Investigating the proximity effect within a competitive food environment: A study protocol

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Abstract

Obesity and overweight levels are rising nationally, despite recent governmental advertising campaigns being implemented to tackle the prevalence rise at a population level. Therefore, alternative approaches should be investigated in an effort to reduce obesity prevalence rises. One such approach modifies the external cues and the environment where decisions about food are made, and it is commonly known as Choice Architecture (CA). The proximity effect is a strategy within CA that could reduce overall calorie consumption by placing healthier foods at relatively closer distances compared to unhealthy foods. Amongst studies examining the proximity effect, only one so far has explored the simultaneous presentation of healthy and unhealthy foods, referred to as a competitive food environment. As unhealthy foods are often preferred over healthy foods, the current study aims to investigate whether food choice can be overridden by varying degrees of proximity effect and whether key factors such as visual salience, perceived effort, BMI, age, food preference, and executive function moderate this effect. A sample of 48 undergraduate students will participate in a laboratory experiment, believing they are taking part in a relaxation study. Participants will be simultaneously presented with two bowls of food: A healthier fruit selection and an unhealthier chocolate option, each varying according to proximity (either 20cm or 70cm). The participants will be asked to complete a questionnaire measuring multiple factors that may influence food consumption, such as perceived effort and hunger level. The primary outcome of the study is the amount of each food consumed (in grams) depending on relative proximity, with the secondary outcome exploring whether the effect of the latter is influenced by the key moderators. The proposed study explores the proximity effect in a competitive food environment, an area rarely explored in research but high in real-world applicability. If a greater amount of the most proximal food is consumed in each condition, regardless of food healthiness, the intervention can be scaled up to a novel field experiment to further evaluate the effectiveness of the proximity effect in reducing calorie intake.

Key Words: Proximity, Competitive environment, Choice Architecture, Behaviour Change, Food Healthiness

Background

The prevalence of obese and overweight individuals has risen steadily for a number of decades (Ng, Fleming, Robinson, Thomson, & Graetz, 2014), both in developed and developing countries (Di Cesare et al., 2016; Popkin, Adair, & Ng, 2013). Recent surveys from the Organisation for Economic Co-operation and Development (OECD) indicate that the prevalence of overweight and obese individuals is now above 50% in 22 of the 34 OECD countries (OECD, 2016), rising from 19 of 34 in 2011 (OECD, 2011). Di Cesare et al. (2016) claimed the probability of ‘halting global obesity’, a goal set out by the World Health Organisation, is ‘virtually zero’ (WHO; 2013). Traditional methods to combat the increase in obesity such as advertising and educational campaigns (Jebb, Aveyard, & Hawkes, 2013) are thought to be fundamentally limited (Marteau, Hollands, & Fletcher, 2012), often having little effect on actual behaviour (Webb & Sheeran, 2006). Further, educational interventions such as using food labels to promote healthier choices are heavily associated with socio-economic position (SEP), poverty, and education level (Just & Payne, 2009; Ollberding, Wolf, & Contento, 2010). Those belonging to a lower SEP also have a higher obesity and overweight prevalence, as well as a lower average education level, and are disproportionately affected by food price rises (Lifestyle Statistics Team, 2015, 2016). When taken together, these factors seem to demonstrate that people in lower SEP are currently least affected by educational campaigns, but seemingly are most in need of a successful intervention to reduce obesity levels. For a strategy to be successful in reducing obesity in lower SEP populations as well as higher SEP populations, fresh approaches should perhaps be explored (Marteau et al., 2012).

One alternative approach which has been gaining popularity in research (Hollands et al., 2013) applies behavioural economics principles to commonly experienced food-related scenarios, ranging from the environment food is eaten in to the cutlery used to consume food (Just & Gabrielyan, 2016; Wansink, 2006). Such research has uncovered that the vast majority of individuals significantly under-estimate the number of decisions about food they make on a daily basis (14 estimated vs over 220 actual decisions; Wansink & Sobal, 2007). Wansink and Sobal (2007) suggest that people do not consciously monitor the number of decisions they make, and so are generally

unaware of the external cues that influence their decisions (e.g., plate sizes; Prinsen, De Ridder, & De Vet., 2013). This unawareness can, and often does, lead to an over-consumption of calories, through excess consumption or selection of unhealthier options (Hollands et al., 2015).

Building on the notion that many individuals do not monitor their food consumption, recent researchers and policy makers have increased focus on the development of non-conscious interventions aimed at improving people's decisions about food (Behaviour Insight Team, 2010; Hollands et al., 2015; Marteau, Hollands, Shemilt, & Jebb, 2015; Sunstein, 2016). These interventions apply behavioural economic principles and require little to no extra effort than regular day-to-day behaviour from individuals as they often operate without people's awareness (Hollands et al., 2016; Marteau et al., 2012). Such interventions have strong potential to be effective in promoting behaviour change (Marteau et al., 2012; Sheeran, Gollwitzer, & Bargh, 2013), and are already being used for research in real world field studies (Hansen, Skov, Jespersen, Skov, & Schmidt, 2016; Rozin et al., 2011).

A popular technique which incorporates non-conscious biases is Choice Architecture (CA; Thaler & Sunstein, 2008), defined as manipulating the micro-environment where food related decisions are made, such as moving an item's location in order to influence choices in a predictable way. This consistently instigates behaviour change (Bucher et al., 2016), such as influencing the amount eaten (Wansink, Painter, & North, 2005), or certain foods being selected over others due to the location of the food (Keller, Markert, & Bucher, 2015). The latter scenario is an example of the Proximity Effect, a form of CA with promising potential (Bucher et al., 2016; Marteau et al., 2012), but is rarely explored in relation to other effects, such as container size (Hollands et al., 2013, 2015). The proximity effect can be defined as the difference in selection and consumption as a result of the physical distance between an individual and the selected food item. The effect is generally robust, with closer (proximal) placement of food resulting in higher consumption and selection relative to food that is further away (distal; Bucher et al., 2016). The only systematic review to date also emphasises the clear need for higher-quality studies (Bucher et al., 2016), suggesting well-planned experiments could lead to cost-effective methods of reducing calorie intake and aiding weight loss.

In the nine proximity studies identified by Bucher et al. (2016), the mechanisms underpinning the proximity effect are debated. Wansink et al. (2006) argue that visual salience may underpin the proximity effect, as those rating the snacks as attracting more attention consume more of said snacks. However, more recent evidence (Maas, de Ridder, de Vet, & de Wit, 2012) suggests that perceived effort to attain snacks due to the increased physical distance moderates the proximity effect, whilst salience does not impact on consumption. In addition, Hollands et al. (2017) suggest that biological state may influence food selection. Research unrelated to proximity studies show that hunger (Furst, Connors, Bisogni, Sobal, & Falk, 1996; Hoefling & Strack, 2010), tiredness (Brondel, Romer, Nougues, Touyarou, & Davenne, 2010; Hogenkamp et al., 2013), and stress (Van Blyderveen et al., 2016; Zellner et al., 2006) influence food selection, with higher levels of each of these factors inducing unhealthier food selection. Bucher et al. (2016) highlight that the participants' BMI does not moderate the proximity effect. Further, a current study protocol outlines an investigation into whether executive functioning moderates the proximity effect, with the hypothesis that the effect is consistent regardless of executive functioning level (Hunter, Hollands, Couturier, & Marteau, 2016). Additionally, Helbig and Gabbard (Helbig & Gabbard, 2004) showed that people often use the closest hand to select items, rather than our dominant hand. This finding lends itself to a proximity-based study, as it may be the distance between the closest hand and the stimulus, rather than dominant hand, which should be considered in proximity studies. Finally, individuals acceptance of nudging and non-conscious interventions may also moderate the proximity effect (Bruns, Kantorowicz-reznichenko, Klement, Luistro, & Rahali, 2016; Petrescu, Hollands, Couturier, Ng, & Marteau, 2016), but is yet to be experimentally tested.

While internal cues such as perceived effort are often considered when designing proximity studies, the food used within the study is also an important factor. Whilst the majority of proximity-based studies use a single food type at a time (Bucher et al., 2016), only Privitera and Zuraikat (2014) implement a choice between healthy and unhealthy food types. The latter scenario is known as a competitive food environment as individuals often have to choose between foods that differ in terms of healthiness. Privitera and Zuraikat (2014) demonstrated that while individuals often prefer buttered

popcorn (unhealthy option) over apple slices (healthy option), when popcorn was presented at a distal position (200cm away) and apple slices were proximal (30cm), the proportion of apple slices consumed was significantly greater than popcorn. The proximity effect therefore seems to have a greater impact on food consumption than the type of food. Another potential concern from the Privitera and Zuraikat's (2014) study is the lack of a condition where neither food type is proximal, an issue which was considered when designing the present study. Further, the proximity effect has been observed between smaller distances (20cm and 70cm) than those used by Privitera and Zuraikat (2014).

The present study expands current research with an experimental trial meeting previously noted requirements for high quality proximity effect research (Bucher et al., 2016). The study incorporates the distances used by Maas et al. (2012) within a competitive food environment to investigate the consumption of different food types. The present study assesses biological factors (hunger, tiredness, and stress), as well as previously explored factors (BMI, perceived effort, visual salience) in order to explore the role of potential moderators of the proximity effect.

Methodology

Aims

The primary aim of the study is to investigate whether the proximity effect can be observed in a competitive environment where food is presented at relatively close distances (20cm and 70cm), whilst accounting for potential moderators of the proximity effect, including perceived effort, visual salience, hunger, and tiredness.

Hypotheses:

H1) Consumption of food will be significantly higher when proximal (20cm) than distal (70cm), regardless of food type, in line with previous findings (Bucher et al., 2016).

H2) Overall, participants will consume significantly more of the unhealthy food compared to the healthy food, as Rozin et al. (1991) found that chocolate attracted consistently high hedonic ratings. In addition, in Privitera and Zuraikat's (2014) study participants rated sweet popcorn more favourably than fruit.

H3) There will be a significant interaction between food type and proximity with unhealthy food presented in the proximal condition being consumed more than healthy food presented in the distal condition (Privitera & Zuraikat, 2014). Consumption from healthy proximal and unhealthy distal conditions will fare in between the aforementioned food placements.

H4) Higher subjective tiredness, stress, and hunger ratings will positively correlate with chocolate consumption, as past research suggests that higher levels of each factor increase unhealthier food selection (Greer, Goldstein, & Walker, 2013; Hoefling & Strack, 2010; Hogenkamp et al., 2013; Van Blyderveen et al., 2016). Further, BMI, age, food preference/liking (Bucher et al., 2016), acceptability (Petrescu et al., 2016) and executive functioning (Hunter et al., 2016) are all expected to not significantly moderate food consumption.

Design

The study utilises a mixed design with three independent variables: Food type (within-subjects: Healthy vs Unhealthy), Unhealthy food location (between-subjects: proximal/20cm vs distal/70cm), and Healthy food location (between-subjects: proximal/20cm vs distal/70cm). Participants will be randomly assigned through use of a randomly generated number sequence to one of the four possible conditions. Each participant will be presented with 250g of each food on a table in separate clear, round bowls located at either 20cm or 70cm. The position of the bowls will be measured from the edge of the table to the edge of the bowl closest to the participant (see Figure 1 below). A small selection of neutral magazines will be placed in the centre of the table, with a laptop (for questionnaire completion) presented in front of the participant. For each condition, half of the participants will have the healthy food placed on the left, whilst the remainder will have the healthy

food placed on the right hand side of the table, in order to adequately counterbalance the presentation side.

Figure 1. Layout of Testing Area

Participants and Recruitment

The study will recruit undergraduate students from a university in the Midlands, UK, via a research participation scheme, for which they will be rewarded with 30 minutes worth of credits. Participants with known allergies, intolerances, and other food related illnesses (including but not limited to nut, wheat, gluten, lactose, soy, and oats) will be excluded from participation. A relaxation study cover story will be presented in order to reduce possible demand characteristics, in line with previous research (Hunter et al., 2016). Additionally, participants will be asked not to eat for two hours prior to the study. Participants who wish to withdraw from the study shall be allowed with no consequence, with their data removed from the database and deleted.

Sample Size: Power analysis using effect sizes from Privitera and Zuraikat (2014; $d = 1.16$ and $d = 1.25$, for studies 1 and 2 respectively), aiming for a power = 0.8 and alpha = .05, suggests a required sample size between 36 and 56 participants. After considering both power analyses, and with the sample size required to be a multiple of 8 due to the counterbalancing of presentation side of each

food, a sample of 48 participants is desired, equating to 12 participants in each of the 4 conditions. This sample is powered to detect differences in the primary outcome, rather than powered to detect differences within moderators. If a large number of participants move either bowl during the study, additional participants will be recruited until usable data from 12 participants is collected for each condition.

Materials

A small selection of fruits, including apple slices (as used in Privitera & Zuraikat, 2014), red and green grapes, and peeled orange segments will be used as the healthy food. Chocolate M&M's® (as used in Maas et al., 2012; Hunter et al., 2016) will be used as the unhealthy food. Each bowl shall be filled with 250g of the corresponding food (either fruit or M&M's). Both bowls will contain food differing in colour, which should make visual salience comparable. Consumption will be measured to the closest 0.01g on a digital scale, calculated by the difference between the weight before and after each trial. Participants' BMI will be calculated at the end of the study using a stadiometer and a weighing scale.

Questionnaire: Participants will be asked to complete a short computerised questionnaire for the duration of the experiment (See Additional file 1). The questionnaire will include previously examined factors (food liking, BMI, SEP, hunger, impulse control and executive functioning, salience, awareness, and perceived effort), in addition to novel, previously unexplored factors within a proximity study (tiredness, perceived daily stressors, and nudge acceptability; See Additional file 2 for more details and the validated measures used in the questionnaire).

Procedure

Participants meeting the study criteria will be asked to attend a single laboratory session. Once a participant has been seated and provided consent, the researcher will instruct him/her to complete section one of the questionnaire, which contains questions on age, SEP, handedness, and executive functioning. Participants will be informed that, whilst the researcher leaves the room (for 10 minutes) to file the consent documentation, they will be free to eat as much or as little of the food

provided, and they may browse the magazines after they have completed the questionnaire. Upon return, the researcher will remove the two bowls from the table and instruct the participant to complete section two of the questionnaire, which contains the remaining questions (e.g., on salience and perceived effort, see additional file 1 for exact questions). The researcher will again leave the room, justifying this decision to the participant as preparation of fresh food for the following trial. Whilst out of the room, the researcher will record the weight of each bowl to the nearest 0.01g, returning to the laboratory to measure the participant's height and weight. The participant will then be fully debriefed regarding the true intent of the study.

Analysis

Descriptive analysis will be run on the demographic data (age, BMI, gender and ethnicity), in order to identify whether all groups are comparable, thereby ensuring the group randomisation was successful. The data will then be examined to check for parametric assumptions. A one-way ANOVA will then be run for each moderator (i.e. BMI, hunger) to identify whether groups are statistically different for each moderator. If conditions are not statistically different to one another for any specific moderator, the factor will not be included in the subsequent main analysis of a 2(food type; Healthy, Unhealthy) x 2(Healthy Distance; Proximal, Distal) x 2(Unhealthy Distance; Proximal, Distal) mixed ANCOVA. Due to previous findings, visual salience, perceived effort, and any moderator identified from the one-way ANOVA's will be inputted as covariates. Post-hoc analyses will be performed to break down interaction effects and to further explore the effects of the covariates, if necessary. During the study, there will be a chance of participants moving the bowls as they are not fixed to the table. In this case, sensitivity analysis will be conducted to determine whether inclusion/exclusion of any participant moving the bowl has any effect on the relationship between the independent, outcome and moderating variables.

Discussion

The currently proposed study will further investigate the use of the proximity effect to influence food consumption, simulating a competitive food environment with healthy and unhealthy foods, whilst examining key moderating variables. Specifically, the study will be the first to investigate any potential role perceived stressors, nudge acceptability, and tiredness may have on the proximity effect. Importantly, the study also aims to meet the quality requirements set out by Bucher et al. (2016) that are however not met in previous proximity effect studies. The findings will be compared to those of Privitera and Zuraikat (2014) in order to test the notion that food preference does not moderate the proximity effect. Additionally, the results to the current study will determine whether perceived effort (Wansink et al., 2006) and/or visual salience (Maas et al., 2012) underpin the proximity effect.

Finally, the findings of this experiment will inform future studies in more ecologically valid scenarios, such as manipulating the proximities of various foods in a local café to inform choice architectural design. Ultimately, this strand of research could promote choice of healthy alternatives, thus increasing nutrient gain and/or reducing calorie consumption in line with the WHO's aim to halt the rise in obesity (World Health Organization, 2013).

Additional Files

Additional File 1: Complete questionnaire given to participants [DOC, 37KB)

Additional File 2: Rationale for including each measure, and overview of which validated measures are used for the study [DOC, 26KB]

Abbreviations

OECD, Organisation of Economic Co-operation and Development; WHO, World Health Organisation; SEP, Socio-economic position; CA, Choice Architecture.

Authors' information and Declarations

Daniel Knowles (DK) is a PhD student under the supervision of Dr. Kyle Brown (KB) and Dr. Silvio Aldrovandi (SA). KB and SA are Senior Lecturers of Applied Psychology at Birmingham City University. DK planned the study, with revisions and feedback provided by KB and SA. The study was carried out by DK, with the manuscript drafted by DK under the supervision and feedback of KB and SA. Data analysis will be carried out by DK. All authors have read and approved the final version of the manuscript. Data will be made available following completion of the study. This study was ethically approved by Birmingham City University Ethics Committee under the reference 063.17. Informed consent was attained from participants prior to each trial, with all data being kept anonymous and stored securely. The authors declare they have no competing interests. The first author (DK) is funded as PhD student at Birmingham City University. The Doctoral Research College had no part in designing the study, collecting or analysing data, or preparing the manuscript. No external funding was gained for the study.

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