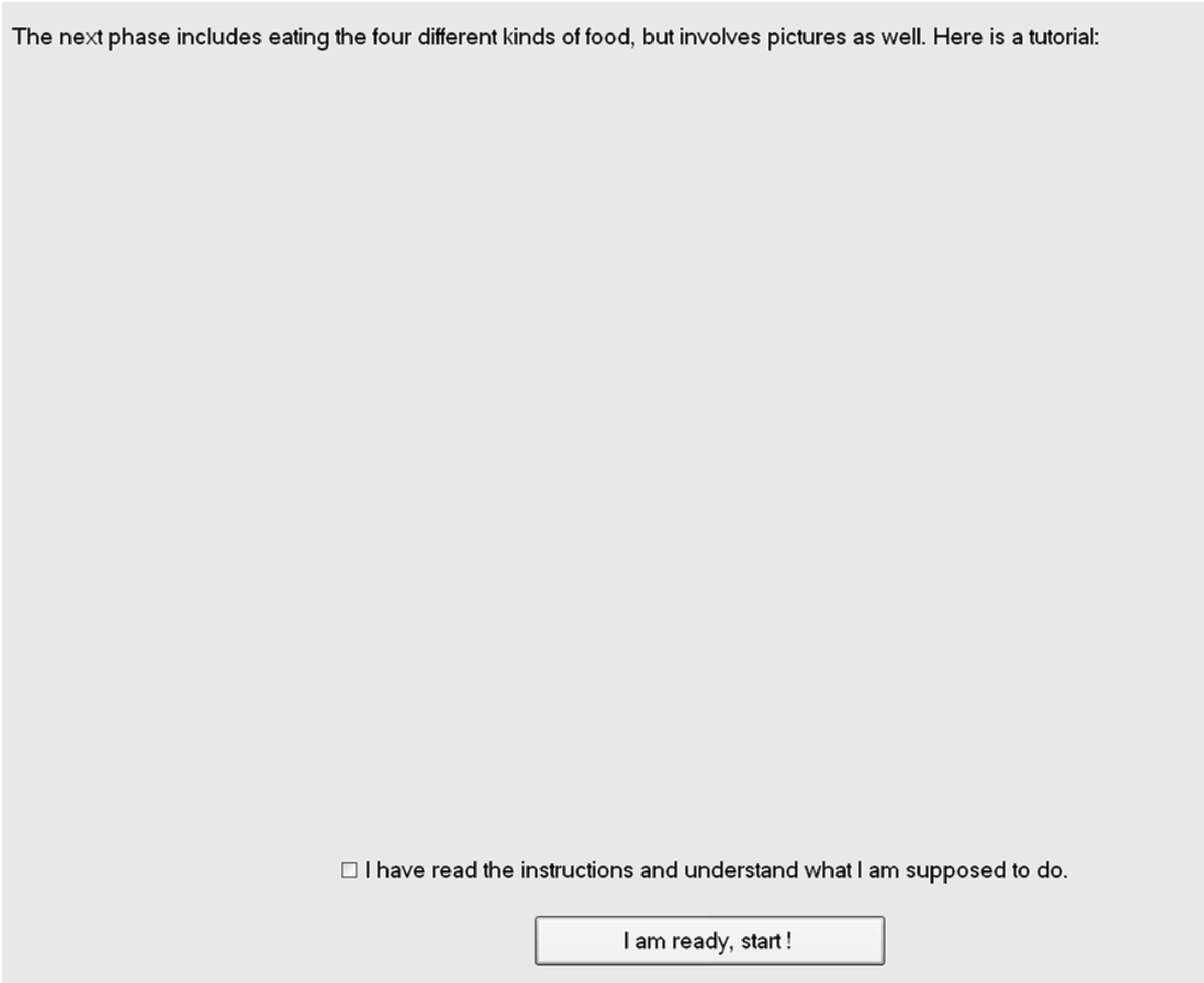
The next phase of the experiment does not involve eating any food, but looking at several pictures in the following pattern, please go through the tutorial:

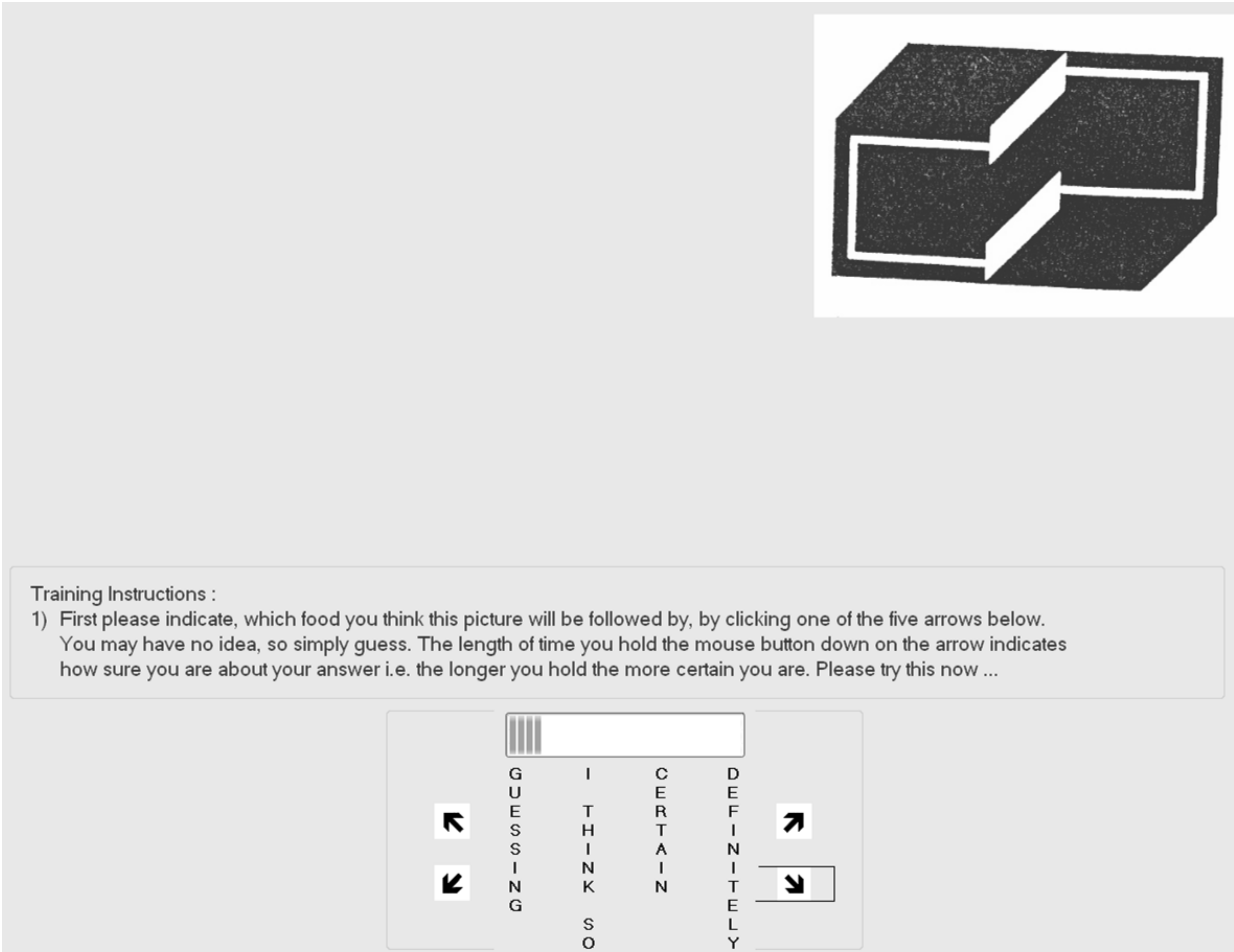
☐ I have read the instructions and understand what I am supposed to do.

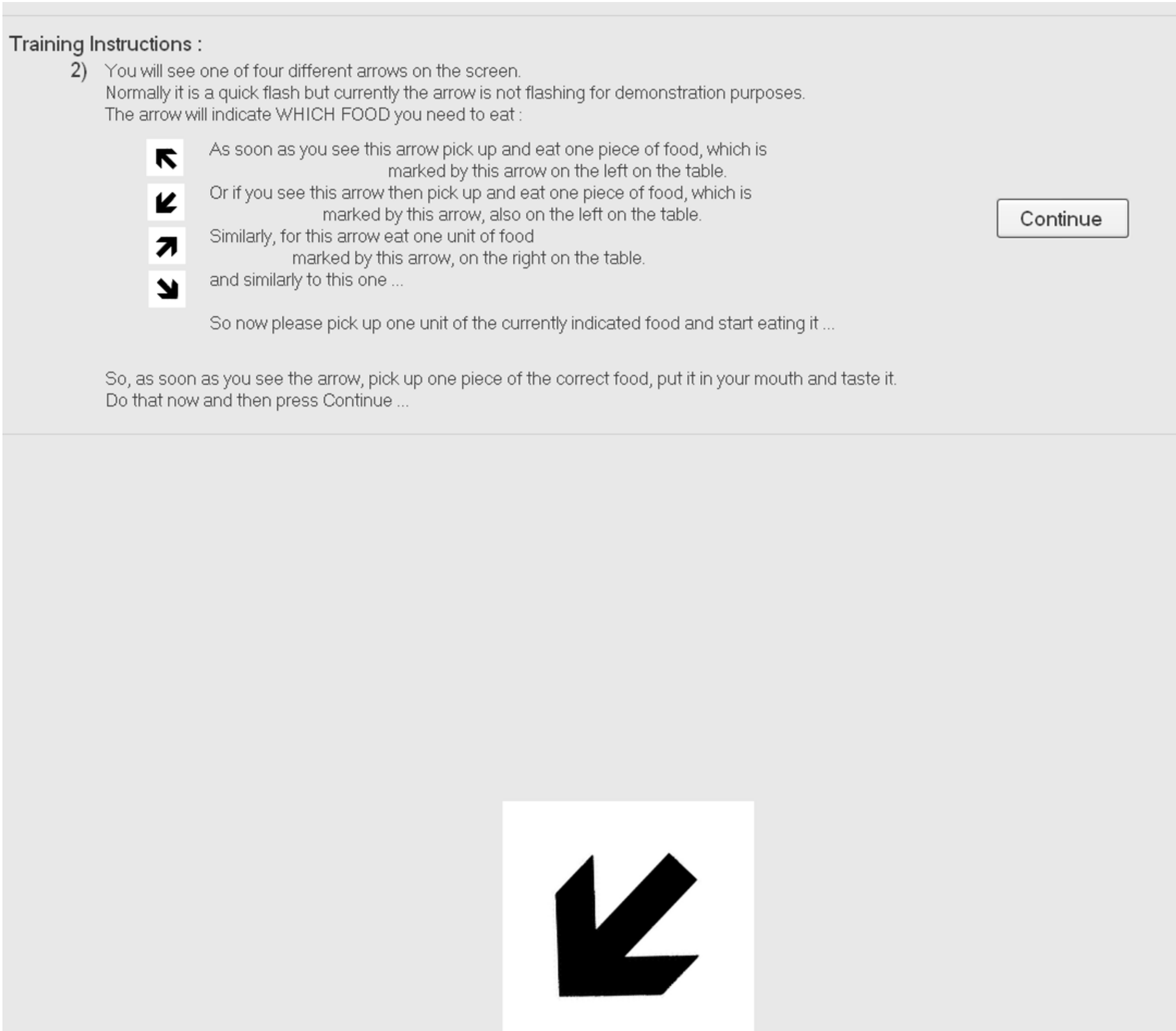
I am ready, start !

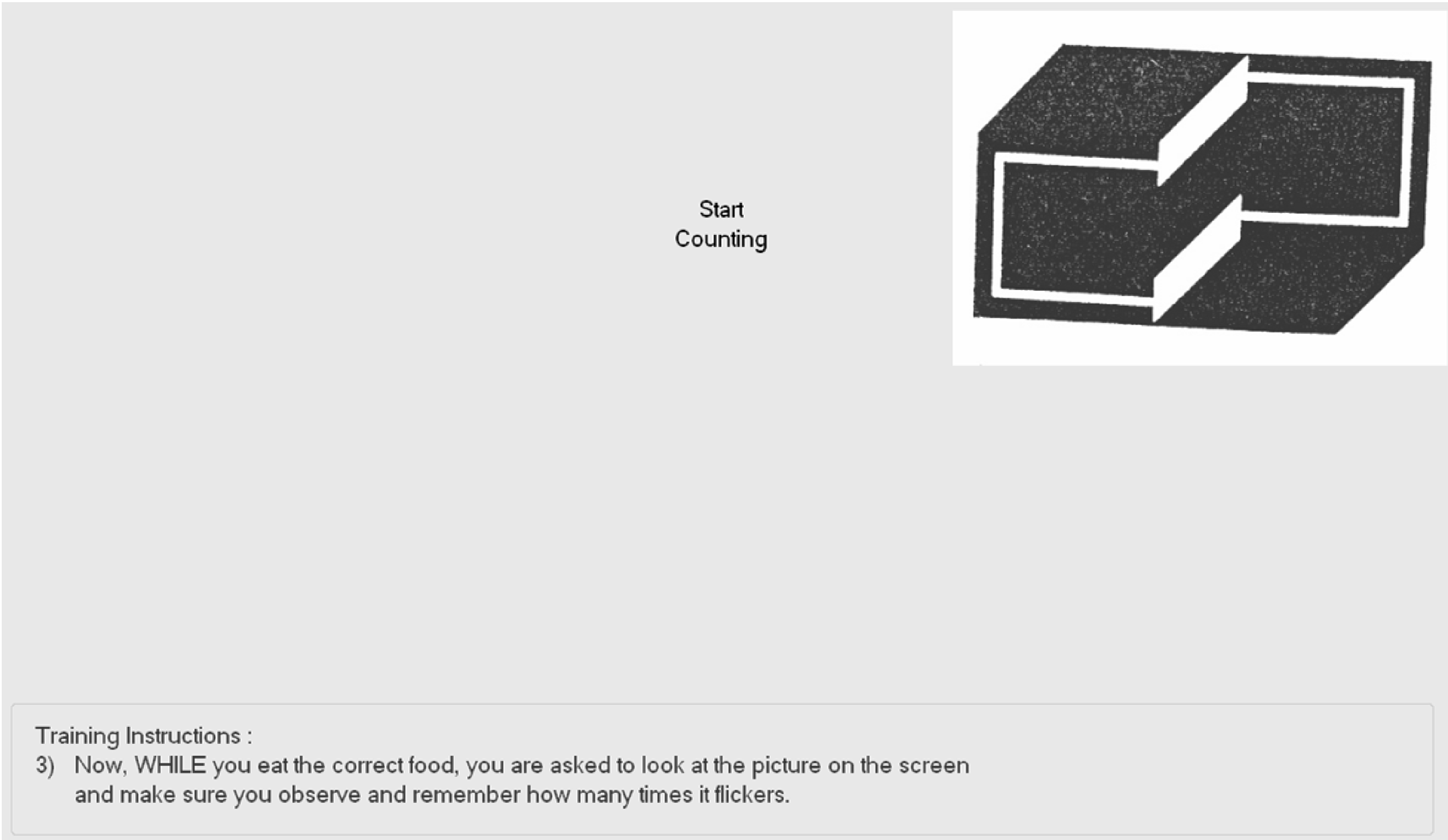

Training Instructions :
1) The picture appears either on the left or right side of the screen and you need to respond to that
by pressing either key G (for left side) or key H (for right side) on the keyboard as soon as the picture appears.
Please make sure to always use your dominant hand's middle and index finger when indicating,
which side of the screen the picture appears on.
Please press the appropriate key now and then click continue (normally you have to press the key within 2 seconds, however)
Continue

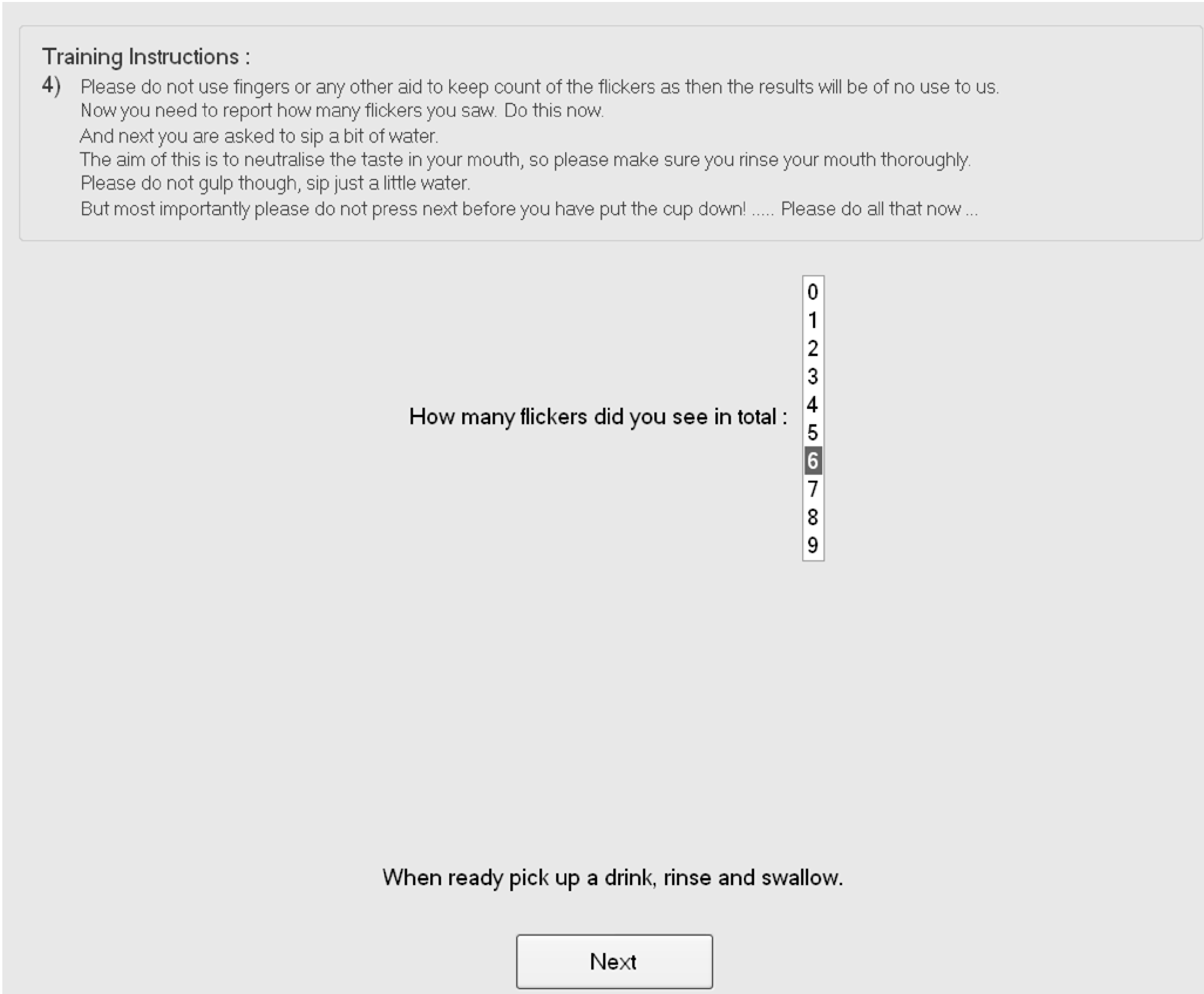

Training Instructions :
2) Now please rate the picture.
We ask for your immediate impression, your data is not of use if you start to think about it, please simply provide your immediate initial reaction. For that purpose,you normally have a max of 7 seconds for making this rating.
How much do you like this picture ?
Please give your immediate reaction ...
Done
80
60
40
20
0
-20
-40
-60
-80
LIKE EXTREMELY
LIKE VERY MUCH
LIKE MODERATELY
LIKE SLIGHTLY
NEITHER LIKE NOR DISLIKE
DISLIKE SLIGHTLY
DISLIKE MODERATELY
DISLIKE VERY MUCH
DISLIKE EXTREMELY


The next phase includes eating the four different kinds of food, but involves pictures as well. Here is a tutorial:
☐ I have read the instructions and understand what I am supposed to do.
I am ready, start !


Training Instructions :
1) First please indicate, which food you think this picture will be followed by, by clicking one of the five arrows below.
You may have no idea, so simply guess. The length of time you hold the mouse button down on the arrow indicates
how sure you are about your answer i.e. the longer you hold the more certain you are. Please try this now ...
GUESSING
I THINK SO
CERTAIN
DEFINITELY


Training Instructions :
2) You will see one of four different arrows on the screen.
Normally it is a quick flash but currently the arrow is not flashing for demonstration purposes.
The arrow will indicate WHICH FOOD you need to eat :
As soon as you see this arrow pick up and eat one piece of food, which is marked by this arrow on the left on the table.
Or if you see this arrow then pick up and eat one piece of food, which is marked by this arrow, also on the left on the table.
Similarly, for this arrow eat one unit of food marked by this arrow, on the right on the table.
and similarly to this one ...
So now please pick up one unit of the currently indicated food and start eating it ...
So, as soon as you see the arrow, pick up one piece of the correct food, put it in your mouth and taste it.
Do that now and then press Continue ...
Continue

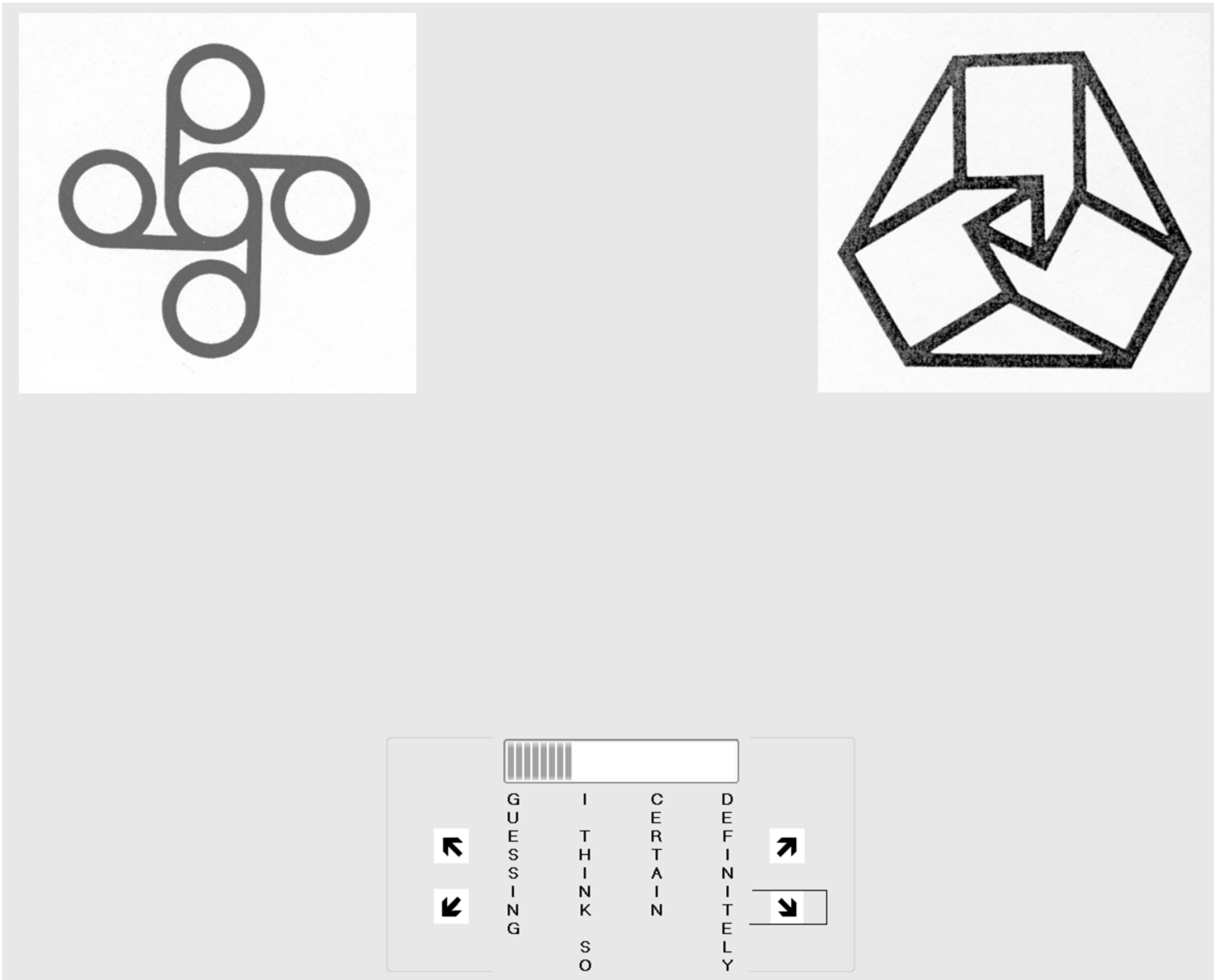

Start
Counting
Training Instructions :
3) Now, WHILE you eat the correct food, you are asked to look at the picture on the screen
and make sure you observe and remember how many times it flickers.

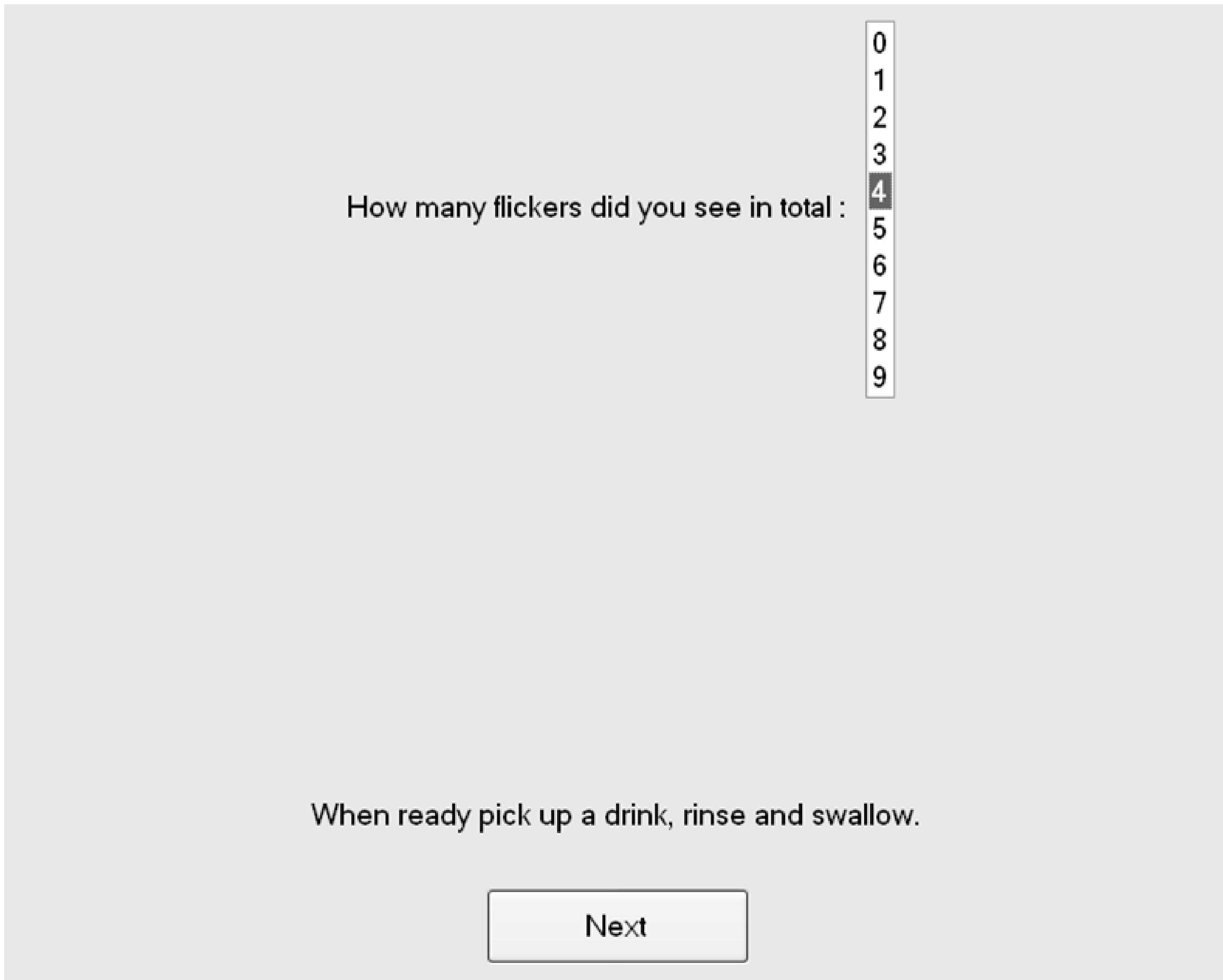

Training Instructions :
4) Please do not use fingers or any other aid to keep count of the flickers as then the results will be of no use to us.
Now you need to report how many flickers you saw. Do this now.
And next you are asked to sip a bit of water.
The aim of this is to neutralise the taste in your mouth, so please make sure you rinse your mouth thoroughly.
Please do not gulp though, sip just a little water.
But most importantly please do not press next before you have put the cup down! ..... Please do all that now ...
How many flickers did you see in total :
0
1
2
3
4
5
6
7
8
9
When ready pick up a drink, rinse and swallow.
Next

The following phase includes eating the four different kinds of food again. It is very similar to what you had to do earlier, except this time there are two pictures that flicker and you have to count the total number of flickers (e.g. if picture on the left flickers once and picture on the right twice, then that counts as three flickers).
Also, remember that how long you press down the mouse button on the arrow indicates how sure you are about your prediction.

☐ I have read the instructions and understand what I am supposed to do.

I am ready, start !


GUESSING
I THINK SO
CERTAIN
DEFINITELY


How many flickers did you see in total :
0
1
2
3
4
5
6
7
8
9
When ready pick up a drink, rinse and swallow.
Next

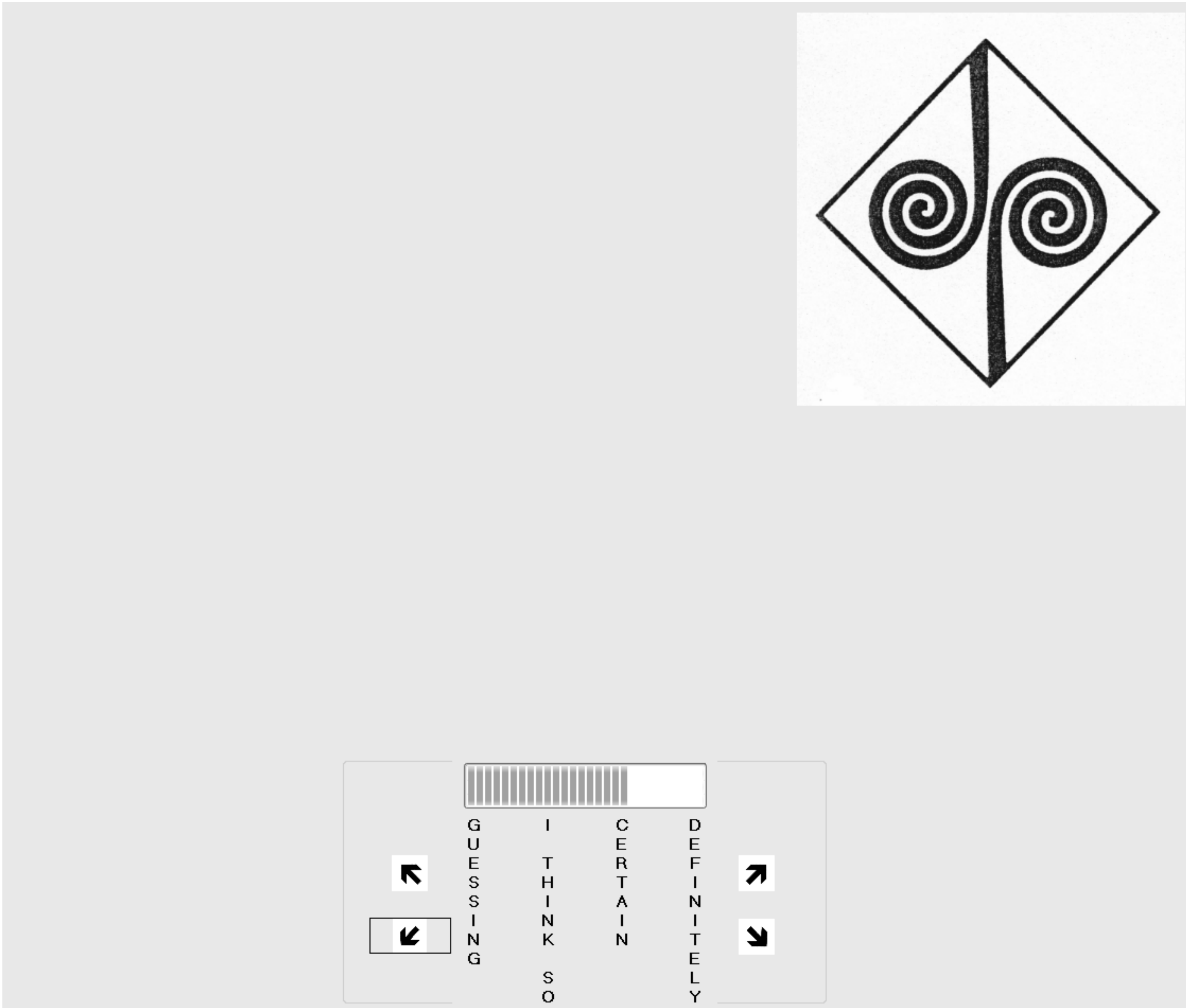
The following is the penultimate stage. It is a short version of what you did during eating and here all you have to do is indicate which food you think a given picture was followed by.

There is no feedback as to whether your prediction is correct and there is no eating of any food. Also, remember that how long you press down the mouse button on the arrow indicates how sure you are about your prediction.

New pictures will follow straight one after another, for each one simply click on the food arrow that you think went with the picture on the screen.

☐ I have read the instructions and understand what I am supposed to do.

I am ready, start !


GUESSING
I THINK SO
CERTAIN
DEFINITELY

[Attach sensors]

[Clap test]

I am ready, start !

Dear Participant

Thank you for taking part!

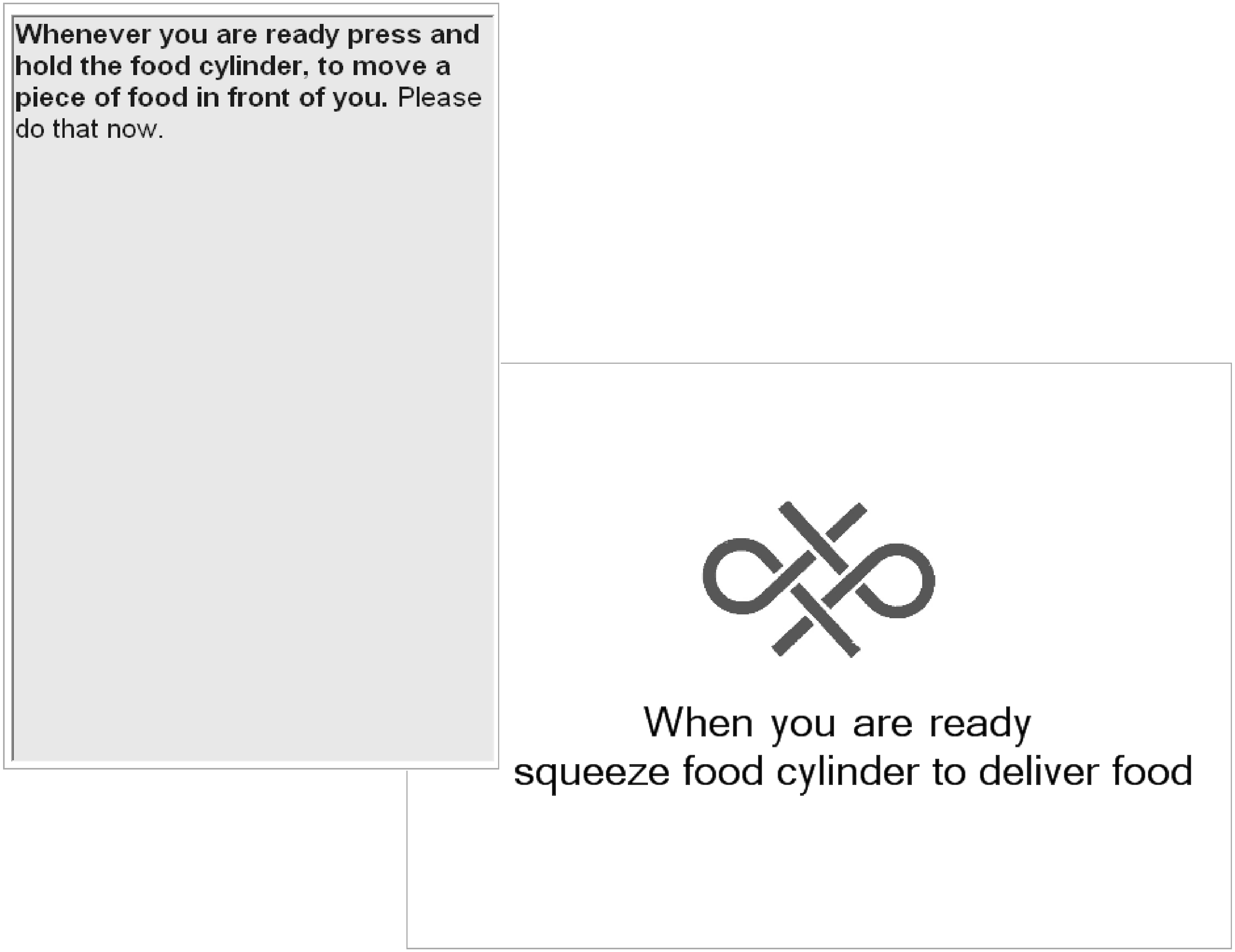
From now on everything should be explained on the screen here, so you can go through the experiment independently.

- Firstly, you will go through a **tutorial** that explains every step
- Secondly, there is a **practice** on what you learnt in the tutorial
- And thirdly, the **main part** of the session follows.

The session should be straight-forward and pleasant, but should there be any problems or any questions, do not hesitate to call the experimenter at any point - the **mobile** number is **on the right wall**.

Please press the **button** now **to start the tutorial**.

I am ready, start !


Whenever you are ready press and hold the food cylinder, to move a piece of food in front of you. Please do that now.
When you are ready
squeeze food cylinder to deliver food

Now please eat the food and rate how much you like it

Please remember this sequence:

----

1) Put food in your mouth

------

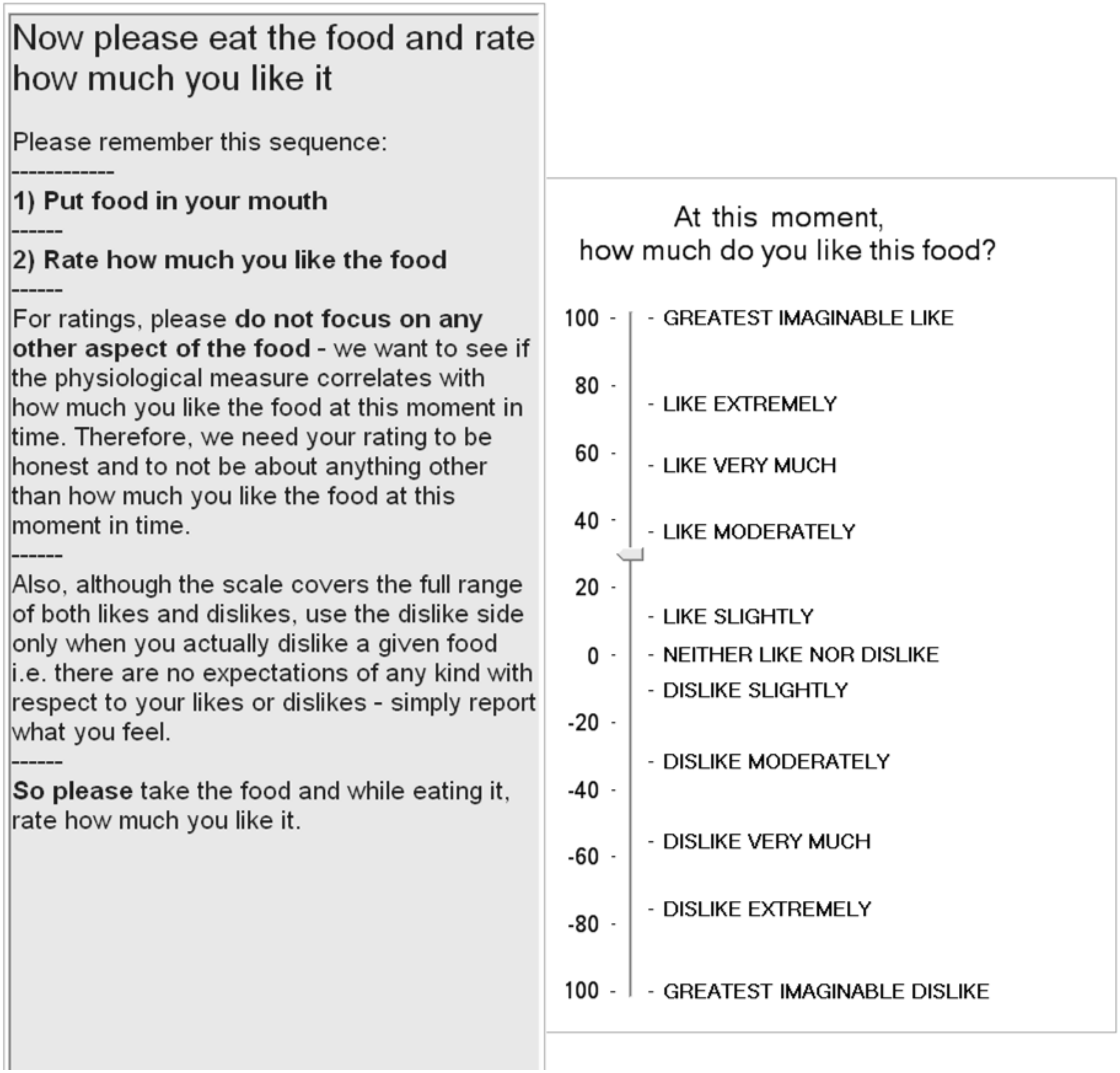
2) Rate how much you like the food

For ratings, please **do not focus on any other aspect of the food** - we want to see if the physiological measure correlates with how much you like the food at this moment in time. Therefore, we need your rating to be honest and to not be about anything other than how much you like the food at this moment in time.

Also, although the scale covers the full range of both likes and dislikes, use the dislike side only when you actually dislike a given food i.e. there are no expectations of any kind with respect to your likes or dislikes - simply report what you feel.

So please take the food and while eating it, rate how much you like it.

Take food and eat it


Now please eat the food and rate how much you like it
Please remember this sequence:
----
1) Put food in your mouth
------
2) Rate how much you like the food

For ratings, please do not focus on any other aspect of the food - we want to see if the physiological measure correlates with how much you like the food at this moment in time. Therefore, we need your rating to be honest and to not be about anything other than how much you like the food at this moment in time.

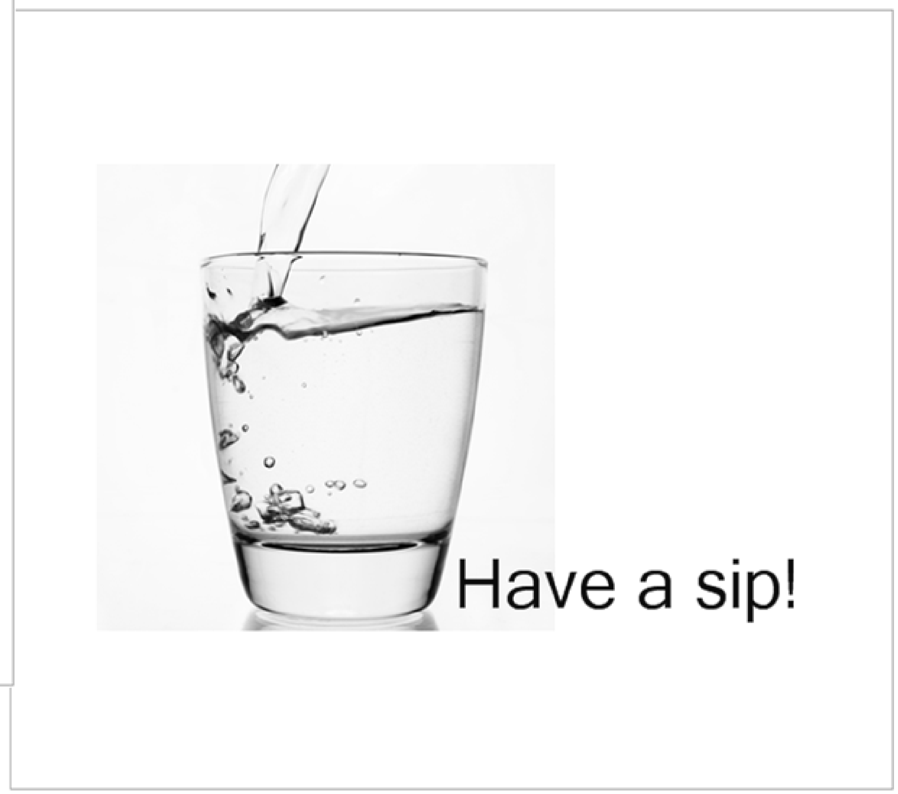
Also, although the scale covers the full range of both likes and dislikes, use the dislike side only when you actually dislike a given food i.e. there are no expectations of any kind with respect to your likes or dislikes - simply report what you feel.

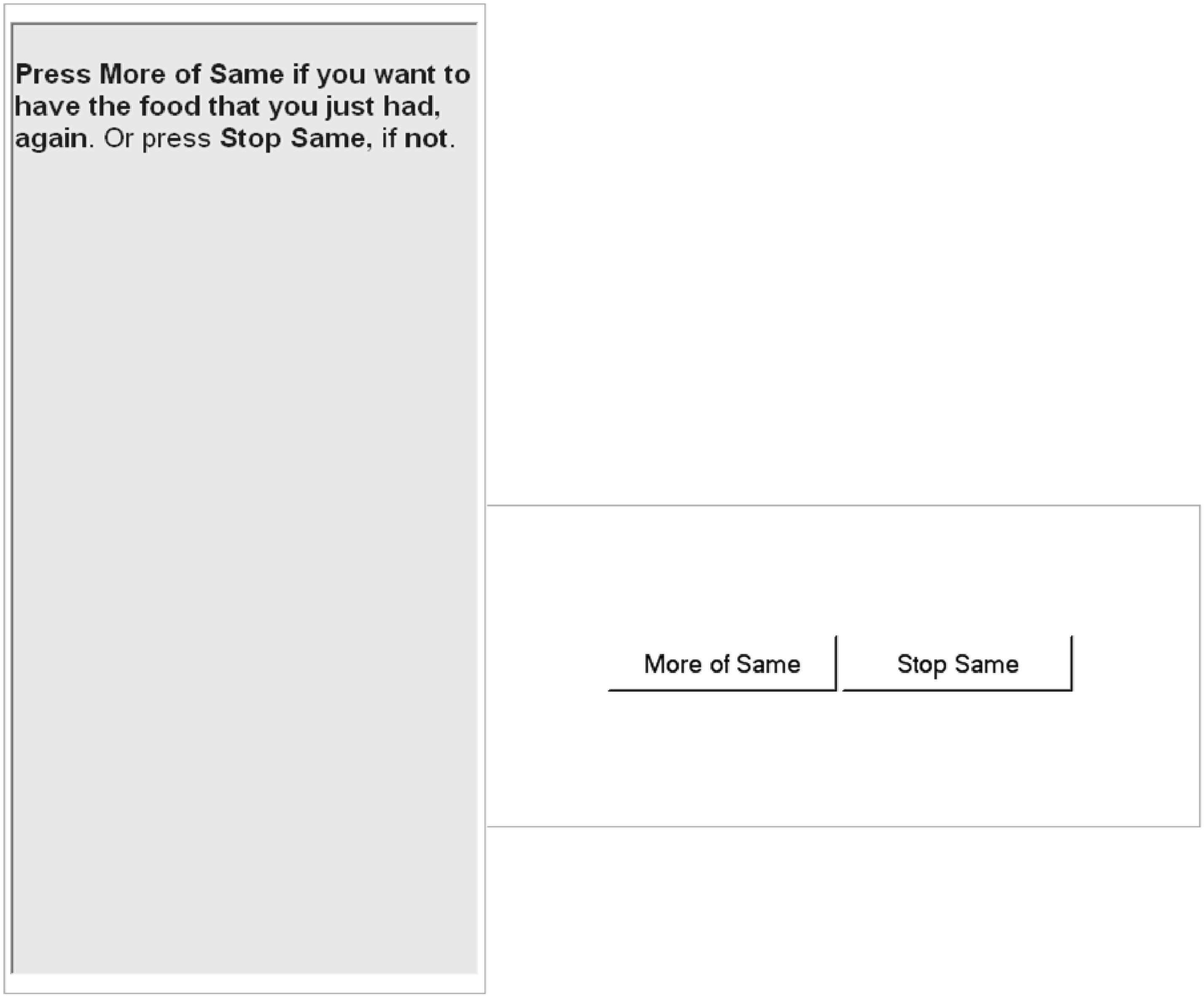
So please take the food and while eating it, rate how much you like it.
At this moment, how much do you like this food?
100 - GREATEST IMAGINABLE LIKE
80
LIKE EXTREMELY
60
LIKE VERY MUCH
40
LIKE MODERATELY
20
LIKE SLIGHTLY
0 - NEITHER LIKE NOR DISLIKE
DISLIKE SLIGHTLY
-20
DISLIKE MODERATELY
-40
DISLIKE VERY MUCH
-60
DISLIKE EXTREMELY
-80
100 - GREATEST IMAGINABLE DISLIKE

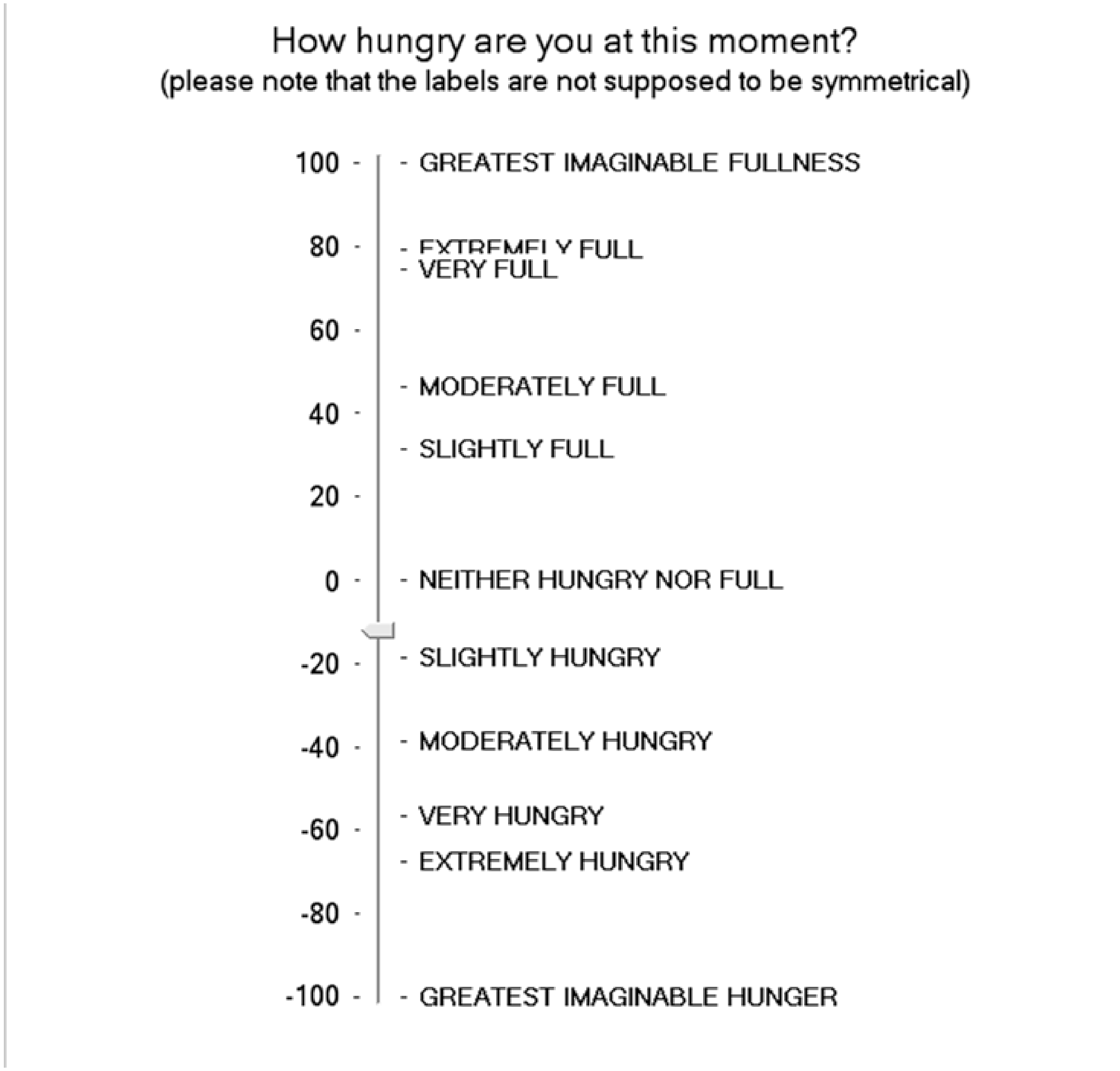
Sip a bit of water

Now please sip **a bit** of water **to neutralise the taste in your mouth.**
Make sure to rinse your whole mouth with water.

(Don't worry, the bottles are sterilised after each participant)
Please do that now.




Press More of Same if you want to have the food that you just had, again. Or press Stop Same, if not.
More of Same
Stop Same


How hungry are you at this moment?
(please note that the labels are not supposed to be symmetrical)
100
80
60
40
20
0
-20
-40
-60
-80
-100
GREATEST IMAGINABLE FULLNESS
EXTREMELY FULL
VERY FULL
MODERATELY FULL
SLIGHTLY FULL
NEITHER HUNGRY NOR FULL
SLIGHTLY HUNGRY
MODERATELY HUNGRY
VERY HUNGRY
EXTREMELY HUNGRY
GREATEST IMAGINABLE HUNGER

Karen Douglas
Secretary

Dr Anthony Dickinson
Department of Experimental Psychology
Downing Street
Cambridge

UNIVERSITY OF CAMBRIDGE

CAMBRIDGE PSYCHOLOGY RESEARCH ETHICS COMMITTEE

27 November 2008

Application No: 2008.63

Dear Dr Dickinson

Cross-Modal Evaluative Conditioning and Evaluative Blocking

The Cambridge Psychology Research Ethics Committee has given ethical approval to your research project: Cross-Modal Evaluative Conditioning and Evaluative Blocking, as set out in your application dated October 2008.

The Committee attaches certain standard conditions to all ethical approvals. These are:

(a) that if the staff conducting the research should change, any new staff should read the application submitted to the Committee for ethical approval and this letter (and any subsequent letter concerning this application for ethical approval);
(b) that if the procedures used in the research project should change or the project itself should be changed, you should consider whether it is necessary to submit a further application for any modified or additional procedures to be approved;
(c) that if the employment or departmental affiliation of the staff should change, you should notify us of that fact.

Members of the Committee also ask that you inform them should you encounter any unexpected ethical issues. If you will let me know that you are able to accept these conditions, I will record that you have been given ethical approval.

Yours sincerely

K S Douglas

17 Mill Lane
Cambridge CB2 1RX
Telephone: 01223 766894
Fax: 01223 332355
E-mail: mb422@admin.cam.ac.uk

Favourite Food Experiment

Welcome to the information and recruitment webpage for the Favourite Food Experiment. Here you will find information regarding the study followed by a recruitment questionnaire for you to fill in if you wish to take part.

Short Description

Take part in a pleasant study involving some simple computer-based tasks as well as eating food you like.
We are investigating physiological responding with Galvanic Skin Response, which is done by attaching a few completely harmless sensors to your fingers.
The study takes place in the Department of Experimental Psychology (easy walking distance) and lasts about one and a half hours.
If you wish to take part, you will be provided free food and paid 10 pounds.

Eligibility Criteria

The one and only real condition is that you skip breakfast or have a light lunch on the day of your participation,
so that you will have not eaten anything for at least 4 hours before the start of the experimental session i.e. so that you would be really quite hungry.

More Detailed Information

Your contact person for this study is Kristjan Laane (K.Laane@psychol.cam.ac.uk), please feel free to get in touch with any queries.

Scheduling for Your Participation

Choose a date for the experimental session : [ ] select

Choose a time slot suitable for you, for the date chosen above : [▾]

Your Basic Details

Name :

Email :

Phone / Mobile :

How good is your English :
- Mother tongue
- Fluent
- Advanced
- Intermediate
- Beginner

Gender :
- Female
- Male

Year of birth :

Dominant hand :
- Left
- Ambidextrous
- Right

What is your main speciality or field of study :

Food Questionnaire

Do you generally enjoy food :
- Yes
- No

Favourite Foods

In each category or line below, please choose and specify your favourite food items. Make sure to pick a sub-category in each row and then write out the specific brand or kind of product you most like e.g. choose "Chocolate" from the list and then write "Toblerone" or "white chocolate bought from Sainsbury's"

But please avoid food that has to be warmed up or kept cold or that comes in liquid(ish) form and the choices should generally be available in the Cambridge area.
Do not worry if you do not have an absolute favourite, just make sure you fill in all the boxes, including the textboxes.

- Fruit
- Bakery
- Berries
- Sw eets and Chocolate
- Snacks
- One more or other

Now please put the whole list above in order of preference, so that the food you like most comes top, then your overall second favourite, then third and so on.
To order the list drag and drop the grey areas up or down with left mouse button.
(Please note that you are not guaranteed to be provided with your top choices)

Meal Times and Allergies

Meal	**Average Time**
Breakfast	
Lunch	
Dinner	

Do you have any allergies to food, please list :

Prof Anthony Dickinson and Kristjan Laane
Dept of Experimental Psychology
Cambridge,
CB2 3EB, UK
Tel: +44 (0) 1223 333563
K.Laane@psychol.cam.ac.uk

Favourite Food Experiment Consent Form

Please read the information below to decide if you would like to take part in the project:

The purpose of this experiment is to investigate physiological responding to foods by measuring changes in the resistance of your skin, which is done by attaching two completely harmless sensors to your fingers (the Galvanic Skin Response), as well as your liking for the foods. If you take part, the whole session will last no more than 1.5 hours and involve some simple computer-based tasks as well as eating food you like. The task will be fully explained to you, and you have an opportunity to practice before you start. The chosen foods are provided for free plus you will be paid 10 pounds after completing the session. The one and only real condition for you to take part is that you skip breakfast or have a light lunch on the day of your participation, so that you will have not eaten anything for at least 4 hours before the start of the experimental session i.e. so that you would be really quite hungry.

Confidentiality. Your data will be entered via a code number that will not identify you by name.

Use of Data. In the first instance, the data will be reported in a PhD thesis. However, at a later date it may also be published in an academic journal and disseminated at research meetings. If any individual data is presented, the data would be totally anonymous.

Withdrawal. You are free to withdraw from the study at any time without explanation by informing the experimenter that you wish to do so.

Approval. The project has received ethical approval from the Psychology Research Ethics Committee of the University of Cambridge.

STATEMENT OF CONSENT

I agree to take part in this experiment. I understand that I am free to withdraw from the experiment at any time, and that the data collected will be stored in accordance with the Data Protection Act.

NAME SIGNATURE DATE

Sample ID Choose an item. Interview for EX **Study**

Before Session

General Questions

Q: When did you last drink coffee or similar and how does that compare to your regular consumption?
A: Click here to enter text.

Q: Do you smoke? If so, how many per day?
A: Click here to enter text.

Q: How much alcohol do you drink in a week?
A: Click here to enter text.

Q: Did you feel ill today, do you feel ill now?
A: Click here to enter text.

Q: Do you wear glasses or contact lenses, how good is your vision?
A: Click here to enter text.
Q: Are you colour blind?
A: Click here to enter text.

Study Specific Questions

Q: When and what exactly did you eat most recently prior to this experimental session?
A: What: Click here to enter text.
A: When: Click here to enter a date. Click here to enter text.

Q: Do you remember when you last ate the foods here today?
A: Click here to enter text.

After Session

Experience of Session

Q: Did you forget to follow instructions or did you get confused at any point in the experiment?
A: Click here to enter text.

Q: Did you feel unpleasant or uncomfortable at any stage of the experiment?
A: Click here to enter text.

Q: Did you use any specific strategies at any stage of the experiment? Please describe.
A: Click here to enter text.

Q: Did you get bored or tired at all during the session?
A: Click here to enter text.

Experimental Hypothesis

Q: Do you know any other participants that already took part or plan to take part of this study?
A: Click here to enter text.

Q: What do you think this experiment investigated? Please separate what you think now and what you thought during the experiment.
A: Click here to enter text.

Study Specific Questions

Q: Did you do exercise today before you came here?
A: Click here to enter text.

Q: In the last stage, did you feel you remember what picture went with what food?
A: Click here to enter text.
Q: Can you describe any particular pictures now which you remember went with a specific food?
A: Click here to enter text.

Q: Why do you think there was a stage where there were two pictures presented together during eating?
A: Click here to enter text.
Q: Did you look directly at them?
A: Click here to enter text.

Q: Did any of the pictures evoke any immediate thoughts or feelings that came in your mind the second you saw this picture? I.e. did any of the pictures remind you of anything or where they just abstract pictures to you?
A: Click here to enter text.

Q: Did you try to actively remember anything during the experiment or did you go through the stages passively?
A: Click here to enter text.

Q: When you had to press left and right (G and H) did you try to be as fast as you could?
A: Click here to enter text.
Q: Did you find your responses getting quicker as the experiment progressed?
A: Click here to enter text.

Q: Did the sensors hinder you or were they too tight or similar?
A: Click here to enter text.

Q: How did you like the foods in general?
A: Click here to enter text.

Q: Did the pictures evoke any emotions in you?
A: Click here to enter text.

Q: Did you pour more water?
A: Click here to enter text.

Q: Was the prediction bar that showed your certainty hard to use?
A: Click here to enter text.

Q: Did remembering that a picture was paired with a specific food affect your rating of that picture?
A: Click here to enter text.

General Feedback

Q: What are your general impressions and observations from this experiment? What could be done better?
A: Click here to enter text.

Q: Do you have any comments or questions?
A: Click here to enter text.