Exploring incentive salience in relation to pre and post-consumption measures within the proximity effect: A study protocol

Introduction

When we are in a rush and go to choose what to eat, we rarely weigh up the decision for a very long time, instead quickly choosing what will satisfy our hunger and taste good, often tending to also be unhealthy (Kearney, 2010). This contributes to the increasing obesity prevalence around the world, with record levels of obesity and overweight in the UK (Di Cesare et al., 2016; Digital NHS England, 2017; OECD, 2017). While governments tend to promote healthier eating through campaigns and advertisements such as ‘5-a-day’ and regulations to lower the amount of sugar in sugar-sweetened beverages, many of these policies and guidelines are generally ineffective (Marteau, 2017; Mozaffarian, Angell, Lang, & Rivera, 2018; Schaefer & Magnuson, 2014). Conversely, interventions which make minor modifications in the environment where we make these food-related decisions are becoming increasingly popular, both in research and governments (Benartzi et al., 2017; Marchiori, Adriaanse, & De Ridder, 2017; Matjasko, Cawley, Baker-Goering, & Yokum, 2016; Oliver, 2011). An promising method of changing behaviour which is relatively under-researched, exploits the ‘Proximity Effect’, where a food is chosen and consumed less when it is positioned further away compared to when positioned close to an individual (Bucher et al., 2016; Hollands et al., 2013).

The proximity effect can regularly be seen on large-scales such as building positions and proximity of fast-food restaurants to an individual’s home (Athens, Duncan, & Elbel, 2016; Le, Engler-Stringer, & Muhajarine, 2016), as well as in distances within the same dinner hall or café, or a short walk between distances (Engell, Kramer, Malafi, Salomon, & Leshner, 1996; Meiselman, Hedderley, Staddon, Pierson, & Symonds, 1994; Privitera & Zuraikat, 2014; Vanata, Ph, Hatch, & Depalma, 2011). However, in order to select a food or snack, one must interact with it within the micro-environment (Hollands et al., 2013). The proximity effect has been demonstrated at these micro-level distances between 20cm and 70cm, where an individual is able to select either option from a static, seated position (Maas, de Ridder, de Vet, & de Wit, 2012). However, recent studies have found that the proximity effect within these distances may be more complex, as the position of one snack may

influence the selection and consumption of another (Knowles, Brown, & Aldrovandi, 2019a), or may be relatively weak compared to other nudges (Hunter, Hollands, Pilling, & Marteau, 2019; Hunter, Hollands, Couturier, & Marteau, 2018). Moreover, it is relatively unknown what mechanisms may influence the effect. Past research suggests that the perception of effort required to attain the snack may also relate to consumption (Maas et al., 2012), with recent findings suggesting that visual salience may be related to consumption (Knowles et al., 2019a). However, this visual salience measure was self-report, and implemented after individuals had consumed their snacks, so it is plausible that individuals who consumed more of the snack had a clearer image of the snack in their mind, and therefore rated the snack as more salient due to their increased consumption. Therefore, the present study will explore this possibility by assessing measures such as visual salience (as measured by Maas et al., 2012) both before and after consumption to determine whether consumption of a food itself changes self-reported perceptions of salience, or whether individuals are consuming more snacks simply because they view the snack as more visually salient to themselves.

While the measure is referred to by Maas et al., (2012) as visual salience, the measure refers to how ‘tempting’ and ‘nice’ the individual perceives the snack to be, rather than simply the visual aesthetics of the snack. Elements of the visual salience measure overlap with incentive salience, often referred to as the ‘wanting’ for a food or snack (Berridge, 2007; Finlayson, Arlotti, Dalton, King, & Blundell, 2011; Pool, Sennwald, Delplanque, Brosch, & Sander, 2016). Therefore, the present study also aims to measure incentive salience to determine whether the two may be closely related despite separate names and intentions. Incentive salience is notoriously difficult to measure, with Berridge and colleagues repeatedly stating this while examining the cognitive aspects of food choice and consumption (Berridge, 2007, 2009; Berridge & Robinson, 2017; Berridge, Robinson, & Aldridge, 2009). Food liking is often entangled with many psychometric measures of food wanting, with the best and seemingly most reliable measure to determine food wanting being the Leeds Food Preference Questionnaire (LFPQ; Finlayson, King, & Blundell, 2008). The LFPQ shows individuals images of two snacks, where the individual is asked to state which food they want to eat most at that time, with reaction times covertly recorded. This measure is useful for determining implicit wanting of overall food groups, but is not as practical for a more simple measure of wanting such as in the present study (Finlayson et al., 2011; Finlayson & Dalton, 2012). Rogers and colleagues (Brunstrom & Rogers, 2009; Rogers & Hardman, 2015) argue that asking an individual to state how much they would be *willing* to pay for a food can indicate

how much they *want* the food. Therefore, the present study will use adaptations of the measures used in the aforementioned studies, as well as measuring specific snack liking, in an effort to measure food wanting and disentangle liking and wanting. However, as this is a secondary aim of the study, extensive exploration into this will not be conducted.

In addition to the visual and incentive aspects of salience, the present study will also measure olfactory or smell salience. It is accepted that the perceptions of many people are influenced by smell (Holland, Hendriks, & Aarts, 2005; Stevenson & Oaten, 2010; Valentin, Chrea, & Nguyen, 2006), and could justifiably be related to consumption within the proximity effect, as the smell of a snack may be stronger and more appealing when positioned close to an individual compared to when at arms-length away. Further measures of perceived effort, food liking, and eating behaviour will also be implemented to determine what may contribute to the proximity effect.

Aims and Hypotheses

The study aims to further investigate the role of salience in consumption for the proximity effect. The first aim of the study is to provide further confirmation of the proximity effect, with overall consumption expected to be higher and more likely to be consumed when chocolate is placed at 20cm than 70cm (H1). Second, the study expects more milk chocolate to be consumed than dark chocolate, as milk chocolate is believed to hold a higher incentive salience than dark chocolate (H2), with a possible interaction between distance and chocolate type also hypothesis (H3). To explore whether the chocolates do differ in incentive salience, the mean incentive salience, liking, and smell salience, will be compared across chocolate types (H4). This hypothesis will also act as a manipulation check to ensure the types of chocolate do hold different levels of incentive salience, despite being similar in terms of visual salience. Correlations between the measures will also be conducted to determine whether the measures are strongly related (for example '*higher smell salience is associated with higher wanting*', H5). Finally, visual salience, visibility, smell salience, incentive salience, and perceived effort will be compared between pre and post-consumption to determine if consuming chocolate influences any of these measures, most specifically the visual salience measure, as previous studies have found visual salience to strongly correlate with likelihood and actual consumption (H6; Knowles, Brown, & Aldrovandi, *in preparation*). Whilst presented as a main hypothesis, H6 also acts as a check for post-

consumption recall bias in ratings which may have influence findings in previous studies. The hypotheses can be expressed simply as below.

H1. Likelihood and overall consumption to be higher at 20cm than 70cm

H2. Milk chocolate to be consumed more than dark chocolate

H3. Two-way interaction between distance and chocolate type

H4. Milk chocolate to have higher scores for incentive salience, liking, and smell salience, than dark chocolate

Exploratory Hypotheses

H5. Smell salience to be positively correlated with incentive salience

H6. Hypotheses for each measure:

- a) Visual salience to be higher post-consumption than pre-consumption
- b) Visibility to be similar between pre and post-consumption
- c) Smell salience to be higher post-consumption than pre-consumption
- d) Incentive salience to be higher post-consumption than pre-consumption for milk chocolate but not for dark chocolate.

Method

Recruitment and Participants

Power analysis was conducted with an effect size from a previous proximity effect study ($\eta = .111$; Knowles, Brown, & Aldrovandi, 2019), suggesting a sample of $N = 65$ required to attain 80% power with alpha set at 0.05. In addition, the study will follow guidelines set out by Robinson, Bevelander, Field, and Jones, (2018) to attain at least 20 observations per condition. Hence, a sample of $N = 84$ will be used as it encompasses both of these suggested sample sizes, and allows for removal of outliers or withdrawals from the study. If multiple participants withdraw from the study, additional data collection will be conducted to ensure an adequate sample is gathered.

Participants will be recruited via an online recruitment system at a university in the West Midlands, United Kingdom, in Spring 2019, as well as at a University Open Day at the same West Midlands University. Participants recruited via the online recruitment system will be rewarded with research credits, with any individuals with a known food related illness or allergy asked not to participate in the study. Participants will be assigned to one of four conditions via a computerised random number sequence in a 2(Chocolate Type; Milk Chocolate, Dark Chocolate) $\times$ 2(Distance; 20cm, 70cm) between subjects design. The study will be advertised with a cover story of “How do videos impact snack perceptions?”, as to reduce social desirability and related biases impacting individual’s consumption. To test whether this cover story is successful, participants will be asked what they think the intent of the study is.

Materials

Food Stimuli: Two different types of chocolate will be used in the study, as incentive salience is expected to be manipulated. The study will present participants with a bowl containing 250g of Cadbury Dairy Milk Chocolate (Cadbury ®), or 250g of Cadbury Bournville Dark Chocolate (Cadbury ®), each with individual chocolate squares presented in a 17cm diameter transparent bowl. Previous pilot data suggests milk chocolate is liked more than dark chocolate (Knowles, Brown, & Aldrovandi, 2018), and are believed to hold different levels of incentive salience or “wanting” due to the bitter taste of dark chocolate (Berridge & Kringelbach, 2015). The bowls of chocolate will be weighed before and after each trial to calculate consumption using a digital weighing scale (0.01g accuracy).

Video Stimuli: To avoid individuals becoming bored during the study, a short 5 minute video clip from an episode of Friends (“The one with all the rugby”) will be shown to all participants. This clip has been previously used (Knowles, Brown, & Aldrovandi, 2019), and is thought to be engaging and enjoyable. The clip has no reference to food, and will be shown with no advertisements or breaks.

Questionnaire Stimuli: Participants will be asked to complete a two-part questionnaire, either side of watching the video. Participants will be told the cover story that the study is exploring how different video types influence perceptions of snacks, so will be expecting both to rate snacks on a number of measures, and watch a short video (See OLSM 1). The questions being asked in the study are as follows:

Visual Salience: The visual salience measure previously devised by (Maas et al., 2012) will be used to measure ‘visual salience’, as it has been used previously in proximity effect research (Hunter et al., 2018; Knowles et al., 2019a; Maas et al., 2012). The measure has been found to correlate strongly with amount consumed, contributing to the present study being devised. The measure will consist of five items using a 5-point Likert scale, with previous studies attaining a strong reliability for the measure.

Visibility: Deng and Srinivasan, (2013) developed a short, 3-item scale to measure snack visibility. The measure was found to have strong reliability, with colourful Froot Loops® being rated as more ‘attractive’ than visually plain Cheerios®. The measure is therefore used in the present study in addition to the visual salience measure (above), as it may offer valuable information regarding consumption and the proximity effect. If visual salience and visibility ratings are vastly different, it may suggest the visual salience measure of Maas et al., (2012) either does not fully encompass visual aspects of salience, or is influenced by non-visual factors.

Olfactory Salience: One of the strongest senses to trigger consumption of food is olfactory or smell (Stroebele & De Castro, 2004), but has not previously been measured in relation to the proximity effect. Further, it is suggested that individuals in previous proximity effect studies may have had their consumption influenced by the smell of the snack being offered (Brownies and M&M’s; Knowles, Brown, & Aldrovandi, 2018b; Knowles et al., 2018a). Hence, smell salience is being measured by a novel 7-item construct, with participants being asked to respond to questions on a 5-point Likert scale, to make the results comparable to the aforementioned visibility and visual salience measures (i.e. “*The snack smells sweet*”, “*The smell of the snack puts me off eating it*” [reverse scored]).

Incentive Salience: Incentive salience or “wanting” is often entangled with food liking, but is a distinct factor of its own (Berridge & Robinson, 2017; Finlayson & Dalton, 2012; Pool, Brosch, Delplanque, & Sander, 2014). Many studies have attempted to measure incentive salience effectively, with the best measure being the Leeds Food Preference Questionnaire (Finlayson et al., 2008). However, this is a much longer measure than desired for the present study, and states which food an individual prefers over another, rather than their specific wanting for a snack placed in front of them. Therefore, the present study uses a question similar to that of the LFPQ to ascertain food wanting (“*How pleasant would you find the taste of this chocolate right now?*”). Also, the present study uses two separate questions to determine wanting for the chocolate (“*How pleasant would a mouthful of the chocolate be?*” and “*How much do you want a mouthful of the chocolate?*”), measured on separate 100-point visual analogue scales (VAS). Finally, the study uses a similar measure to that used by Brunstrom and Rogers, (2009), asking individuals what is the maximum price they would be willing to pay for the bowl of chocolate at a shop, anchored with £0.01 and £5.00. Given 100g of each chocolate would commonly cost £1.00, the “value” of each bowl should be £2.50. The ‘willingness to pay’ responses will be scaled from 1-100, and a mean score be calculated for overall incentive salience.

Perceived Effort: Maas et al., (2012) developed a short 5-item measure to determine how much effort an individual feels is required to attain a snack from a certain position. While results are consistent that snacks at 70cm require more effort than those at 20cm, reliability is inconsistent (Knowles et al., 2018a). Nonetheless, the 5-item construct will be used to measure perceived effort in the present study.

Snack Liking: As is commonly seen with food-related studies, participants will be asked to state how much they like a small selection of snacks on a 100-point VAS. The snacks for the present study will include both milk and dark chocolate, and will be used as part of a manipulation check to ascertain whether dark chocolate is liked and wanted less than milk chocolate.

Hunger: Individuals will be asked to state how hungry and full (reverse scored) they currently feel, both before and after snack consumption, with hunger often being thought to relate to consumption (Zitron-Emanuel & Ganel, 2018).

Eating Behaviour: The Three-Factor Eating Questionnaire (TFEQ; Karlsson, Persson, Sjöström, & Sullivan, 2000) will be used to determine the restrained, emotional, and

uncontrolled eating sub-scales of the sample. It is thought that the sample will be largely similar to the general population, as individuals with known food-related conditions being asked not to participate, and so individuals with eating disorders are not thought to be involved in the study.

Study Awareness: A funnelled debrief procedure will be implemented to determine whether individuals are aware of their environment, and of their behaviour, as suggested by Hollands, Marteau, and Fletcher, (2016). Individuals will be asked whether they think they know the true intent of the study, how clearly they remember how many chocolates they consumed, and whether the laboratory influenced their behaviour.

Demographics: Participants will be asked to state their age, sex, height, weight, postcode, ethnicity, and highest education level, in order to attain an overview of the sample and to be used in a randomisation check to ensure conditions are similar on the participant characteristics.

Procedure

Eligible participants will be asked to participate in a 25-minute single laboratory session, with those recruited via the online recruitment system being rewarded with 4 research credits. The participant will be asked to sit at a desk with a bowl containing 250g of chocolate placed either 20cm or 70cm away, and a 27" computer monitor 1m away. An information sheet will be handed to the participant, with the participant asked to declare their consent through a computerised consent form. Upon providing consent, the researcher will read out the study instructions (See OLSM 2), informing the individual more specifically on what they are asked to do within the study, with the ability to ask questions after the instruction script has been read. After answering any questions, the researcher will ask the individual to start the first part of the questionnaire without eating any of the chocolates, then leaves the room while the participant completes the form. The first part of the questionnaire will contain items on visual salience, visibility, smell salience, incentive salience, perceived effort, snack liking, hunger, sex, education level, and ethnicity, in the stated order. The keyboard is not required for any of these questions, so will be placed out of sight as to not arouse suspicion of an irregularly placed keyboard. Once the participant has completed the first part of the questionnaire, they will be asked to watch the short video clip for 5 minutes, and told as a reward for the study they may consume the chocolate freely while watching they

if wish. After the video finishes, the researcher will return to the lab, remove the chocolates from sight, then ask the participant to complete the second part of the questionnaire, containing the same questions on visual salience, visibility, smell salience, incentive salience, perceived effort, food liking, hunger, eating behaviour (TFEQ), funnelled debrief, age, height, and weight, in the stated order. Height will be measured using a SECA® Stadiometer, with weight measured with a digital weighing scale. These two measurements will be used to calculate BMI. Upon reaching questions relating to height and weight, the researcher will return to the room, assist in measurements, then ask the participant to submit their responses and end the trial. The participant will then be debriefed and allowed to leave the room. The researcher will then weigh the chocolate, refilling the bowls if necessary in preparation for the following trial.

Planned Analysis

Descriptive and manipulation check

A series of 2x2 ANOVA's will be conducted on age, BMI, eating behaviour subscales, and hunger (pre and post), to determine whether conditions are similar for these participant characteristics. If conditions significantly differ for any measure, this will be considered in future analyses. Separate 2x2 ANOVA manipulation checks will be conducted on chocolate liking, visual salience, visibility, smell salience, and incentive salience, to determine if conditions, both between all four conditions and across the two chocolate type levels, differ for these measures. If there are differences found, this will suggest the manipulation has been successful, and milk chocolate is more salient than dark chocolate. A 2x2 ANOVA will also be conducted on perceived effort to identify if participants perceive attaining each bowl to require more effort at 70cm than 20cm. Reliability analyses will be conducted for all measures, in particular the novel smell salience measure and the adapted incentive salience measure, as these hold potential to be new additions to the field of measuring perceptions of snacks. Relevant post-hoc testing will be conducted where necessary, with all analysis conducted in R (v3.5.0) and suitable packages being used where required.

Main Outcomes

Likelihood of Consumption: Participants who do not consume any of the chocolate will be coded as "0", with any individual who consumes at least 1 piece of chocolate coded as "1". These will then be used in a binary logistic regression to test models for predicting likelihood of consumption. At least four models are planned to be tested, each with additional factors being added sequentially. Additional exploratory models may be carried out and reported. Models will aim to predict how likely an individual is to consume at least one piece of chocolate.

The planned models are as follows:

- 1) Main Effects Only: Distance + Chocolate Type
- 2) Main Effects and Interaction: Model 1 + (Distance x Chocolate Type)
- 3) Main Effects, Interaction, and Regular covariates: Model 2 + Visual Salience + Perceived Effort

4) Main Effects, Interaction, and New Covariates: Model 3 + Smell Salience + Incentive Salience + Visibility + Liking

Actual Consumption: Amount of chocolate consumed will be measured in grams (0.01g accuracy), with a 2x2 ANCOVA being conducted to determine whether consumption is significantly different across conditions. Perceived effort and visual salience will be included as covariates, as has been conducted in previous studies (Knowles et al., 2019a, 2018a, 2018b). Additional analyses will be conducted with the visibility, incentive salience, and smell salience also being included. All outcomes will be reported. Analysis will be conducted with the whole sample, and repeated with any outliers removed to determine whether the outcomes are sensitive to the presence of outliers. Any significant effects will be followed up with relevant post-hoc tests (i.e. correlation, Tukey's-HSD corrected t-tests). Further, analyses will be conducted with the subsample containing only those who consumed chocolate, thus removing the non-consumers from analysis. This is due to the high number of non-consumers likely positively-skewing the consumption data.

Discussion

The proposed study aims to explore multiple forms of salience, whether they change after consuming chocolate, as well as consumption of chocolate when placed at 20cm or 70cm, as in the traditional proximity effect. The study implements a 2x2 between subjects design in order to fully explore outcomes in a fully factorial design, with outcomes being expected to inform future proximity effect and wider food consumption studies. The study will build on previous research while adding to the current knowledge base.

Previous studies have found that the visual salience measure strongly correlates with snack consumption, with higher ratings being associated with those who have consumed more of the snack on offer. The present study will examine whether visual salience responses are higher before consumption, which would suggest that individuals consume more due to the snack being more salient to themselves, or whether individuals perceive the snack to be more salient only after they have consumed a large amount of it. Previous studies have commonly used brightly colour M&M's, which is chocolate based with a sugary coating. The present study will manipulate snack salience through offering a more commonly liked snack in milk chocolate, or a snack with similar appearance yet a lower liking in dark chocolate. It is hypothesised that individuals will perceive offer higher liking ratings for the milk chocolate, and 'want' the milk chocolate more, as seen by stating the milk chocolate would be more rewarding and willing to pay more for the milk chocolate. Both of these factors are thought to lead to the milk chocolate being consumed in greater quantity than the dark chocolate, which is thought to hold a lower incentive salience and be less liked.

Overall, the study aims to explain what construct is being measured through the visual salience measure first designed by Maas et al., (2012), as well as confirm whether the rating is influenced by consuming chocolate. Previous studies which have measured visual salience have not been able to determine its true association with consumption, with Maas et al., (2012) and Hunter et al., (2018) simply measuring but not relating the outcome to consumption, and Knowles et al., (2018a, 2018b, 2019) finding correlations between consumption and visual salience response, but not being able to determine any causal relationship. The present study aims to be the first to experimentally answer this.

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