DOES SOCIAL MEDIA AFFECT OUR PERCEPTIONS OF WHAT MOST PEOPLE EAT, WHAT WE CHOOSE TO EAT AND OUR BODY WEIGHT?

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A diet high in fruit and vegetables can help prevent obesity and decrease the risk of associated chronic comorbidities and mortality, however many people do not consume the recommended amounts. Thus, innovative ways of encouraging healthier food choices are needed, for example, by using social influences. Social norms, which describe how the majority of people behave, have consistently been shown to be associated with, and to affect, eating behaviour. Nowadays, one way such norms may be communicated is via social media, however, the relationship between social norms conveyed via social media and eating behaviour has received little attention. Therefore, this thesis aimed to quantify the extent to which social norms communicated via social media influenced food consumption, and whether social media could be used as the basis for an online social norms intervention, aimed at nudging healthier consumption. Associations with body weight were also considered. Through cross-sectional and longitudinal survey studies, it was established that our perceptions of what social media users eat predicts our own choices, both acutely and over time. A laboratory-based experimental study also demonstrated that exposing participants to socially endorsed social media images significantly nudged the proportion of food consumed towards low energy-dense vs. high energy-dense snacks, allowing causal conclusions to be established. Additionally, social norms may enhance attention towards LED foods in those with overweight and obesity, however, these findings were not statistically significant. Finally, in a two-week, online social media intervention using social norms, participants reported consuming significantly more fruit and vegetables than those in the control condition. These results therefore demonstrate the potential utility of a social norms-based social media intervention in nudging consumption towards healthier food choices. Wider implications for policy, as well as advertising industries are discussed. Future research should aim to replicate these results with larger and more diverse samples.

Key words: social norms; eating behaviour; food choice; healthy eating.

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DISSEMINATION

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List of Abbreviations

ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
BMI	Body Mass Index
FV	Fruit and vegetables
HED	High energy-dense
LED	Low energy-dense
NHS	National Health Service
ONS	Office for National Statistics
PCA	Principal components analysis
SES	Socio-economic status
SFDAF	Student Food and Drink Attitudes Form
SFFFQ	Short Form Food Frequency Questionnaire
SSB	Sugar sweetened beverage
TFEQ	Three-factor Eating Questionnaire
TPB	Theory of Planned Behaviour
UFDIQ	Usual Food and Drink Intake Questionnaire
VAS	Visual Analogue Scale
WHO	World Health Organization

CHAPTER 1. GENERAL INTRODUCTION

1.1 Obesity and healthy eating

In 2016, the World Health Organisation reported that 13% of the world's population were obese and 39% of adults were overweight, with some estimates arguing that by the 2050s, obesity levels will be at their maximum level, the highest of these being in the UK and the USA (Janssen, Bardoutsos & Vidra, 2020). Obesity represents a major risk factor for developing other chronic diseases such as type 2 diabetes, certain forms of cancer, coronary heart disease and other respiratory problems (Kopelman, 2000). Poor dietary behaviour and eating habits are significant contributing factors towards obesity. Indeed, a diet high in fruit and vegetables and low in sugary and fatty foods is also likely to help prevent obesity (World Health Organization, 2019), as well as decrease the risk of cancer and cardiovascular mortality and increase well-being (Oyebode, Gordon-Dseagu, Walker & Mindell, 2014). However, according to the Health Survey for England (2018), only 28% of adults across all age ranges consume the recommended 5 portions a day. While interventions using health education, such as the '5 a day' programme in the UK, have attempted to encourage fruit and vegetable consumption through health education and advertising campaigns (World Health Organization, 2003), success has been limited (Rekhy & McConchie, 2014). Thus, in order to help prevent these non-communicable diseases, it is necessary to explore innovative ways of nudging food choices and consumption towards healthier options. A different approach to encouraging healthier eating and behaviour change for obesity may be to consider the role of other factors, such as social influences.

1.2 Social influences on eating behaviour

Previous research has identified eating as a social phenomenon that takes place within a social context (for a review, see Higgs & Thomas, 2016). Our social context has been found to impact how much and what we eat (De Castro, Brewer, Elmore & Orozco, 1990), for example eating together with others has been found to encourage healthy eating, compared to eating alone (Maldoy, De Backer & Poels, 2020). There are different ways in which social influences may exert their influence, for example, by direct observation of what others are eating, as well as modelling the eating behaviour of others (e.g. Hermans, Larson, Lochbueler, Nederkoorn, Herman & Engels, 2013) or through environmental cues, such as leaving empty snack bar wrappers (Burgur et al., 2010; Prinsen, de Ridder & de Vet, 2013) to give a proxy for how others behave. However, it has been found that eating can often be misattributed to internal cues such as hunger, instead of external cues, such as others' behaviour (Vartanian, Spanos, Herman & Polivy, 2017). This misattribution suggests that others' behaviour can be highly influential in altering eating behaviour but may have more of an implicit and subtle effect on what we eat, and consequently may result in misattributing eating to other cues. Thus, it is important to investigate what the effects of social context and others' behaviour are on eating behaviour further, to understand the consequences of this fully.

1.3 Social norms

One area that is gaining increased attention is the impact of social norms on eating behaviour. Social norms are implicit rules that communicate the behaviour of the majority (Cialdini & Trost, 1998), for example, a common social norm is to queue behind someone, rather than to push in front of someone. Different norms have been utilised when studying food intake and choice, including descriptive norms, which convey what most people *do* (e.g. 'most people eat fruit and vegetables') and injunctive norms, which convey what most people *should* do (e.g. 'most people should eat fruit and vegetables'). It has been found that we look to social cues, such as social norms to guide what and how much to eat in the presence of others, especially when physiological inhibitors, such as satiety, are absent (Herman, Roth & Polivy, 2003). Thus, social norms can have a powerful effect on our food intake and can indicate when to start or stop eating when physiological indicators are absent.

Social norms have also been conceptualised as key motivational factors in behaviour change models, such as the Theory of Planned Behaviour (TPB; Buchan, 2005) and Social Cognitive Theory (Bandura, 2001). These models are often applied to health behaviours, where in the Theory of Planned Behaviour, social norms are argued to predict our intentions and behaviour. Further, Social Cognitive Theory posits that individual level factors such as cognition and an individual's attitudes and behaviour interact with environmental factors, such as social norms, to determine behaviour. Indeed, subjective norms (whether we think others will approve of our behaviour) have been used previously as part of TPB-based interventions aiming to nudge healthier eating behaviour, with success (Louis, Davis, Smith & Terry, 2007). However, other social influence variables, such as social norms (descriptive and injunctive) resulted in increased intentions to consume fruit and vegetables, in addition to the TPB variables and subjective norms (Louis et al., 2007), suggesting there may be a role for social norms in affecting intentions to consume low energy-dense (LED) foods. Additionally, Social Cognitive Theory constructs, such as cognitive (e.g. self-efficacy to carry out a behaviour) and social (e.g. observational learning, which includes modelling and norms) determinants of behaviour were found to mediate the effects of adolescents' social economic position on intake of fruit, high energy dense-snacks and fast foods (Ball, MacFarlane, Crawford, Savige, Andrianopoulous & Worsley, 2009). Social determinants including observation and support of family were more strongly related to healthy eating than observing the eating habits of friends or peers (Ball et al., 2009). Therefore, social influence variables, including norms could be an important part of changing eating behaviour.

According to Cialdini's theory (1998), social norms may be used as a form of normative social influence, whereby norms are adhered to because they are viewed as socially approved of or accepted (Cialdini & Goldstein, 2004; Cialdini & Trost, 1998; Deutsch & Gerard, 1955), or as a form of informational social influence, whereby the norm communicates appropriate behaviour when it is not clear what to do (Cialdini & Trost, 1998;

see Higgs 2015 for a review). Indeed, normative information about the typical behaviour of others has been found to increase other healthy behaviours such as stair climbing (Slaunwhite, Smith, Fleming & Fabrigar, 2009) and decrease risky behaviours such as drink driving (Neighbors, Larimer & Lewis, 2004; Perkins, Linkenbach, Lewis & Neighbors, 2010), suggesting that exposure to social norms can be used to nudge a variety of health-related behaviours.

1.3.1 Perceptions of the norm

Cross-sectional research has found that when participants are asked to report their perceptions about how others eat, this is associated with their own food intake and choices. For example, perceptions about peers' intake of pastries and sugar sweetened beverages have predicted participants' self-reported consumption of these calorific foods (Robinson, Otten & Hermans, 2016). Similarly, momentary norms, or perceptions about what others eat in a specific context or setting, predicted increased odds of snacking in similar contexts (Schüz, Papadakis & Ferguson, 2018). This suggests that without any direct observation or knowledge about their peers' food intake and choices, participants will adjust their own intake to be in line with what they *perceive* others typically consume.

Importantly, this has previously been reported for perceived descriptive norms, but not injunctive norms when asking adolescents about their peers eating behaviour (Lally, Bartle, & Wardle, 2011), suggesting that perceptions about what peers *actually do* may be the most influential, or more consistent in predicting participants' own food consumption. Further, injunctive norms (i.e. what others should do or approve of doing) have been found to have negative effects on intended fruit consumption, as well as having no association with fruit, vegetable, unhealthy snack and sugar sweetened beverage (SSB) consumption (Lally et al., 2011; Stok, de Ridder, de Vet & de Wit, 2014). Specifically, injunctive norms were found to not only have no influence on fruit intake but also had a negative association with intentions to consume fruit compared to a descriptive social norm message (Stok, de Ridder et al., 2014). This could therefore suggest that perceived injunctive norms may be less likely to influence food consumption than other norms, possibly because injunctive norms may result in resistance, or people reacting against the behaviour that they are told they *should* be enacting (Stok, de Ridder et al., 2014). However, injunctive norms have been shown to predict healthy food choices (Mollen Rimal, Ruiter & Kok., 2013) as well as snacking in specific situations (Schüz et al., 2018), suggesting instead that the effects of injunctive norms may depend upon the context in which participants' food choice takes place, and may warrant further investigation.

Additionally, cross-sectional surveys have found that social norm perceptions may not always be accurate. For example, adolescents underestimated their peers' fruit and vegetable intake and overestimated their peers' snack food intake (Lally, et al., 2011). Consequently, these misperceptions were also associated with adolescents' own consumption of these foods, with participants reporting that they also consumed less fruit and vegetables and more energy-dense snacks (Lally et al., 2011). This has also been found in younger children, who underestimated their peers' intake of and attitudes towards fruit and vegetables and consequently ate less themselves (De Noia & Cullen, 2015). These perceptions were also inaccurate, suggesting that it may be highly important to correct misperceptions, as they could be directly associated with participants unhealthy eating habits. One way of altering these misperceptions could be through exposure to normative information about what others actually do (descriptive norms). This has been demonstrated to be an effective strategy when trying to change misperceptions and behaviour around alcohol consumption (Neighbors, Larimer & Lewis, 2004). For example, a social marketing campaign using descriptive norms in advertisements (e.g. "most other young adults don't drink and drive"), changed young adults' misperceptions around drink-driving, as well as reducing their drink-driving behaviour (Perkins, Linkenbach, Lewis, & Neighbors, 2010). Considering interventions to improve healthy eating, descriptive norms could also be utilised for behaviour change.

Relatedly, perceptions about different social groups' behaviours have also been found to affect self-reported food consumption differentially (Pelletier, Graham & Laska, 2014; Harmon, Forfother, Bantum & Nigg, 2016). For example, in a cross-sectional survey, young adults reported consuming more fast food and sugar sweetened beverages if they perceived that their family and friends also consumed these regularly. However, fruit and vegetable consumption were associated only with friends' behaviour (Pelletier et al., 2014). In other research family have also been perceived to have worse eating habits than friends but have a stronger influence on eating behaviour (Harmon et al., 2016). This suggests that close relationships with family and friends influence young adults' food intake and choices, as a result of informing their perceptions. Thus, it may be particularly important to consider the social circles that an individual has, when trying to alter misperceptions or nudge healthier eating behaviour. For young adults, this may include their friends in wider social circles, as these different groups may influence consumption of different types of food, compared to family.

While this cross-sectional evidence demonstrates that perceptions of norms can predict food intake, more longitudinal and experimental research is needed to establish the causal links between norms and their effect on food consumption, and also, whether any influence is maintained over time (Robinson, 2015). Indeed, one study has considered the longitudinal associations of high energy-dense (HED) food intake and peer descriptive norms, but found that these were only associated with participants' consumption of cakes and pastries and not sugar sweetened beverages and alcoholic beverages, after one year (Jones & Robinson, 2017). Thus, the effects of normative perceptions may be limited, and more research is needed to understand to what extent they may be a useful way of influencing food choices and consumption, particularly for healthy foods, such as fruit and vegetables. Additionally, much of the research focusses largely on adolescents and more research is needed to investigate how perceived norms and different social identities can influence adults' perceptions and food consumption. Further, as much of the cross-sectional work uses self-report measures, it would also be useful to measure the extent to which social norms affect actual intake, for both LED and HED foods. Thus, research including objective measures would be useful to ensure these conclusions are accurate.

1.3.2 Exposure to social norms: experimental evidence

Building on cross-sectional research, experimental work has used exposure to descriptive norms to experimentally manipulate perceptions and nudge healthy eating. For example, a message stating 'Most students eat more vegetables than you'd expect. A lot of people aren't aware that the typical student eats over three servings of vegetables each day', increased students' own consumption of fruit and vegetables in a subsequent buffet of high and low energy-dense foods (Robinson, Fleming & Higgs, 2014). Further, exposure to descriptive norm messages conveying that students eat less junk food than they would expect, were also found to decrease students' subsequent intake of high calorie snacks (Robinson, Harris, Thomas, Aveyard & Higgs, 2013). This suggests that exposure to different norms about what others actually do (descriptive norms) can result in the corresponding behaviour, including blunting intake of energy-dense foods, as well as increasing fruit and vegetable consumption. In addition, there may also be compensatory effects of descriptive norm messages. For example, exposure to a message about other students' fruit and vegetable consumption not only increased participants' own fruit and vegetable intake, but the same message also reduced intake of energy-dense snacks (Robinson et al., 2014). This suggests that descriptive norms, particularly about others' fruit and vegetable consumption, may be highly useful in simultaneously nudging different aspects of healthy eating behaviour.

Experimental studies also suggest that the type of norm used to nudge healthy eating behaviours may result in varying effects. As outlined above, much of the research has focussed on descriptive norms, which appear to have a robust effect on intended and actual food intake (e.g. Robinson, Harris et al., 2013; Robinson et al., 2014; Stok et al., 2012; Thomas et al., 2017). However, the evidence is more mixed for injunctive norms. For example, messages relaying that other students *should* eat more fruit (injunctive norm message) not only had no effect on fruit consumption but also decreased intentions to consume fruit, whereas the descriptive norm message was found to positively affect fruit intake intentions (Stok, de Ridder et al., 2014). This may suggest that being told how one should behave could result in resistance, possibly because it is more suggestive and does not give individuals the sense of choice about whether to follow this behaviour, compared to more factual descriptive norms (Stok, de Ridder et al., 2014). However, injunctive norms have predicted healthy food choices (Mollen et al., 2013) as well as snacking in specific situations (Schüz et al., 2018), suggesting instead that the effects of injunctive norms may depend upon the context in which participants' food choice takes place, and may warrant further investigation.

Additionally, laboratory research has found that exposure to other norms including liking norms, or perceptions about others' liking of a food, resulted in higher broccoli consumption, compared to descriptive or injunctive norm messages (Thomas, Liu, Robinson, Aveyard, Herman & Higgs, 2016). However, few other studies have considered liking norms and so further research is needed to replicate and ensure these conclusions are valid. Thus, considering the type of norm used and including designs which make it possible to compare the effects of different norms, especially when trying to encourage consumption of healthy foods may be particularly important, with evidence suggesting that descriptive and possibly liking norms may be most beneficial. However, these studies, which are largely laboratory-based may lack external validity and the results may not translate outside of these artificial settings.

Field studies however have utilised social norms to nudge eating behaviour in real life settings. For example, signs in a university canteen, conveying healthy descriptive norms about other students' salad consumption, encouraged students to also choose more salads compared to a control and unhealthy descriptive norm (Mollen et al., 2013,). This suggests that norm messages emphasising positive, healthy behaviours of others may be more effective in nudging healthy eating than emphasising negative ones (Mollen et al., 2013). The authors also found that a healthy injunctive norm message also resulted in more healthy choices being made compared to the unhealthy descriptive norm, however the message for an injunctive norm was 'Have a salad for lunch!' which may not actually communicate social approval of eating salads. Furthermore, in this study a substantial number of participants did not see the poster messages, thus limiting conclusions and meaning many were removed from the experimental condition. Thomas et al., (2017) extended the above study to examine whether this effect can be maintained over time, in a 6-week pre-/post-test design. During a 2-week intervention phase, posters displaying descriptive norm messages were placed in workplace canteens, conveying the vegetable purchases of other diners. These messages were found to increase the percentage of meals bought with vegetables from pre- to post-intervention, suggesting that descriptive norms can influence daily food intake and choices, even in more familiar and ecologically valid contexts, and therefore, could be used to nudge healthy eating in the real-world. However, more field studies are needed to assess whether these effects hold for longer periods of time and to compare these effects against control and other norm messages, to ensure their effectiveness.

1.4 Moderators of social norms

The influence of social norms may also be attenuated or amplified by other variables. Further, eating behaviour itself can be affected by many variables. Thus, it is necessary to consider the potential moderators of the relationship between social norms and eating behaviour, in order to be able to control for these appropriately. For example, participants' habitual consumption of foods has been found to moderate the effect of descriptive norms on vegetable consumption. Specifically, there was only an effect for those who were low habitual consumers of vegetables (Robinson et al., 2014). Similarly, low habitual consumers of vegetables ate more broccoli when exposed to liking norms (perceiving what others like), compared to low habitual consumers in the control condition (Thomas et al., 2016), suggesting that norms may have more of an effect for those who do not habitually eat lots of fruit and vegetables. It has been argued that this effect did not occur for high consumers as they perceive themselves as already behaving in line with the norm, or exceeding it (Robinson et al., 2014). This suggests that despite the type of norm used to nudge healthy eating, food intake and choice may at least partly be moderated by an individual's usual consumption of foods. Therefore, interventions aimed at encouraging healthy eating using social norms may wish to consider targeting low habitual consumers of fruit and vegetables, as these interventions may be most beneficial and effective for these individuals.

Gender also appears to affect the strength of norms on eating behaviour, with women being more affected by social influences on eating than men, especially for different types of food (Robinson, 2015). Given that studies often measure consumption of high-energy dense snacks, which carry certain social connotations, eating in line with these social norms may be more important for women compared to men and so women may be more influenced by social norms (Robinson, 2015). Additionally, adolescent boys have been reported to eat differently to adolescent girls, particularly consuming more unhealthy foods and drinks (De la Haye, Robins, Mohr & Wilson, 2010; Wouters, Larsen, Kremers, Dagnielie & Geenen, 2010). One explanation for this could be because stereotypes dictate that healthier eating, including consumption of smaller portions of low-fat foods like fruit and salad is seen as more feminine, and unhealthier larger meals such as hamburgers or high energy-dense snacks are seen as more masculine (see Vartanian, Herman & Polivy, 2007 for a review). Thus, while studies may wish to establish whether an effect occurs using only women as participants, studies aiming to replicate the effects of social norms may wish to include samples of both men and women to examine whether these effects can be generalised.

Eating style (Capperelli et al., 2009) and socioeconomic status (Hanson & Chen, 2007) have also been found to impact eating behaviour and therefore could be moderating the relationship between social norms and eating behaviour. For example, cognitive restraint was found to be higher in those following an omnivorous diet, compared to those following a vegan or vegetarian diet, suggesting that different diets may correspond to different levels of restraint (Brytek-Matera, 2020). Further, individual eating styles such as those seen in binge eating disorder have been linked to overeating in response to exposure to unhealthy food commercials, suggesting again that individual eating styles may shape the relationship between exposure to norms and eating behaviour (Egbert, Nicholson, Sroka, Silton & Bohnert, 2020). Additionally, SES was found to moderate the relationship between intake of fruit in children and other social environment factors, such as availability of fruit and social influence, so that children in the higher SES groups consumed more fruit than those in the lower SES groups (Sandvik, Gjestad, Samdal, Brug & Klepp, 2010). However, a more recent review and meta-analysis concluded that the Theory of Planned Behaviour variables were significantly and positively associated with healthier dietary behaviours, and this relationship was not moderated by individual level SES (Li, Figg & Schuz, 2019), therefore, SES may not be a consistent moderator of dietary intake when considering constructs such as self-regulation and normative perceptions of healthy eating. However, while norms do appear to have a robust effect on eating behaviour, it is important to carefully consider the role of these factors in affecting how norms impact both perceptions as well as actual food intake and choice and control for these if necessary, to understand the full effects of these variables on eating behaviour and be able to target interventions appropriately.

Another potential moderator of the effect of norms is how strong identification is with the referent group, or group whose behaviour is influential. For example, self-identification as similar to a particular group (for example, other students at the same university) and whether this group was proximal or distal to the individual (same university or same nationality), mediated the link between descriptive norms and intentions to eat vegetables in adolescents (Stok, Verkooijen, de Ridder, de Wit & de Vet, 2014). When the norm was conveyed as being proximal and so from students at the same university, this resulted in higher intentions to eat vegetables. Therefore, certain identities can make particular norms salient and more likely to be adhered to. This is in line with focus theory of normative behaviour, which suggests that norms direct behaviour when they are made salient or focussed upon (Cialdini, Kallgren & Reno, 1991). Research has also demonstrated that proximal norms, or those from closer social ties or whom we identify with strongly, may exert more influence than distal ones, or groups that we identify less with (Pelletier et al., 2015; Stok, de Vet, de Ridder & de Wit, 2016 for a review; Yun & Silk, 2011).

Further, we are more likely to adhere to a norm if we perceive the group to be relevant and perceive that it is important to fit in, and hence match to the norm (Higgs & Thomas, 2016). Indeed, research has demonstrated that traits related to social acceptance (self-esteem and empathy) predicted whether participants were likely to match their intake of sweets to that of their dyadic partner, as a means of ingratiating themselves with their partner (Robinson, Tobias, Shaw, Freeman & Higgs, 2011). Research has also demonstrated that a desire to 'fit in' with a certain social group prompted students to follow the perceived eating norms set by that social group, with students consuming more popcorn if they perceived that others from the same university, rather than another university, also had (Cruwys et al., 2012). Therefore, norms may influence food intake as a result of individuals identifying with a group and consequently adhering to the group's norm to gain their approval. Consequently, emphasising a referent group that participants can identify with may be a key aspect when thinking about how norms can be used to alter eating behaviour.

1.5 Mediators of social norm effects

While more is known about the potential factors that moderate the relationships between social norms and eating behaviour, less is known about the mechanisms through which norms operate, which can help to explain why they are adhered to. One theory about why norms may be adhered to, is that they provide a form of informational social influence, whereby they communicate what is appropriate behaviour in uncertain situations (Cialdini & Trost, 1998). As previously outlined, norms can be used to guide behaviour, for example in remote confederate studies by using environmental cues to nudge healthy choices (e.g. Burger et al., 2010) and when trying to encourage healthy eating in the laboratory, where there is a novel and specific context (see Robinson, Blissett & Higgs, 2013 for a review). On the other hand, norms may have an influence on eating behaviour through normative influence, whereby behaviour is copied because it is seen as socially approved of or accepted, or where there is a concern to ‘fit in’ with a certain group (Cialdini & Goldstein, 2004, Cialdini & Trost, 1998, Deutsch & Gerard, 1955). Therefore, it may be that these different mechanisms result in different norms being used in different situations. Descriptive norms may be more useful in uncertain or novel eating situations and used to make decisions based on what others are doing, whereas injunctive norms may be used where there is more ambiguity around social approval (Lally et al, 2011; Sharps & Robinson, 2017). Although research has started to examine this (e.g. Robinson et al., 2011), mainly in adults, there is little conclusive evidence as to the exact mechanisms underlying how norms affect eating behaviour. Understanding these mechanisms could provide more certainty in predicting when norms are likely to work and therefore aid the design of effective interventions to change eating behaviour.

While social influence variables have been examined as mechanisms of norm effects, less is known about other psychological processes that may facilitate norm effects. However, there is evidence that cognitive mechanisms, such as memory and attention may affect eating behaviour. For example, there is evidence that attentional bias may be a key factor in how we interact with food. Indeed, both healthy restrained and non-restrained eaters showed enhanced attention to food stimuli over non-food stimuli (Werthmann, Roefs, Nederkoorn, Mogg, Bradley & Jansen, 2013), demonstrating that that there may be an attentional bias towards food, across individuals with different eating styles. Further, research using reaction times and eye tracking devices has found that both individuals with obesity and normal-weight individuals attend to food images for longer than non-food images when fasting, demonstrating an attentional bias (Castellanos et al., 2009). However, when fed, individuals with obesity maintained this attentional bias for food images (Castellanos et al., 2009). This has also been supported by more recent findings, suggesting that participants showed attentional bias to high energy-dense foods and that this was heightened in disinhibited eaters (Seage & Lee, 2017). Further, inhibition has also influenced overeating, regardless of weight status (Price, Lee & Higgs, 2015). Therefore, this suggests that presenting food stimuli, such as pictures of food could result in more attention to these images, with individuals with obesity and disinhibited individuals being particularly susceptible to this. Thus, as cognitive mechanisms affect attention to food and eating behaviour in this way, it is plausible that these processes could mediate the effect of social norms on our eating behaviour.

Enhanced attention to food cues in the environment could therefore be one mechanism that affects our food choice and consumption. Further, it is plausible that if one of these cues is socially endorsed or it is perceived that others also eat these foods that they are more likely to be paid attention to, and as a result, possibly eaten. The moderating effect of attentional bias on modelling of food intake has been investigated, however it was concluded that social norms were more likely to have explained the modelling effects, rather than attentional bias (Hermans et al., 2013). Additionally, more recently, memory and attention for unhealthy social media posts was stronger than for healthy and control posts and these were also viewed for longer (Murphy, Corcoran, Tatlow-Golden, Boyland & Rooney, 2020). Additionally, adolescents favoured and attended to unhealthy posts shared by different groups, including their peers for longer, suggesting that there may be an interaction between social influences and attention (Murphy et al., 2020). However, little research has investigated the possibility that social norms may specifically operate via cognitive mechanisms, such as attention. This is important as it may be possible to influence eating behaviour via environmental cues, if social norms are found to enhance attention to these.

1.6 Social networks

Given the rapidly changing landscape for social interactions in the 21st Century, it may also be important to consider the ways that social norms about what we eat and how much we eat are communicated in the digital age. For instance, a relatively new format by which social norms about food choice and intake may now be communicated is through social media. Social media, such as social networking sites (e.g. Instagram; Facebook), have become an important part of many people's lives in the UK, with the Office for National Statistics (ONS) reporting that use of the internet for social media has increased from 45% in 2011 to 70% in 2020. Social media use is highly prevalent amongst young adults, with 97% of 16-24-year olds and 91% of 25-34-year olds using social media, compared to 34% of over 65-year olds. Of the social media platforms, Facebook is the most popular across the US and UK, with Instagram also being highly popular amongst 18-29 year olds (Statista, 2021; Pew Research Center, 2021).

Further, exposure to energy-dense foods on social media is high, with unhealthy foods comprising 75% of 107 food-related posts analysed on Facebook (Barre, Cronin and Thompson, 2016). Further out of 1001 posts by adolescents on the site Instagram, only 21% of these were of fruit and vegetables (Holmberg, Chaplin, Hillman & Berg, 2016). Providing pictures of food and serving sizes in experiments have been found to affect how much food is consumed (Versluis, Papies & Marchiori, 2015) and so it is therefore plausible that exposure to these posts on platforms such as Facebook and Instagram may be influencing perceptions about eating norms and implicitly influencing our food choice and consumption.

A few recent studies have considered the role of social media and social endorsement in affecting how we interact with food posts. Indeed, it has been suggested that the high prevalence of images displaying high calorie food and big brands mean that many images shared on social media come with personal recommendations and may have a more powerful effect than advertising (Holmberg et al., 2016). For example, adverts with a high number of likes were more likely to be interacted with and were rated higher than those with lower likes, especially by those who used social media frequently (Lutfeali et al., 2020). Advertisements on social media that were endorsed by celebrities were more favourable and produced greater arousal (Kusumasondjaja & Tjiptono 2019). Further, Kim, Lee & Yoon (2015) have also found that social norms added explanatory statistical power to their model predicting individuals' interactions with social media advertisements, suggesting that these could be critical in predicting behaviour in the social media context. Therefore, social norms may be one way in which eating behaviour may be affected by social media. Sharps, Hetherington, Blundill-Birtill, Rolls and Evans (2019) have investigated the use of a social media intervention in affecting the desired portion size of HED foods via posts displaying the norm for portion size, finding that after 2 weeks this did reduce adolescents' desired portion sizes of HED snacks, suggesting social media could be one viable way of encouraging healthier eating.

However, with the exception of Sharps et al. (2019) these studies do not directly consider how these interactions with social media affect eating behaviour. Additionally, many of these studies focus on adolescents and while this age group is most likely to use social media, the statistics show that young adults are also heavy users of social media. Further, young adults such as students are also prone to poorer eating behaviour and are more independent when it comes to food choices (Deliens, Clarys, Bourdeaudhuij & Deforche, 2014) and so it would be useful to know how social media affects this group and whether it can be used to alter not only portion sizes but also food consumption and choices.

In addition, it is possible that if norms on social media are influencing eating behaviour, that this may have consequences for body weight. Obesity has been found to cluster within social networks, suggesting that our social circles may impact on body weight (Christakis & Fowler, 2007), although the mechanisms that underpins this remains unclear. As the diets of those we are socially connected to influence our eating behaviour (Higgs & Thomas, 2016; Pelletier et al., 2014), social norms may also influence weight. Indeed, individuals on weight loss programmes whose social networks had norms that encouraged acceptance of unhealthy eating behaviour had poorer weight loss (Leahey, Doyle, Xu, Bihuniak & Wing 2015; Leahey, Kumar, Weinberg & Wing 2012). Thus, if norms are perceived as promoting the consumption of certain foods, social networks could also be influencing body weight as a consequence. Importantly, studies considering whether the effect of norms on our food intake may also affect body weight are needed, but also, how the effect of social norms on intake may vary according to the body weight of the individual.

1.7 Thesis aims

The literature to date shows that social norms can have a powerful effect upon eating behaviour, but less is known about the effects of this within a social media context, particularly given that its use is now highly prevalent. While previous research has studied the associations between norms and food consumption both cross sectionally (e.g. Lally et al., 2011) and experimentally (Robinson et al., 2014; Thomas et al., 2016), a pertinent question is whether social norms and normative perceptions relating to our wider social circles can have a similar effect on eating behaviour and food intake, beyond immediate friends and family (e.g. Pelletier et al., 2014). Thus, these kinds of cross-sectional and experimental studies are also needed to investigate the effects of our social media circles on food intake. In addition, ecologically valid methods would also be useful, to extend previous work based solely in the laboratory (e.g. Robinson et al, 2014).

Further, while the existing literature has addressed many important questions with regards to norms, there are also some key gaps in our understanding of how social norms work. For example, it is not known whether the influence of social norms can stretch beyond the time point at which food intake is measured and longitudinal work is needed to assess the extent to which social norms may have an effect. Additionally, while descriptive and injunctive norms have been studied relatively in-depth (e.g. Mollen et al., 2013; Stok, de Ridder et al., 2014; Robinson et al., 2014; Thomas et al., 2017), apart from one study (Thomas et al., 2016) less is known about more novel types of norms such as liking or frequency norms and the role they may play in predicting or affecting food intake. Finally, it is also still unknown exactly how norms work and further research is required to study the possible mechanisms behind this further.

With these points in mind, the aims of this thesis were three-fold; to study the associations between normative perceptions about social media and food intake both cross-sectionally and over time, using different and novel types of perceived norms in a singular comparative model. A second aim was to experimentally investigate the effect of norms communicated by social media on actual intake, as well as to study possible mechanisms further via experimental methods. A final and third aim was to build upon these two approaches to test whether real life social media accounts can encourage consumption of fruit and vegetables, as part of a pilot intervention, to see if it is possible to use social media to shift behaviour.

The first of these overall aims was the focus of Chapters 2 and 3, which aimed to establish whether perceptions about social media users' food consumption is associated with our own intake and BMI. Specifically, the overall aim of these studies was to examine whether normative perceptions about Facebook users predicted participants self-reported intake, both cross sectionally in Chapter 2, as well as over time in Chapter 3, to address the gap in the literature of few longitudinal studies looking at the associations between norms and intake (Jones & Robinson et al., 2016). In addition to this, both of these studies aimed to look more specifically at how different types of norms predict consumption of different food types, in a singular model, as to date research has largely focussed on the effect of descriptive norms and injunctive norms. Thus, a key and novel aim of these studies was to also see if there were associations with liking norms (Thomas et al., 2016) as well as frequency norms (Robinson et al, 2016) as despite few studies focussing on these, research does suggest they may have an association with food intake. A further aim of Chapter 3 was to investigate whether the associations with norms vary according to referent group, as research has also suggested that identifying with different groups may affect behaviour (Stok et al., 2014; Tajfel, 1986).

In addition to this, to address the second overall aim, Chapters 4 and 5 aimed to extend this cross-sectional work by investigating whether norms communicated via a different social media platform, Instagram, have an effect on actual food intake in the laboratory. The aim for these studies was to not only extend previous studies using poster message paradigms to study the effects of norms (e.g. Robinson et al., 2013; Thomas et al., 2016), but also to take advantage of the picture sharing and social validation functions of Instagram and experimentally manipulate a norm to investigate whether this affected actual intake. Chapter 5 also went on to explore how this may be different in individuals of different body weights (Leahey et al., 2015), as well as exploring possible cognitive mechanisms such as attention (e.g. Murphy et al., 2020) as a mediator of social norm effects, to investigate further the potential mediators of social norm effects experimentally.

Finally, Chapter 6 aimed to build upon the methodology of the previous chapters, to test whether a pilot social media intervention study, using real social media accounts can alter intended and self-reported consumption of fruit and vegetables, as well as HED foods. This also aimed to test possible mechanisms of this, including whether taking part in the intervention resulted in a change in consumption, via a change in normative perceptions.

In summary, this thesis aimed to investigate the extent to which social norms on social media impact food intake and consumption and some of the possible mechanisms behind this.

CHAPTER 2: Do perceived norms of social media users' eating habits and preferences predict our own food consumption and BMI?

2.1 Introduction

Previous research has established a relationship between social norms and eating behaviour. In cross-sectional work, participants' perceptions of what others eat have been found to influence their own consumption of calorific foods (Robinson et al., 2016) and fruit and vegetables (e.g. Lally et al., 2011; Pelletier et al., 2014). Experimental evidence has also shown that exposure to normative information about what others do (descriptive norms) can change participants' eating behaviour, blunting intake of energy-dense foods, as well as increasing fruit and vegetable consumption (Robinson, Harris et al. 2013; Robinson et al., 2014). However, to date this has not been considered within the context of social media and whether our perceptions about these wider social circles influence food intake. This could be beneficial as if a link is established, harnessing this information could offer novel ways to encourage healthier consumption.

Further, different types of norms may have different effects on food intake. While there is an established association between descriptive norms and food intake (e.g. Lally et al., 2011; Robinson et al., 2016), injunctive norms (i.e. what others should do or approve of doing) have been found to have negative effects on intended fruit consumption, as well as having no association with fruit, vegetable, unhealthy snack and sugar sweetened beverage (SSB) consumption (Lally et al., 2011; Stok, de Ridder et al., 2014). This could suggest that perceived injunctive norms may be less likely to influence food consumption than other norms. However, injunctive norms have predicted healthy food choices (Mollen et al., 2013) as well as snacking in specific situations (Schüz et al., 2018), suggesting instead that the effects of injunctive norms may depend upon the context in which participants' food choice take place, and may warrant further investigation.

Additionally, other perceived norms, such as perceptions that peers *frequently* consumed SSBs and sweet pastries have also predicted young adults' own consumption of these foods (Robinson et al., 2016). Similarly, liking norms, that is, suggesting that others enjoy eating vegetables, have also been shown to increase broccoli consumption (Thomas et al., 2016). This suggests that while there is little research considering the associations of these types of norms with food intake, they may be having an impact on our eating behaviour. Thus, more research is needed to investigate if such associations exist, particularly including these more novel types of norms to see if these too can predict consumption of different foods. Further, no studies to date have considered all of these perceived norms in a single model, to investigate their comparative predictive ability and understand further how they may predict the consumption of different food types.

Given the rapidly changing landscape for social interactions in the 21st Century, it may also be important to consider the ways that social norms about what we eat and how much we eat are communicated in the digital age. For instance, a relatively new format by which social norms about food choice and intake may now be communicated is through social media. Social media, such as social networking sites, have become an important part of many people's lives in the UK, with the Office for National Statistics (ONS, 2020) reporting that 70% of the population use social networking sites. Social media use is also highly prevalent amongst young adults with 91% of 25–34-year-olds and 97% of 16-24 year olds using social networking sites, compared to 34% of over 65-year olds. Of the social media platforms, Facebook is the most popular across the US and UK (Statista, 2021). According to Barre et al., (2016) 75% of 107 food-related posts analysed on Facebook were of unhealthy foods, suggesting that exposure to energy-dense foods on social media is high. It is therefore plausible that exposure to these posts on platforms such as Facebook, where there is a social context, may be influencing perceptions about eating norms and implicitly influencing our eating behaviour.

In addition, it is possible that if norms on social media are influencing eating behaviour, that this may have consequences for body weight. Obesity has been found to cluster within social networks, suggesting that our social circles may have an impact on body weight (Christakis & Fowler, 2007), although the mechanism that underpins this remains unclear. As the diets of those we are socially connected to influence our eating behaviour (Higgs & Thomas, 2016; Pelletier et al., 2014), social norms may also influence weight. Indeed, individuals on weight loss programmes whose social networks had norms that encouraged acceptance of unhealthy eating behaviour had poorer weight loss (Leahey et al., 2015; Leahey et al., 2012). Thus, if norms are perceived as promoting the consumption of certain foods, social networks could also be influencing body weight as a consequence. However, very few studies have considered the relationship between perceived eating norms, communicated via social media, and young adults' eating habits and their body weight.

In order to study the effects of perceived norms further, this study aimed to investigate whether four different perceived norms, including perceived descriptive, injunctive, liking and frequency norms, about Facebook users' food and drink consumption, predicted participants' own food and drink consumption, and BMI. It was predicted that the four perceived norms about Facebook users' consumption of fruit, vegetables, high energy-dense (HED) snacks and SSBs would positively predict participants own consumption of these foods, as well as positively predict participants' body weight (BMI).

2.2 Method

Participants

A total of 494 undergraduate and postgraduate students were recruited through a Psychology Research Participation Scheme, flyers and university mailing lists, and took part in an online survey. Adverts stated that participants should have no current or previous food allergies, diabetes or eating disorders (as this could confound dietary measures) and should be between 18-65 years old. Of the 494 participants who signed up, 83 were excluded for incomplete data (i.e. discontinuing the survey before completion), and a further 42 were excluded based on the exclusion criteria (food allergies, diabetes or eating disorders, and age) leaving a final sample of 369 (49 men and 320 women). Participants took part in exchange for course credits or entry into a prize draw for one of three £50 Amazon vouchers. The study was approved by Aston University Life and Health Sciences Committee (#1273) and conducted in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants.

Sample size

Using G*Power (3.1.9.3), with power at 80%, alpha = .05, f squared = .04 (small-medium effect size), the minimum number of participants required was 304, but to account for any exclusions/incompletes, we aimed to recruit over this number and so recruited for a period of 10 months to ensure a sufficient sample size. Similar studies have used reasonably comparable sample sizes (e.g. Lally et al., 2011; N = 264).

Design

The study used a cross-sectional design, with a regression model consisting of four predictors: perceived descriptive norms (perceived number of servings that *are* consumed by Facebook users), perceived injunctive norms (number of servings that participants perceive *should* be consumed by Facebook users), perceived liking norms (perceived *liking* of food by Facebook users), and perceived frequency norms (perceived *frequency* of consumption by Facebook users). The outcome variables were participants' own consumption of fruit and vegetables and HED snacks and SSBs, as well as participants' BMI (see 'Main analysis' section for more details). Theoretical covariates included mood and appetite and eating style as these are likely to affect participants' food consumption (as used in Robinson, Harris et al., 2013). Further, time spent on social media and affiliation with Facebook users were also included as covariates as these may determine participants' perceptions of what Facebook users consume.

Materials

Participants completed the following measures, as part of an online survey, delivered via Qualtrics. The order of these was fixed as follows, for all participants:

The Student Food and Drink Attitudes Form (SFDAF) was adapted from Thomas et al., (2016) to measure normative perceptions about Facebook users' consumption of the different foods and drink. The term 'Facebook users' was left open to interpretation to the participants, to gain insight into perceptions of Facebook users from those with and without accounts. This scale uses open-ended questions to measure perceived descriptive and injunctive norms for each food and drink. For example, '*How many servings of [vegetables] do you think a typical Facebook user [should] eat a day?*, where participants respond with a number (e.g. 3), to indicate number of servings. A Visual Analogue Scale (measured from 0, 'Not at all', to 100 'Very much') was also used to measure perceived liking norms for each food type (e.g. '*How much do you think a typical Facebook user enjoys eating vegetables*?'). To measure norms about frequency of consumption, the question *'how often do you think a typical Facebook user eats/drinks…'* was used (as in Robinson et al., 2016). Answers were rated on a 5-point scale from 'Never' (0) to 'Daily, or almost daily' (4).

Social Networking/Social media use was assessed using 9-items adapted for use with Facebook (as in Slater, Varsani & Diedrichs, 2017). This measured whether participants had a Facebook account, frequency of Facebook use (e.g. '*How often do you post a picture to your account?*'), time spent using Facebook, the types of posts made, number of accounts 'followed' and 'followed by', other social media accounts used and how much time was spent on these. Participants' responses were indicated on Likert scales, for example from 1 (Never) to 6 (Daily), or through open-ended questions.

Mood and Appetite Visual Analogue Scales (VAS) were used to assess mood and appetite. Participants were asked to indicate on a scale from 0 (Not at all) to 100 (Very much) how alert, drowsy, light-headed, anxious, happy, nauseous, sad, withdrawn, faint, hungry, full, desire to eat and thirsty they felt at the time of the study (as in Thomas et al., 2015).

The 21-item revised version of the Three-Factor Eating Questionnaire (TFEQ-21R; Cappelleri et al., 2009) measured three different forms of eating style, including cognitive restraint (e.g. 'I don't eat some foods because they make me fat'), emotional eating (e.g. 'I start to eat when I feel anxious') and uncontrolled eating (e.g. 'Sometimes when I start eating, I can't seem to stop'). Responses were measured on a Likert scale (i.e. 'definitely true', 'mostly true', 'mostly false', 'definitely false'). The TFEQ-21R is a widely used measure and has been validated in obese and non-obese samples demonstrating good psychometric properties (Cappelleri et al., 2009).

A Lifestyle Questionnaire (as used in Thomas et al., 2016) was used to obtain demographic information such as gender, age and ethnicity, as well as lifestyle habits such as dietary preferences, medical conditions, alcohol use, whether participants smoked and self-reported height and weight to calculate BMI. This information was also used to verify that participants met the study criteria.

The Short-Form Food Frequency Questionnaire (SFFFQ; Cleghorn et al., 2016; University of Leeds) measured frequency of food consumption of various food types, such as fruit and vegetables, snack foods, dairy, fresh and processed meats and fish, on a Likert scale from 'Never' (0) to '5+ times a day' (7). Along with the UFDIQ, this was used as a measure of broader dietary behaviour and to validate the shorter food frequency measure below (UFDIQ). The questionnaire has been found to be valid compared to longer food frequency questionnaires (Cleghorn et al., 2016).

The Multicomponent In-Group Identification Scale (Leach et al., 2008) was adapted to measure whether participants identify as and affiliate themselves with Facebook users. Questions (e.g. *'The fact that I am a Facebook user is an important part of my identity'*) were measured on a Likert-scale from Strongly Disagree (0) to Strongly Agree (7). These items have been found to be reliable across different identities with Cronbach's α ranging from .86 to .93 (Leach et al., 2008).

The Usual Food and Drink Intake Questionnaire (UFDIQ) as in Robinson, Harris et al., (2013) was used as a shorter food frequency questionnaire (along with the SFFFQ) to measure participants' own consumption of fruit, vegetables, HED snacks and SSBs. Usual consumption was recorded using two open ended questions (e.g. '*How many servings of [vegetables] do you normally eat a day [did you eat yesterday]?*'), participants' liking of foods was measured using Visual Analogue Scales (e.g. From 0 (*'Not at all') to 100 ('Very Much',* *how much do you like eating vegetables?*') and frequency of consumption (e.g. *'How often do you eat vegetables?'*) was measured on a 5-point Likert scale ('Never' to 'Daily, or almost daily'). The UFDIQ has been used widely in other peer-reviewed publications (e.g. Robinson, Harris, et al. 2013; 2014; Thomas et al. 2017).

Demand Awareness. Finally, participants were asked what they thought the aims of the study were using an open-ended question ('*What do you think the aims of this study were?'*).

Procedure

Participants were told that they were taking part in a study on social media and lifestyle habits. The exact aims of the study were withheld until the end of the study, in order to not bias behaviour. Participants completed the survey online using Qualtrics. After reading a participant information sheet and providing informed consent, the following measures were completed: SFAF, Social Networking Use, Mood and appetite VAS, TFEQ-21, Lifestyle Questionnaire (including self-reported height and weight), SFFFQ, Student/Facebook Affiliation Questionnaire, UFDIQ and Demand Awareness. Participants were debriefed, thanked for their time and credited or entered into the prize draw. The study took approximately 20 minutes to complete. Data collection took part from February 2018-November 2018.

Analysis

Main analysis: Multiple linear regression was used to investigate whether the four perceived norms (descriptive, injunctive, liking, frequency) of Facebook users' consumption of fruit and vegetables and HED snacks and SSBs predicted participants' own consumption of these, as well as their BMI, as outlined in the design. To create a parsimonious model and based on significant positive correlations, fruit and vegetables were combined into a single metric, as were HED snacks and SSBs. This was done for both consumption of these foods (by the participant) and perceived consumption (by the Facebook users). So, for example, the four perceived norms (descriptive, injunctive, liking and frequency) about Facebook users' fruit *and* vegetable consumption combined, were entered as predictors, and participants' consumption of fruit *and* vegetables combined, was entered as an outcome.

Data were screened for outliers for all regression analyses, VIF and Tolerance diagnostics checked, as well as semi-partial correlations for multicollinearity.

Principal component analyses: Principal component analysis (PCA) was carried out with Varimax rotation for measures of Facebook affiliation. This yielded 3 factors with eigenvalues >1, which explained a total of 67% of the variance. Factors included 'positive aspects of Facebook use' (items related to being pleased, glad, proud, feeling good, having things in common and being similar to Facebook users), 'affiliation to Facebook users' (items related to being committed to being a Facebook user, Facebook as an important aspect of participants' identity and how they see themselves, having a bond and solidarity with Facebook users and often thinking about their identity as a Facebook user) and 'similarity of Facebook users' (items related to Facebook users being similar and having things in common with each other). A PCA was also conducted on the VAS (mood and appetite). This yielded 4 factors with eigenvalues >1, which accounted for a total of 69% of the variance. Factors included 'feeling unwell' (light headedness, nausea, anxiety), 'appetite' (hunger, thirst, full, desire to eat), 'negative emotions' (sad, happy, withdrawn), where happy was reverse coded to reflect a negative state, and 'alertness' (alert, drowsy).

Covariate analysis. The following theoretical covariates were correlated (Pearson's r) with the outcome measures to determine whether they should be entered as covariates in the regression models: mood and appetite measures (VAS PCA items); eating style (TFEQ-R21 subscales); time spent on social media; and affiliation with Facebook users (Facebook PCA items). Measures were included as covariates if they significantly correlated with the outcome measure ($p < .05$).

2.3 Results

Participant characteristics

The final sample consisted of 369 participants. The mean age for the sample was 22.1 years of age, 87% (*n* = 320) were women and 13% (*n* =49) were men. Ethnic background; 48% White, 34% Asian, 9% Black, 5% mixed ethnicities and 4% 'Other'. Participants' average BMI was within a healthy range (mean = 23.7, standard deviation = 5.10), 8% had an underweight BMI (BMI <18.5), 63% had a healthy BMI (BMI of 18.5-24.9), 21% had an overweight BMI (BMI of 25.0-29.9) and 8% had an obese BMI (BMI =>30.0). Eight percent were smokers and 62% drank alcohol. For food frequency (SFFFQ), on average, participants consumed fruit and vegetables 2-3 times a week, salad once a week, crisps and sweet snacks 2-3 times a week and SSBs once a week. Measures from the SFFFQ were positively and significantly correlated with measures from the UFDIQ; i.e. frequency measures for fruit, vegetables, SSB and junk food intake (all *r*s => 0.5; all *p*s < 0.001), and measures of amount consumed for fruit and vegetables (both *r*s => 0.8; all *p*s < 0.001). Hence, UFDIQ measures were used in all subsequent analyses. For further information regarding social media use, and other measures, see Tables 1, 2 and 3.

Table 1. Frequencies and percentages for social media use

Measure	N (= 369)	Percentage (%)
Facebook Account - Yes	299	81
Facebook Account - No	70	19
*Time spent on Facebook**		
No time	22	6
Less than 10 min	85	23
10-30 mins	86	23
30-60 mins	62	17
Over an hour	44	12
*Use of other social media accounts**		
Yes	286	76
No	13	81

* Responses to both measures were for participants who said 'yes' to having a Facebook account

Table 2. Participants' consumption, perceptions, mood and eating style (mean and standard deviation)

Measure	Mean (SD)
Participants' daily consumption (servings)	
Fruit and vegetables combined	3.7 (2.0)
HED snacks and SSBs combined	2.9 (1.9)
Perceived consumption by others (servings)	
Fruit and vegetables combined	3.8 (1.7)
HED snack and SSBs combined	6.9 (2.9)
Facebook Perceptions and Affiliation	
Positive aspects of Facebook	3.2 (1.2)
Affiliation to Facebook users	2.3 (1.1)
Perceptions of Facebook users	2.9 (1.4)
VAS	
Feeling unwell	20.2 (19.0)
Appetite	51.3 (25.1)
Negative emotions	31.2 (20.7)
TFEQ-R21	
Uncontrolled eating	2.3 (0.6)
Cognitive restraint	2.6 (0.7)
Emotional eating	2.1 (0.8)

SSBs = Sugar Sweetened Beverages; HED = High energy Dense; VAS = Visual Analogue Scales; TFEQ = Three-Factor Eating Questionnaire.

Key: *Facebook Perceptions and Affiliation* (whether participants identify and affiliate with Facebook users) rated from Strongly agree (1) to Strongly Disagree (7); *VAS* (mood and appetite) rated from 0 (Not at all) to 100 (Very much); *TFEQ-R21* (eating style) rated Definitely false (1) to Definitely true (4).

Table 3. Participant characteristics for perceived consumption and participants own consumption (mean and standard deviation)

Measure	Type of norm Descriptive Mean (SD)	 Injunctive Mean (SD)	 Liking Mean (SD)	 Frequency Mean (SD)
Participants' perceived consumption by others (servings)				
Vegetables	1.9 (1.1)	4.1 (2.4)	40.9 (18.5)	3.3 (0.8)
Fruit	1.9 (0.9)	3.8 (1.4)	59.5 (17.6)	3.5 (0.7)
HED snacks	3.8 (1.7)	1.4 (1.0)	86.6 (13.8)	3.9 (0.5)
SSBs	3.1 (1.7)	1.2 (1.1)	82.9 (14.8)	3.7 (0.6)
Participants' own consumption (servings)				
Vegetables	2.0 (1.4)	-	68.4 (24.2)	4.6 (0.8)
Fruit	1.7 (1.1)	-	76.4 (21.9)	4.5 (0.8)
HED snacks	1.8 (1.3)	-	78.4 (21.7)	4.4 (0.8)
SSBs	1.1 (1.2)	-	61.1 (30.1)	3.7 (1.3)

SSBs = Sugar Sweetened Beverages; HED = High energy Dense

Key: Descriptive: how much is actually consumed; Injunctive: how much should be consumed; Liking; how much a food is liked; Frequency: how often a food is consumed

Associations between covariates, consumption and BMI

Pearson's correlations for theoretical covariates revealed that the three types of eating style (uncontrolled eating, cognitively restrained eating and emotional eating, as defined by the TFEQ) were significantly positively correlated with fruit and vegetable consumption and HED snack and SSB consumption (with the exception of cognitively restrained eating, which was negatively associated with HED snack and SSB consumption), as well as BMI (all *p*s <.01). and were therefore controlled for. None of the other measures correlated with the outcomes and were not included as covariates.

Predictors of participants' food consumption

Multiple linear regression revealed that the final models with perceived descriptive, injunctive, liking and frequency norms, as well as the three eating styles (uncontrolled, cognitive restraint and emotional eating) significantly predicted participants' consumption of fruit and vegetables, ($F(7) = 6.90$, $p = <.001$, $r = .35$, $R^2 = .12$), and HED snack and SSBs ($F(7) = 18.97$, $p = <.001$, $r = .54$. $R^2 = .29$). Perceptions of how many servings of fruit and vegetables Facebook users eat (perceived descriptive norms), as well as perceptions about how often Facebook users eat fruit and vegetables (perceived frequency norms) both significantly predicted participants' own fruit and vegetable consumption. Uncontrolled, as well as cognitive restrained eating styles, also significantly predicted participants' self-reported fruit and vegetable consumption. See Table 4.

However, for participants HED snack and SSB consumption, in the final model, only perceptions of how many servings of HED snacks and SSBs Facebook users *should* eat (perceived injunctive norms) was a significant predictor. Again, an uncontrolled eating style also significantly predicted participants' own HED snack and SSB consumption, as well as cognitive restrained eating style. See Table 4.

Predictors of participants' BMI

The regression model with the four perceived norms about Facebook users' fruit and vegetable consumption and the three eating styles significantly predicted BMI, $F(7) = 3.64$, $p = .001$, $r = .26$, $R^2 = .07$. However only emotional eating was a significant predictor of participants' BMI. The model with perceived norms about Facebook users' HED snack and SSB consumption and the eating styles also significantly predicted BMI, $F(7) = 3.82$, $p = .001$, $r = .27$, $R^2 = .07$, however, as above, only emotional eating was a significant predictor.

Table 4. Predictors of food and drink consumption, and BMI

Predictor Perception of norm / Covariate	Outcome Participants' fruit and vegetable consumption					Participants' HED snack and SSB consumption					Participants' BMI (fruit and veg norms as predictors)					Participants' BMI (HED snack and SSB norms as predictors)				
	β	SE	Sβ	95% CI Lower	Upper	β	SE	Sβ	95% CI Lower	Upper	β	SE	Sβ	95% CI Lower	Upper	β	SE	Sβ	95% CI Lower	Upper
Perception of norm corresponding to outcome variable																				
Descriptive	.22	.08	.19**	.07	.37	.06	.04	.09	-.02	.13	-.07	.19	.19	-.45	.31	-.06	.16	.12	-.28	.17
Injunctive	.05	.04	.07	-.03	.13	.35	.06	.35***	.24	.46	.04	.10	.10	-.16	.23	-.03	.17	.17	-.37	.31
Liking	-.004	.003	-.06	-.01	.003	.006	.004	.08	-.002	.01	-.001	.01	.01	-.09	.02	-.002	.01	.01	-.03	.02
Frequency/ often	.21	.08	.14**	.04	.37	.003	.12	.001	-.24	.25	.01	.22	.22	-.43	.44	.26	.37	.40	-.46	.99
TFEQ-R21 (covariates)																				
Uncontrolled eating	-.43	.20	-.14*	-.82	-.05	.39	.18	.12*	.03	.75	.34	.52	.52	-.68	1.36	.24	.55	.55	-.84	1.31
Cognitive restrained	.44	.14	.16**	.16	.72	-.69	.13	-.26***	-.95	-.44	.65	.38	.38	-.10	1.39	.70	.39	.39	-.08	1.47
Emotional eating	.23	.15	.10	-.06	.52	.23	.13	.10	-.12	.41	1.37	.39	.39***	.60	2.14	1.46	.40	.40***	.68	2.24

HED = high energy-dense; SSB = sugar sweetened beverages; BMI = Body Mass Index; TFEQ-R21 = Three-Factor Eating Questionnaire (Revised); *p <.05, **p <.01, *** p<.001

Post-hoc Mediation analysis

Given that there was no direct effect of the perceived norms on BMI in the regression models, exploratory mediation analysis was carried out to investigate if there was an indirect effect of each of the perceived norms, about Facebook users' consumption of fruit and vegetables, and HED snack and SSB consumption, on participants BMI, through participants' own consumption of these foods (see Figure 1 below for model).

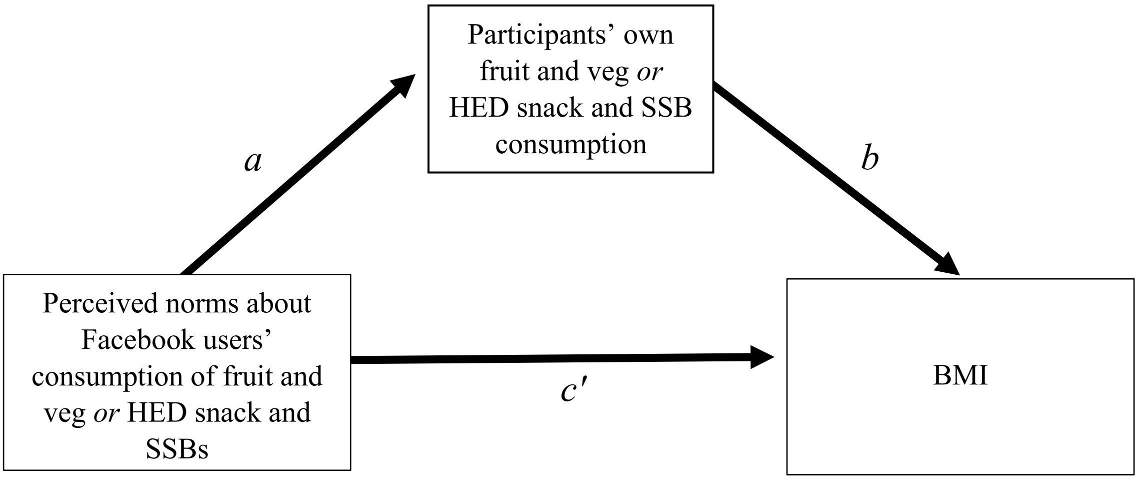

Figure 1. Mediation model of effect of perceived norms on BMI, via participants' food/drink consumption.

All analyses revealed that there was no significant mediation. To be precise, there was no significant indirect effect of the four perceived norms about Facebook users' fruit and vegetable consumption or HED snack and SSB consumption, on BMI, via participants' consumption of fruit and vegetables or HED snack and SSBs, respectively (all *p*s >.05).

2.4 Discussion

We examined whether four different perceived norms about Facebook users' consumption of fruit, vegetables, HED snack foods and SSBs predicted participants' own consumption of these foods. Our results revealed that descriptive and frequency norms about how much and how frequently participants perceived Facebook users to consume fruit and vegetables positively predicted participants' own consumption of fruit and vegetables, whereas perceived injunctive norms about what others should eat positively predicted participants' consumption of HED snack foods and SSBs. Thus, the more participants perceived Facebook users to consume fruit and vegetables, the more participants consumed themselves. Whilst the more HED snacks and SSBs they perceived Facebook users should consume, the more they consumed themselves. However, there were no associations between perceived liking norms and participants' food or drink consumption. Similarly, the four perceived norms did not predict BMI, suggesting that social media and our social networks may communicate norms about others' eating habits, which implicitly influence our own eating habits, but may not necessarily influence BMI.

As demonstrated by previous work (e.g. Lally et al., 2011; Robinson et al., 2016; Thomas et al. 2017), participants' perceptions of others' eating habits predicted their own self-reported food consumption, with participants matching their consumption to their perception of the norm. Moreover, these results suggest that norms communicating what others actually do (i.e. descriptive/frequency norms) may guide consumption of low energy-dense foods, as in previous work (e.g. Robinson et al., 2014; Thomas et al. 2017; Stok et al., 2012), whereas perceived norms relating to social approval (i.e. injunctive norms) may guide consumption of HED snack foods and beverages (e.g. Schüz et al, 2018). One possible explanation for perceived descriptive and frequency norms predicting consumption of LED foods could be that, due to the high frequency of HED food related posts (Barre et al., 2016), social media may provide less or no information about others' consumption of fruit and vegetables. This may make social media an unusual context in which to gauge eating norms for fruit and vegetable consumption (i.e. participants are less certain of *how much* and *how frequently* people are consuming fruit and vegetables, as they receive less information about this). As Higgs (2015) suggests, in unfamiliar contexts, participants tend to use descriptive norms about what others *actually* eat to guide their own consumption, because norms about what others actually do provides information that we can base our own behaviour on. Therefore, perceptions of how much and how frequently social media users consume fruit and vegetables, even if this is based on very little information, may have been most influential in predicting participants' consumption, because it is the *most useful* norm for guiding consumption of these foods in this context.

In contrast, consumption of HED snack foods and SSBs, which are typically perceived as 'unhealthy', may be more related to social endorsement and approval. Or in other words, matching consumption to the perceived injunctive norm for HED snacks and SSBs may have occurred because the act of doing so is less likely to incur a negative judgement, within a social media context, where desire for social acceptance is likely to be high (Clark, Algoe & Green, 2018). Therefore, normative information about what others *approve* of may be more useful in guiding consumption of HED snack foods and SSBs, which may have more (negative) social connotations attached to them. It is also important to note that Facebook, like many other social platforms, allow users to signal their approval with various tools (e.g. the like button). Thus, it is possible that these digital social environments are uniquely conveying approval, in a way that is different from everyday perceptions of norms among our peers. An emergent question is whether the norms we perceive in our digital social circles are more salient, or exert a greater influence, than the norms we perceive in the physical world around us? This is an important question, as the answer may also indicate whether certain environments and norms are more amenable and useful for social norm interventions to enhance healthy eating.

Taken together, these findings add to the literature to suggest that there may be variability in how norms influence food consumption. Measuring these concurrently within a single study, for the first time, provides evidence that different types of norms may selectively predict the consumption of different types of food, expanding previous evidence considering the effect of norms or types of food in isolation, or compared to other types of messages (e.g. Robinson et al. 2014; Stok et al., 2012; Lally et al., 2011). This knowledge could be used to develop and test social norm-based interventions, to specifically target the consumption of high or low energy-dense foods, through exposure to different norms via experimentally manipulated social media posts or encouraging people to follow highly liked healthy eating social media accounts. Further this evidence suggests that exposure to descriptive norms concerning fruit and vegetable consumption may present the optimum social norm intervention to enhance consumption of these foods. Similarly, exposure to injunctive norms regarding the consumption of HED snacks and beverages may be particularly effective in blunting their consumption.

Interestingly, while our hypothesis that perceived norms would positively predict participants' food and drink consumption was partially supported, perceived liking norms did not significantly predict participants' food and beverage consumption. At first glance, this seems at odds with previous research showing that manipulation of liking norms can produce an increase in vegetable consumption (Thomas et al., 2016). However, actively exposing participants to a liking norm that has been selected on the basis of appearing positive and persuasive, is clearly different to assessing passive perceptions of liking. It may also be that social approval is valued over and above perceptions of liking or enjoyment of a food, in certain contexts or with certain norm referent groups.

Unexpectedly, the four different perceived norms about Facebook users' consumption of foods and beverages did not predict participants' BMI. Further, there was no indirect effect of perceived norms on BMI via consumption (the mediator). Participants perceived their peers to consume more HED foods and drinks than they themselves did, and based on previous research (e.g. Leahey et al., 2012), it would be expected that these perceived norms might predict body weight. However, unlike this sample, who on average had a healthy BMI weight, Leahey and colleagues research was focussed on individuals with overweight/obesity, which may account for the null result here. Another explanation is that participants match their behaviour to the norm, even if these norms are momentary or within specific contexts (Schüz et al. 2018). As perceptions about Facebook users' consumption are likely to be based on posts which are constantly changing, it follows that norms on Facebook could also be momentary, if they are dependent on these posts. Therefore, while participants may shift their short-term food consumption to match these norms (explaining how these norms predict intake), BMI, which is a long-term reflection of food consumption and energy balance, may not be predicted by momentary norms. If BMI is indeed partly a long-term consequence of norms in networks (e.g. Leahey et al. 2015), then it would be useful to study whether perceptions about social media users' eating habits affect participants' dietary behaviour and BMI over time; this would provide a more robust test of whether perceived norms actually predict BMI.

Although this study used a large sample, including both men and women, and represented a variety of ethnicities, there are some limitations to consider. Firstly, the use of self-report measures means that participants' perceptions of the norm, consumption and BMI may be inaccurate or biased, though these measures are typical of this field (e.g. Lally et al., 2011; Robinson et al., 2016). Secondly, when using BMI, there are many notable caveats with this measure, such as the inability to consider percentage of body fat (Nuttall, 2015), though again, it is a widely used metric. Despite these limitations, this study is one of the first to consider whether different types of norms predict participants eating habits and BMI, in a social media context. To our knowledge, this study provides the first evidence to suggest that our wider online social circles may be implicitly influencing our eating habits via normative perceptions. Moreover, the influence of norms on intake appears to be nuanced, with theoretical implications of how and why these norms have selective predictive ability.

2.5 Conclusions

This study has demonstrated that perceived descriptive and frequency norms about what Facebook users *actually* eat predicted participants' own fruit and vegetable consumption, whereas norms relating to social approval predicted their own consumption of HED foods and SSBs. This suggests that certain social norms may be more or less influential in determining the types of food that we choose to consume, and that the norms we perceive in our social media circles predict our food choices, though further work is required to explore causality. Perceived norms about Facebook users eating habits did not predict BMI in this cross-sectional study, however, future work will consider the long-term effects that perceived norms may have on eating habits and BMI.

CHAPTER 3: Do perceived norms about social media users' eating habits and preferences predict food consumption and BMI over time?

3.1 Introduction

Different social norms have previously been found to be associated with consumption of different foods (Chapter 2). Indeed, in cross-sectional studies, participants' perceptions of what others eat have been found to influence their own consumption of calorific foods (Robinson et al., 2016) and fruit and vegetables (e.g. Hawkins, Farrow & Thomas, 2020 (Chapter 2); Lally et al., 2011; Pelletier et al., 2014). However, many of these studies only consider the effect of norms on food consumption at one time point (Robinson, 2015). While one study has considered the longitudinal associations between descriptive peer norms and participants consumption of cakes, pastries, sugar sweetened beverages (SSBs) and alcohol (Jones & Robinson, 2017), there are very few studies considering how different norms may be associated with food consumption over time, especially also considering consumption of low energy-dense foods, such as fruit and vegetables. This may be important in understanding further how social norms predict consumption of different foods and could be used to nudge healthier eating.

Given the widespread use of social media, it is now plausible that we are implicitly exposed to norms in our wider social circles, and that these influence our eating behaviour, and consequently, BMI. Previously, we demonstrated that students' perceptions of how many portions of fruit and vegetables Facebook users eat (perceived descriptive norms) predicted their own consumption of fruit and vegetables (Chapter 2). Further, perceiving that Facebook users approved of eating HED snacks and SSBs (perceived injunctive norms) predicted participants' own consumption of these foods (Chapter 2). These results were important because they demonstrated that different social norms about social media predict consumption of different foods. However, this was a cross-sectional study meaning it was not possible to assess whether these associations persisted past one time point and it would be useful to know whether these associations can be replicated to consider how social media predicts food consumption over time.

Further, while our previous study found that norms about Facebook users predicted participants' consumption, it may also be important to consider other groups outside of this to investigate whether social norms about social media users predict consumption differently to perceptions about those in the physical world. For example, as social identity theory (Tajfel, 1981) suggests, some groups are more influential to us because we can identify heavily with the individuals within that in-group (Lapinski & Rimal, 2005). Thus, they are more proximal and so may have a greater effect on behaviour. While studies have considered this within various health behaviours such as physical activity (Strachan, Shields, Glassford & Beatty, 2012) as well as eating behaviour (Cruwys et al., 2012), no studies have considered whether social media may be a unique group and whether there are differences in perceptions and behaviour in this group compared to a more general referent group, such as the general population. Thus, extending our previous paradigm, this study aimed to examine whether perceptions about Facebook users predicted food and beverage consumption differently, compared to a proposed more general referent group, such as other members of the UK population.

Additionally, our previous study found that while norms were associated with food choice and consumption, they were not associated with BMI. It was proposed that this could be due to BMI being a construct that changes over time and the previous study only measured this at one time point. Therefore, we aim to replicate these results, as well as investigate whether perceived norms do predict BMI over time.

Aims

The first aim of this study was to replicate the previous findings from Chapter 2, to see if perceived norms about Facebook users' consumption predicted participants' own consumption of fruit and vegetables, HED snacks and SSBs, but not BMI. Further, this study aimed to examine the longitudinal associations between perceptions of Facebook users' and the UK population's consumption of fruit, vegetables, HED snacks and SSBs, as well as BMI, at three time points over the course of a year. It was predicted that perceived descriptive norms for Facebook users' fruit and vegetable consumption would predict participants' own fruit and vegetable consumption and perceived injunctive norms for Facebook users' HED snack and SSB consumption would predict consumption of HED snacks and SSBs, as found in the previous study (Chapter 2). Further, as BMI is linked to food consumption over time, we hypothesised that perceived norms would not predict BMI at baseline but would predict BMI at 5 and 12 months. It was also predicted that there would be differences in how perceptions about the two referent groups predicted consumption of the different foods and beverages, for example it was expected that as we are more likely to know Facebook users personally, we may connect with them more and therefore these perceptions may better predict food consumption, however no specific hypotheses were made for this.

3.2 Methods

Participants

A total of 294 male and female participants took part in the study at time point one. Participants were recruited via a Psychology Research Participation Scheme, flyers and university mailing lists, and were invited to take part in a longitudinal study, with follow ups at 5 and 12 months. Adverts stated that participants should have no current or previous food allergies, diabetes or eating disorders (as this could confound dietary measures) and should be between 18-65 years old. Participants were also excluded if they completed the study more than once with the same details at baseline, to ensure duplicate responses by the same participants were removed. Thus, 253 participants completed the survey at baseline (0 months, T1), of which 143 also took part at 5 months (T2). The final sample at 12 months (T3) was 101. Participants took part in exchange for course credits or entry into a prize draw for one of three £50, £75 and £100 Amazon vouchers at the three time points (increased reward for each time point). The study was approved by Aston University Life and Health Sciences Committee

(#1411) and conducted in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants.

Sample size

Using G*Power (3.1.9.3), with power at 80%, alpha = .05, f squared = .10 (small-medium effect size), the minimum number of participants providing data at all time points was N = 125, but to account for any exclusions/incompletes, we aimed to recruit a total of 250 participants at T1 to account for a 50% drop out by T3.

Design

A longitudinal design, using surveys to measure key variables at 0 months (baseline), 5 months and 12 months was used. The design used a regression model, consisting of four predictors: perceived descriptive norms (perceived number of servings that *are* consumed) perceived injunctive norms (number of servings that participants perceive *should* be consumed), perceived liking norms (perceived *liking* of food), and perceived frequency norms (perceived *frequency* of consumption). Perceived norms were asked in relation to both Facebook users and members of the UK population at each time point. The outcome variables were participants' own consumption of fruit and vegetables combined and HED snacks and SSBs combined, as well as participants' BMI at each of the time points (see 'Main analysis' section for more details). Theoretical covariates included mood and appetite and baseline eating style as these are likely to affect participants' food consumption (Robinson et al., 2013). Further, time spent on social media and affiliation with Facebook users were also included as covariates as these may determine participants' perceptions of what Facebook users consume.

Materials

Participants completed the following measures at each time point, as part of an online survey, delivered via Qualtrics. The Three-Factor Eating Questionnaire (TFEQ-21R) was omitted at time point 2 and 3 as eating style is a stable construct (Cappelleri et al., 2009). The order of these was fixed as follows, for all participants:

The Student Food and Drink Attitudes Form (SFDAF) was adapted from Thomas et al., (2016) to measure normative perceptions about Facebook users and members of the UK population's consumption of the different foods and drink (see Chapter 2).

Mood and Appetite Visual Analogue Scales (VAS) were used to assess mood and appetite. Participants were asked to indicate on a scale from 0 (Not at all) to 100 (Very much) how alert, drowsy, light-headed, anxious, happy, nauseous, sad, withdrawn, faint, hungry, full, desire to eat and thirsty they felt at the time of the study (as in Thomas et al., 2016).

The 21-item revised version of the Three-Factor Eating Questionnaire (TFEQ-21R; Cappelleri et al., 2009) was used to measure cognitive restraint emotional eating and uncontrolled eating (see Chapter 2). For this sample, Cronbach's alpha demonstrated good internal consistency for all subscales: uncontrolled eating $\alpha = .88$, cognitive restraint $\alpha = .84$ and emotional eating $\alpha = .90$.

Social Networking/Social media use was assessed using 9-items adapted for use with Facebook to measure different aspects of Facebook use (as in Slater et al., 2017; see Chapter 2).

A Lifestyle Questionnaire (as used in Hawkins et al., 2020) was used to obtain demographic information and to verify that participants met the study criteria (see Chapter 2).

The Usual Food and Drink Intake Questionnaire (UFDIQ) as in Robinson, Harris et al., (2013) was used to measure participants' own consumption of fruit, vegetables, HED snacks and SSBs (see Chapter 2).

The Short-Form Food Frequency Questionnaire (SFFFQ; Cleghorn et al., 2016; University of Leeds) was used as a measure of broader dietary behaviour to validate the UFDIQ (see Chapter 2).

Visual Analogue scales (Stok, de Ridder et al., 2014) were used to measure how strongly participants identify as and affiliate themselves with Facebook users and/or as a member of the UK population. Two statements (e.g. *'I identify with my [Facebook peers]'; 'I feel a strong connection to [members of the UK population]'*) were measured on a 0 ('Not at all') to 100 ('Very Much') scale.

Demand Awareness. Finally, at T3, participants were asked what they thought the aims of the study were using an open-ended question at the end of the study ('*What do you think the aims of this study were?'*).

Procedure

Participants were invited to take part in a survey investigating social media and lifestyle habits on Qualtrics at T1. After reading the participant information and giving consent, participants completed all measures on Qualtrics and entered their email to be contacted for the next study. Participants were debriefed, thanked for their time and credited or entered into the prize draw. The precise aims of the study were withheld until the end of the last survey, so as not to bias behaviour. Each questionnaire took approximately 20 min to complete at each time point. Data collection took part from October 2018 – October 2019.

Analysis

Main analysis: Firstly, multiple linear regression was used to investigate whether the four perceived norms (descriptive, injunctive, liking, frequency) of Facebook users' consumption of fruit and vegetables and HED snacks and SSBs predicted participants' own consumption of these, as well as their BMI, at T1 (to replicate the results of Chapter 2). Secondly, multiple linear regression was used to investigate the longitudinal associations between perceived consumption norms at T1 (for both perceptions about Facebook users and the UK population) and participants' consumption, and BMI, at T1, T2 and T3. For the longitudinal analysis, only those from the replication at T1 who continued the study to T2 (n=143) were included. Participant data were linked across each time point, through their email address (which was also needed to contact participants about the second and third stages of the study). For this reason, participants were asked to enter the same email each at each time point. To create a parsimonious model, and based on significant positive correlations, fruit and vegetables were combined into a single metric, as were HED snacks and SSBs. This was done for both consumption of these foods (by the participant) and perceived consumption (by the Facebook users/UK population). So, for example, the four perceived norms (descriptive, injunctive, liking and frequency) about Facebook users' fruit *and* vegetable consumption combined, were entered as predictors, and participants' consumption of fruit *and* vegetables combined, was entered as an outcome (this also applies to HED snacks and SSB consumption). Data were screened for outliers for all regression analyses, VIF and Tolerance diagnostics checked, as well as semi-partial correlations for multicollinearity.

Principal component analyses: A PCA was conducted on the VAS (mood and appetite) measures. This yielded 4 factors with eigenvalues >1, which accounted for a total of 69% of the variance. Factors included 'negative effects' (light headedness, nausea, anxiety, sad, withdrawn, faint), 'appetite' (hunger, full (negatively associated), desire to eat), 'arousal' (alert (reverse coded), drowsy, happy reverse coded,) and 'thirsty' as a stand-alone item.

Covariate analysis: The following theoretical covariates were correlated (Pearson's *r*) with the outcome measures to determine whether they should be entered as covariates in the regression models: baseline mood and appetite measures (VAS PCA items); eating style (TFEQ-R21 subscales); time spent on social media; and affiliation with Facebook users/UK population (VAS items). Measures were included as covariates if they consistently significantly correlated with the outcome measure over 2 or more time points ($p < .05$).

3.3 Results

Replication Analysis: Predictors of Food Consumption at T1

Participant characteristics. At T1 (0 months) the sample consisted of 253 participants. The mean age of participants was 19.8 years of age. Participants' BMI on average was in a healthy weight range (mean = 23.1 kg/m^2). Ninety percent (n= 227) were women and 10% (n = 26) were men. Forty percent reported that they were Asian, 39% White, 11% Black, 6% mixed ethnic group and 4% classed themselves as 'other'. For socioeconomic status, 48% classified themselves as middle class, 30% lower-middle class, 12% middle-upper class, 10% lower class, and .4% as upper class. Thirty-one per cent of the sample also reported a family income between £25 500- £40 000, 28% between £15 500- £25 000, 26% earnt £40 000 and above and 15% earnt below £15 500. Ten percent of the sample smoked and 57% drank alcohol. As measures of the SFFFQ and UDFIQ for frequency of consumption of fruit and vegetables and HED snacks and SSBs were significantly correlated (all ps <.05), measures of the UFDIQ were used in subsequent analyses.

Covariates of participants' consumption and BMI: For the replication analysis with all T1 data, the TFEQ-21 items were included in the model because they were significantly correlated with the outcome measures, with the exception of uncontrolled eating when predicting BMI.

Regression analysis

Multiple linear regression revealed that the model with the four norms (descriptive, injunctive, liking and frequency) significantly predicted participants' fruit and vegetable consumption at T1 ($F(7) = 4.83$, $p = <.001$, $r = .36$, $R^2 = .13$). Perceived descriptive norms of how many servings of fruit and vegetables Facebook users ate, as well as how much they perceived that Facebook users liked fruit and vegetables were both significant predictors of participants' own fruit and vegetable consumption.

For consumption of HED snacks and SSBs, the model with the four norms also significantly predicted participants' HED snack and SSB consumption ($F(7) = 8.07$, $p = <.001$, $r = .44$, $R^2 = .19$). Perceived injunctive norms (perceptions of how much Facebook users approved of eating HED snacks) significantly positively predicted HED and snack consumption. Uncontrolled and cognitively restrained eating style also significantly predicted participants' own HED snack and SSB consumption.

For BMI, the models with the four norms about Facebook users' fruit and vegetable consumption and cognitively restrained and emotional eating styles significantly predicted participants' BMI ($F(7) = 3.08$, $p =.006$, $r = .27$, $R^2 = .07$), however, only the eating style measures predicted BMI. For the norms about Facebook users' HED snack and SSB consumption, the model significantly predicted BMI ($F(7) = 3.10$, $p = .006$, $r = .27$, $R^2 = .07$), however, again only the two eating styles significantly predicted BMI (see Table 5 for coefficients).

Table 5. Predictors of food and drink consumption, and BMI (Facebook perceptions).

Predictor	**Outcome**																			
Perception of norm / Covariate	**Participants' fruit and vegetable consumption**					**Participants' HED snack and SSB consumption**					**Participants' BMI (fruit and veg norms as predictors)**					**Participants' BMI (HED snack and SSB norms as predictors)**				
	β	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**	
				Lower	**Upper**				**Lower**	**Upper**				**Lower**	**Upper**				**Lower**	**Upper**
Descriptive	1.32	0.28	.39***	0.76	1.88	0.05	0.06	0.05	-0.07	0.16	-0.04	0.53	-0.01	-1.08	0.99	-0.3	0.29	-0.08	-0.87	0.28
Injunctive	-0.14	0.17	-0.07	-0.47	0.19	0.37	0.3	.30***	0.2	0.54	-0.48	0.31	-0.13	-1.08	0.13	-0.46	0.42	-0.08	-1.29	0.36
Liking	-0.03	0.01	-.16*	-0.05	-0.004	0.003	0.006	0.03	-0.01	0.01	0.009	0.02	0.03	-0.03	0.05	0.009	0.03	0.02	-0.05	0.06
Frequency	0.13	0.27	0.03	-0.41	0.67	0.09	0.17	0.04	-0.25	0.43	0.18	0.51	0.02	-0.84	1.19	0	0.85	0	-1.67	1.67
TFEQ-R21 UC	-0.01	0.34	-0.003	-0.67	0.65	0.3	0.13	.16*	0.05	0.55	-	-	-	-	-	-	-	-	-	-
TFEQ-21R CR	0.18	0.3	0.04	-0.4	0.76	-0.32	0.11	-.17**	-0.53	-0.1	1.34	0.56	0.15	0.24	2.44	1.2	0.55	.14**	-0.11	2.28
TFEQ-21R EE	0.08	0.27	0.02	-0.45	0.62	0.11	0.1	0.07	-0.09	0.31	0.96	0.43	0.14	0.11	1.81	1.1	0.43	.16**	0.25	1.94

*p < .05, **p <.01, ***p <.001; TFEQ-R21UC = Uncontrolled eating style; TFEQ-R21CR = Cognitively restrained eating style; TFEQ-R21EE – Emotional eating style

Longitudinal analysis: Predictors of food consumption and BMI over time

Participants' social media use and characteristics across the time points are displayed in Tables 6 and 7.

Table 6. Frequencies and percentages for participants' social media use.

Measure	T1		T2		T3	
	N (= 143)	**Percentage (%)**	**N (=143)**	**Percentage (%)**	**N (= 101)**	**Percentage (%)**
Facebook Account - Yes	127	89	116	19	89	88
Facebook Account - No	16	11	27	81	12	12
*Time spent on Facebook**						
No time	16	13	20	17	17	19
Less than 10 min	40	31	34	29	29	33
10-30 mins	41	32	36	31	24	27
30-60 mins	15	12	15	13	14	16
Over an hour	15	12	11	10	5	5
*Use of other social media accounts**						
Yes	123	97	114	98	87	98
No	4	3	2	2	2	2

* Responses to both measures were for participants who said 'yes' to having a Facebook account

Table 7. Participants' consumption, affiliation, mood and appetite and eating styles (mean and standard deviation).

Measure	Mean (SD) T1	Mean (SD) T2	Mean (SD) T3
Age	20.0 (4.2)	20.4 (4.2)	21.1 (4.7)
BMI	23.3 (5.4)	22.8 (3.9)	22.6 (3.8)
Participants' daily consumption (servings)			
Fruit and vegetables combined	1.8 (1.3)	1.9 (1.1)	1.9 (0.9)
HED snacks and SSBs combined	1.6 (1.0)	1.6 (1.0	1.5 (0.9)
Participants' perceived consumption by FB users (servings)			
FV Descriptive	2.0 (1.1)	2.0 (0.9)	1.9 (0.9)
FV injunctive	3.7 (1.4)	3.6 (1.3)	3.7 (1.3)
FV liking	53.8 (17.0)	51.3 (16.0)	50.8 (15.6)
FV frequency	4.4 (0.6)	4.3 (0.7)	4.3 (0.8)
HED Descriptive	3.2 (1.2)	3.3 (1.3)	3.3 (1.2)
HED injunctive	1.4 (0.8)	1.4 (0.9)	1.3 (0.9)
HED liking	85.5 (12.1)	85.7 (12.4)	87.4 (10.6)
HED frequency	4.8 (0.4)	4.7 (0.6)	4.9 (0.3)
Participants' perceived consumption by UK population (servings)			
FV Descriptive	2.4 (1.0)	2.4 (1.1)	2.4 (1.1)
FV injunctive	3.9 (1.7)	3.9 (1.3)	3.9 (1.2)
FV liking	57.5 (16.0)	59.3 (15.6)	59.0 (14.2)
FV frequency	4.5 (0.6)	4.4 (0.7)	4.6 (0.4)
HED Descriptive	3.4 (1.4)	3.2 (1.4)	3.2 (1.2)
HED injunctive	1.3 (0.8)	1.3 (0.8)	1.2 (0.8)
HED liking	85.9 (12.0)	86.5 (11.5)	86.5 (11.5)
HED frequency	4.8 (0.4)	4.8 (0.6)	4.8 (0.6)
Affiliation (VAS)			
Identification with FB	36.9 (25.8)	36.9 (26.4)	32.7 (24.5)
Connection with FB	28.2 (24.2)	27.9 (24.4)	25.7 (22.5)
Identification with UK	48.4 (21.4)	51.6 (23.8)	52.6 (22.4)
Connection with UK	40.4 (21.9)	43.7 (22.5)	44.7 (22.9)
VAS			
Negative affect	20.0 (17.7)	22.6 (20.5)	20.8 (17.0)
Appetite	46.6 (27.1)	51.1 (25.7)	43.5 (27.5)
Feeling unhappy	36.6 (19.3)	37.1 (20.7)	37.6 (21.3)
Thirst	51.9 (28.1)	53.9 (27.8)	57.1 (27.0)
TFEQ-R21			
Uncontrolled eating	2.2 (0.7)	-	-
Cognitive restraint	2.1 (0.6)	-	-
Emotional eating	1.9 (0.7)	-	-

*FV = fruit and vegetables; HED = high energy-dense; VAS = Visual Analogue Scale; FB = Facebook; TFEQ-R21 = Three Factor Eating Questionnaire-Revised (measuring eating style)

Covariates of participants' consumption and BMI: For the longitudinal analyses, TFEQ-21 item cognitive restraint and VAS PCA item thirst at T2 were included when looking at perceptions about the UK population, as well as identification measures with Facebook users when looking at perceptions about Facebook users. As measures about Facebook affiliation were highly correlated (all *r*s .7, p<.001) one composite measure was calculated for measures of identification and connection with Facebook users across all three time points. This was to avoid multiple similar covariates reducing predictive power of the model. For BMI, cognitive restraint and emotional eating style, as well as time on Facebook at T3 were included in the longitudinal models.

Regression analysis: Food Consumption

Facebook Referent Group: The model with the four norms from T1 (and covariates) significantly predicted fruit and vegetable consumption at T1 ($F(7) = 7.26$, $p = <.001$, $r = .52$, $R^2 = .28$), T2 ($F(7) = 7.23$, $p = <.001$, $r = .53$, $R^2 = .28$) and T3 ($F(7) = 5.18$, $p = <.001$, $r = .53$, $R^2 = .28$). Focussing on the norms; the perceived injunctive norm (perceived portions of fruit and vegetables Facebook users should consume) at T1 was a significant positive predictor of T1 fruit and vegetable consumption, whereas the perceived descriptive norm (perceived portions of fruit and vegetables Facebook users actually consume) at T1 was a significant positive predictor of participants' fruit and vegetable consumption at T2 and T3 (see Table 8 below, and for covariates, also).

For Facebook users' HED snack and SSB consumption, the model with the four norms from T1 (and covariates) significantly predicted participants' consumption of these foods at T1 ($F(7) = 5.71$, $p = <.001$, $r = .49$, $R^2 = .24$), T2 ($F(7) = 3.34$, $p = .003$, $r = .39$, $R^2 = .15$) and T3 ($F(7) = 3.57$, $p = .002$, $r = .46$, $R^2 = .21$). Again, focussing on the norms; the perceived injunctive norm at T1 was a significant positive predictor of participants' HED snack and SSB consumption at T1 and T2 (see Table 9 below, and for covariates, also).

UK Population Referent Group: The models including the four norms from T1 (and covariates) significantly predicted participants' fruit and vegetable consumption at T1 ($F(6) = 7.56$, $p = <.001$, $r = .50$, $R^2 = .25$), T2 ($F(6) = 4.61$, $p = <.001$, $r = .41$, $R^2 = .17$) and T3 ($F(6) = 2.21$, $p = .049$, $r = .35$, $R^2 = .13$). For norms, the perceived descriptive norm (perceived portions consumed by members of UK population) and the perceived injunctive norm at T1 (perceived approval of fruit and vegetable consumption by UK population) were significant positive predictors of participants' fruit and vegetable consumption at T1. The perceived descriptive norm was a significant positive predictor and the perceived liking norm at T1 (perceptions that the UK population like to eat fruit and vegetables) was a significant negative predictor of participants' fruit and vegetable consumption at T2. For participants' fruit and vegetable consumption at T3, the perceived liking norm at T1 was a significant negative predictor and the perceived frequency norms (how often participants perceive the UK population to eat fruit and vegetables) at T1 was a significant positive predictor.

For participants' consumption of HED snacks and SSBs the model with the four norms from T1 (and covariates) significantly predicted participants' consumption of these foods at T1 ($F(6) = 7.46$, $p = <.001$, $r = .51$, $R^2 = .26$), T2 ($F(6) = 3.98$, $p = .001$, $r = .39$, $R^2 = .16$) and T3 ($F(6) = 4.16$, $p = .001$, $r = .46$, $R^2 = .21$). At T1, the perceived injunctive norm was a significant positive predictor of HED snack and SSB consumption, but no other norms from T1 significantly predicted HED and SSB consumption at T2 or T3 (see Tables 8 and 9).

Table 8. Predictors of fruit and vegetable consumption over time.

Predictor Perception of norm / Covariate	Participants' fruit and vegetable consumption (T1)					Participants' fruit and vegetable consumption (T2)					Participants' fruit and vegetable consumption (T3)				
	β	SE	Sβ	95% CI		β	SE	Sβ	95% CI		β	SE	Sβ	95% CI	
				Lower	Upper				Lower	Upper				Lower	Upper
Facebook perceptions															
Descriptive	0.29	0.15	0.23	-0.01	0.58	0.41	0.16	.30*	0.1	0.72	0.37	0.16	.33*	0.06	0.67
Injunctive	0.19	0.08	.26*	0.04	0.35	0.14	0.09	0.18	-0.03	0.31	0.04	0.09	0.06	-0.13	0.22
Liking	-0.01	0.01	-0.11	-0.02	-0.004	-0.004	0.01	-0.07	-0.02	0.01	-0.01	0.01	-0.19	-0.02	0.003
Frequency	0.1	0.14	0.06	-0.18	0.39	0.06	0.15	0.04	-0.24	0.36	0.13	0.16	0.09	-0.19	0.45
Identification with Facebook users	0.01	0.004	.19*	0.002	0.02	0.01	0.004	.24**	0.01	0.02	0.02	0.01	0.33	0.01	0.02
TFEQ-21 CR	0.29	0.13	.17*	0.04	0.55	0.19	0.14	0.1	-0.08	0.46	-0.03	0.14	-0.02	-0.29	0.26
Thirst (T2)	-0.001	0.003	-0.02	-0.01	0.01	0.002	0.003	0.04	-0.004	0.01	-0.003	0.003	-0.08	-0.01	0.004
UK perceptions															
Descriptive	0.29	0.14	.22*	0.02	0.56	0.4	0.13	.32**	0.11	0.61	0.18	0.13	0.19	-0.09	0.44
Injunctive	0.19	0.08	.25*	0.04	0.35	0.03	0.07	0.05	-0.11	0.18	0.04	0.09	0.05	-0.16	0.23
Liking	-0.01	0.01	-0.12	-0.02	-0.004	-0.01	0.01	-.19*	-0.03	-0.001	-0.01	0.01	-.23*	-0.03	0
Frequency	0.09	0.19	0.04	-0.28	0.46	0.25	0.17	0.12	-0.1	0.59	0.49	0.22	.25*	0.05	0.93
TFEQ-21 CR	0.52	0.16	.25**	0.21	0.84	0.28	0.14	.16*	0	0.57	0.12	0.15	0.08	-0.18	0.42
Thirst (T2)	-0.003	0.004	-0.06	-0.01	0.004	0.002	0.003	0.04	-0.01	0.01	-0.001	0.003	-0.03	-0.01	0.01

*$p<.05$, **$p<.01$, ***$p<.001$; TFEQ-R21CR = Cognitively restrained eating style

Table 9. Predictors of HED snacks and SSBs over time.

Predictor **Perception of norm / Covariate**	**Participants' HED snack and SSB consumption (T1)**					**Participants' HED snack and SSB consumption (T2)**					**Participants' HED snack and SSB consumption (T3)**				
	β	**SE**	**Sβ**	**95% CI**		**B**	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**	
				Lower	**Upper**				**Lower**	**Upper**				**Lower**	**Upper**
Facebook perceptions															
Descriptive	0.10	0.08	0.12	-0.06	0.26	0.01	0.01	0.01	-0.17	0.19	0.10	0.1	0.12	-0.09	0.29
Injunctive	0.25	0.11	.21*	0.03	0.47	0.29	0.12	.23*	0.05	0.54	0.04	0.12	0.04	-0.2	0.29
Liking	0.003	-0.01	0.04	-0.01	0.02	0.01	0.01	0.09	-0.01	0.02	0.00	0.01	0.001	-0.02	0.02
Frequency	0.06	0.22	0.03	-0.37	0.49	0.05	0.24	0.02	-0.41	0.52	-0.06	0.33	-0.02	-0.71	0.59
Identification with Facebook users	-0.01	0.004	-0.13	-0.01	0.001	0.00	0.004	0.004	-0.01	0.01	-0.003	0.01	-0.05	-0.01	0.01
TFEQ-21 CR	-0.38	0.13	-.24**	-0.64	-0.12	-0.31	0.14	-.18*	-0.59	-0.03	-0.37	0.16	-.23*	-0.68	-0.06
Thirst (T2)	0.01	0.003	.22**	0.002	0.01	0.01	0.003	.19*	0.001	0.01	0.01	0.004	.35***	0.01	0.02
UK perceptions															
Descriptive	0.02	0.07	0.02	-0.13	0.16	0.11	0.08	0.15	-0.05	0.27	-0.04	0.09	-0.07	-0.21	0.13
Injunctive	0.44	0.14	.34**	0.17	0.71	0.17	0.15	0.12	-0.13	0.46	0.15	0.17	0.12	-0.18	0.48
Liking	0.01	0.01	0.1	-0.01	0.02	0.01	0.01	0.08	-0.01	0.02	-0.003	0.01	-0.04	-0.02	0.02
Frequency/ often	0.19	0.24	0.07	-0.28	0.67	0.09	0.26	0.03	-0.44	0.61	0.38	0.34	0.11	-0.29	1.04
TFEQ-21 CR	-0.38	0.13	-.23**	-0.64	-0.12	-0.32	0.15	-.18*	-0.61	-0.03	-0.39	0.16	-.24*	-0.71	-0.08
Thirst (T2)	0.01	0.003	0.15	0	0.01	0.01	0.003	0.16	0	0.01	0.01	0.004	.35***	0.01	0.02

*p<.05, **p<.01, ***p<.001; HED = High energy-dense snack, SSB = sugar sweetened beverages, TFEQ-21 CR = Cognitively restrained eating style

Regression analysis: BMI

Facebook Referent Group: The models with the four norms from T1 about Facebook users' fruit and vegetable consumption, eating styles and time on Facebook did not significantly predict BMI at T1 ($F(7) = 1.12$, $p = .36$, $r = .30$, $R^2 = .09$) but were significant in predicting BMI at T2 ($F(7) = 3.58$, $p = .002$, $r = .49$, $R^2 = .24$) and T3 ($F(7) = 3.79$, $p = .001$, $r = .50$, $R^2 = .25$). At T2 and T3 significant predictors of BMI were time on Facebook and emotional eating. For perceptions about Facebook users' HED and SSB consumption, the model significantly predicted BMI at T2 ($F(7) = 3.76$, $p = .001$, $r = .50$, $R^2 = .25$) and T3 ($F(7) = 3.95$, $p = .001$, $r = .51$, $R^2 = .26$) but not at T1 ($F(7) = 1.29$, $p = .27$, $r = .32$, $R^2 = .10$). Significant predictors of BMI at T2 and T3 were time on Facebook and emotional eating style.

UK Population Referent Group: The models with the norms about the UK populations' fruit and vegetable consumption at T1 significantly predicted BMI at T2 ($F(7) = 3.88$, $p = .001$, $r = .50$, $R^2 = .25$) and T3 ($F(7) = 4.85$, $p = < .001$, $r = .54$, $R^2 = .30$) but did not significantly predict BMI at T1 ($F(7) = 1.26$, $p = .28$, $r = .31$, $R^2 =.10$). Significant predictors of BMI at T2 and T3 were emotional eating style and time on Facebook. However, in addition the perceived liking norm was a significant positive predictor, and the perceived frequency norm was a significant negative predictor, of BMI at T3. For norms about consumption of HED snacks and SSBs in the UK population, the model with the norms at T1 significantly predicted BMI at T2 ($F(7) = 4.67$, $p = <.001$, $r = .54$, $R^2 = .29$) and T3 ($F(7) = 4.97$, $p <.001$, $r = .55$, $R^2 = .31$) but did not significantly predict BMI at T1 ($F(7) = 1.95$, $p = .07$, $r = .38$, $R^2 = .15$) . Significant predictors of BMI at T2 and T3 were emotional eating and time on Facebook (see Tables 10 and 11).

Table 10. Predictors of BMI, including perceptions about fruit and vegetable consumption.

Predictor **Perception of norm / Covariate**	**Participants' BMI (fruit and vegetable consumption norms) (T1)**					**Participants' BMI (fruit and vegetable consumption norms) (T2)**					**Participants' BMI (fruit and vegetable consumption) (T3)**				
	β	**SE**	**Sβ**	**95% CI**		**B**	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**	
				Lower	**Upper**				**Lower**	**Upper**				**Lower**	**Upper**
Facebook perceptions															
Descriptive	0.22	0.98	0.04	1.72	2.17	0.04	0.73	0.01	-1.41	1.49	0.32	0.72	0.07	-1.12	1.75
Injunctive	-0.03	0.54	-0.01	-1.1	1.04	-0.17	0.4	-0.06	-0.96	0.63	-0.28	0.4	-0.1	-1.07	0.51
Liking	0.01	0.04	0.02	-0.08	0.09	0.01	0.03	0.04	-0.05	0.07	0.01	0.03	0.04	-0.05	0.07
Frequency	0.75	1.04	0.09	-1.33	2.82	0.77	0.79	0.11	-0.78	2.31	-0.16	0.77	-0.02	-1.69	1.37
Time on Facebook (T3)	0.73	0.48	0.17	-0.22	1.67	0.84	0.35	.24*	0.14	1.54	1.13	0.35	.33**	0.43	1.82
TFEQ-21R CR	-0.001	0.87	0	-1.73	1.72	0.4	0.65	0.06	-0.89	1.68	0.32	0.64	0.05	-0.95	1.59
TFEQ-21R EE	1.03	0.74	0.16	-0.45	2.49	1.59	0.55	.30**	0.49	2.69	1.43	0.55	.27*	0.34	2.51
UK Perceptions															
Descriptive	-0.24	0.76	-0.05	1.76	1.27	-0.18	0.56	-0.04	-1.3	0.95	-0.27	0.54	0.07	-1.35	0.81
Injunctive	0.24	0.55	0.06	-0.85	1.33	0.21	0.41	0.07	-0.6	1.02	0.23	0.39	0.08	-0.55	1.01
Liking	0.06	0.04	0.2	-0.02	0.13	0.05	0.03	0.22	-0.004	0.11	0.06	0.03	.24*	0.004	0.12
Frequency	-0.58	1.28	-0.06	-3.13	1.97	-1.29	0.95	-0.15	-3.19	0.59	-1.93	0.92	-.22*	-3.76	-0.11
Time on Facebook (T3)	0.75	0.47	0.18	-0.2	1.69	0.85	0.35	.24*	0.15	1.55	1.13	0.34	.33**	0.46	1.81
TFEQ-21 CR	0.07	0.87	-0.01	-1.66	1.79	0.51	0.64	0.08	-0.77	1.79	0.45	0.62	0.07	-0.79	1.68
TFEQ-21 EE	1.03	0.47	0.18	-0.44	2.49	1.61	0.55	.30**	0.52	2.7	1.43	0.53	.27*	0.38	2.48

*p <.05, **p <.01; BMI = Body Mass Index; TFEQ-21CR = Cognitively restrained eating style; TFEQ-21 EE = Emotional eating style

Table 11. Predictors of BMI, including perceptions about HED snack and SSB consumption.

Predictor **Perception of norm / Covariate**	**Participants' BMI (HED snack and SSB norms) (T1)**					**Participants' BMI (HED snack and SSB norms) (T2)**					**Participants' BMI (HED snack and SSB norms) (T3)**				
	β	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**		**β**	**SE**	**Sβ**	**95% CI**	
				Lower	**Upper**				**Lower**	**Upper**				**Lower**	**Upper**
Facebook perceptions															
Descriptive	-0.12	0.52	-0.03	-1.15	0.92	-0.17	0.39	-0.05	-0.94	0.6	0.2	0.38	-0.06	-0.96	0.56
Injunctive	-0.35	0.68	-0.06	-1.7	1.01	-0.66	0.51	-0.15	-1.67	0.35	-0.18	0.5	-0.04	-1.18	0.82
Liking	0.06	0.05	0.14	-0.03	-0.15	0.01	0.04	0.04	-0.06	0.08	0.01	0.03	0.02	-0.06	0.08
Frequency	-0.02	2.04	-0.001	-0.41	0.67	0.79	1.52	0.06	-2.24	3.81	0.49	1.5	0.04	-2.5	3.48
Time on Facebook (T3)	0.66	0.48	0.15	-4.07	4.05	0.82	0.36	.23*	0.1	1.54	1.17	0.36	.34**	0.46	1.88
TFEQ-21 CR	0.02	0.88	0.003	-0.31	1.62	0.28	0.65	0.04	-1.03	-1.58	0.21	0.65	0.03	-1.08	1.49
TFEQ-21 EE	1.25	0.76	0.19	-0.26	2.76	1.75	0.57	.33**	-0.63	2.88	1.52	0.56	.29**	0.41	2.64
UK perceptions															
Descriptive	-0.2	0.47	-0.06	-1.13	0.73	0.31	0.34	0.11	-0.37	0.99	0.27	0.34	0.1	-0.41	0.96
Injunctive	0.64	0.99	0.09	-1.33	2.62	-0.44	0.73	-0.07	-1.89	1.02	-0.18	0.73	-0.03	-1.63	1.27
Liking	0.12	0.05	0.27	0.02	0.22	0.05	0.04	0.14	-0.03	0.12	0.05	0.04	0.14	-0.02	0.12
Frequency	-1.2	1.97	-0.07	-5.12	2.71	-1.03	1.45	-0.08	-3.91	1.85	-2.23	1.44	-0.16	-5.11	0.64
Time on Facebook (T3)	0.81	0.48	0.19	-0.14	1.77	0.98	0.35	.28**	0.28	1.68	1.17	0.35	.33**	0.47	1.87
TFEQ-21 CR	0.39	0.89	0.05	-1.39	2.16	0.76	0.66	0.12	-0.55	2.06	0.64	0.65	0.1	-0.66	1.94
TFEQ-21 EE	1.18	0.72	0.18	-0.24	2.61	1.55	0.53	.30**	-0.5	2.59	1.39	0.53	.26*	0.34	2.43

*p<.05, **p<.01; BMI = Body Mass Index; HED = High energy-dense snack; SSB = sugar sweetened beverage; TFEQ-21CR = Cognitively restrained eating style; TFEQ-21 EE = Emotional eating style

Post hoc analysis: Differences in perceptions between Facebook users and UK populations

To investigate the differences in perceptions between the two referent groups further, a 2 (referent group) x 3 (time) within-subjects ANOVA was carried out to investigate main and interaction effects between the normative perceptions of the different groups over time. For perceived descriptive norms, there was a significant main effect of referent group, ($F(1) = 66.39$, $p = <.001$, partial eta squared = .41) with participants perceiving that the UK population ate significantly more portions (mean = 2.5 portions) of fruit and vegetables than Facebook users (mean = 2.0). However, there was no significant main effect of time ($F(2) = .61$, $p = .55$, partial eta squared = .01) or interaction effect of group and time ($F(2) = .27$, $p = .74$, partial eta squared = .003). For injunctive norms, there was a significant effect of referent group ($F(1) = 34.07$, $p <.001$, partial eta squared = .26) with participants perceiving that the UK population should eat more portions of fruit and vegetables (mean = 4.0) compared to Facebook users (mean = 3.7) but no significant main effect of time ($F(2) = .55$, $p = .55$, partial eta squared = .01) or interaction between group and time ($F(2) = .10$, $p =.88$, partial eta squared = .001). For liking norms, there was a significant main effect of referent group ($F(1) = 3.74$, $p <.001$, partial eta squared = .23) with participants perceiving that the UK population like to eat fruit and vegetables more (mean = 58.3) than Facebook users (mean = 51.8) and a significant interaction between referent group and time ($F(2) = 3.74$, $p = .03$, partial eta squared = .04) but no significant main effect of time ($F(2) = .04$, $p = .97$, partial eta squared = .00). Post-hoc *t*-tests showed that participants perceived that the UK population like eating fruit and vegetables more than Facebook users at T1 ($t(142) = -2.83$, $p =.01$), T2 ($t(142) = -5.18$, $p <.001$) and T3 ($t(100) = -5.04$, $p <.001$) and that these differences significantly increased at each time point (T1 mean difference = -3.7, $p = .01$; T2 mean difference = -8.04, $p<.001$; T3 mean difference = -8.8, $p<.001$; see Table 12 for mean perceived servings of foods and beverages). For perceived frequency norms, there was a significant main effect of referent group ($F(1) = 27.46$, *p*

<.001, partial eta squared = .22) with participants perceiving that the UK population ate fruit and vegetables more often (mean = 4.6) than Facebook users (mean = 4.3) but no significant main effect of time ($F(2) = 1.47$, $p = .23$, partial eta squared = .01) or interaction between referent group and time ($F(2) = 2.95$, $p = .05$, partial eta squared = .03). For HED snacks and SSBs, a 2 x 3 within subject ANOVA showed that there were no significant main effects and no significant interactions for perceptions about consumption of HED snacks and SSBs between groups or over time (all *p*s > .05). See Table 12 for means.

Table 12. Differences in perceptions of fruit and vegetables and HED snacks and SSBs over time (means and standard deviations).

Perceived norms	**Fruit and vegetable consumption (N = 101)**						**HED snack and SSB consumption (N= 101)**					
	Facebook			**UK population**			**Facebook**			**UK population**		
	M (SD)			**M (SD)**			**M (SD)**			**M (SD)**		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Descriptive	2.1 (0.9)	2.1 (0.9)	1.9 (0.9)	2.5 (1.0)	2.5 (1.1)	2.5 (1.1)	3.3 (1.9)	3.3 (1.3)	3.2 (1.2)	3.5 (1.5)	3.3 (1.2)	3.2 (1.8)
Injunctive	3.9 (1.4)	3.7 (1.3)	3.7 (1.3)	4.1 (1.4)	3.9 (1.3)	3.9 (1.2)	1.4 (0.9)	1.4 (0.8)	1.3 (0.9)	1.3 (0.8)	1.3 (0.8)	1.2 (0.7)
Liking	53.6** (16.3	51.1*** (15.9)	50.8*** (15.6)	56.9** (15.6)	58.9*** (16.1)	59.0*** (14.2)	85.5 (11.5)	86.2 (11.8)	87.4 (10.6)	86.1 (11.3)	86.3 (11.6)	86.2 (12.6)
Frequency	4.4 (0.6)	4.3 (0.7)	4.3 (0.9)	4.6 (0.5)	4.5 (0.6)	4.6 (0.4)	4.9 (0.3)	4.8 (0.5)	4.9 (0.3)	4.9 (0.3)	4.9 (0.3)	4.9 (0.4)

$^{**}p < .01$, $^{***}p < .001$; HED = High energy-dense snack; SSB = Sugar sweetened beverage**; Note:** differences are also significant ($p<.05$) for overall means for fruit and vegetable consumption across time points, for each referent group.

Mediation analysis

Given that there was no direct effect of the perceived norms on BMI in the majority of the regression models and to investigate further the effects between perceived liking and frequency norms of the UK population and BMI, exploratory mediation analysis was carried out to investigate if there was an indirect effect of each of the perceived norms, about Facebook users' and the UK populations' baseline consumption of fruit and vegetables at T1, and HED snack and SSB consumption, on participants' BMI at T1, T2 and T3, through participants' own consumption of these foods at T1, T2 and T3 (see Figure 2 below for model).

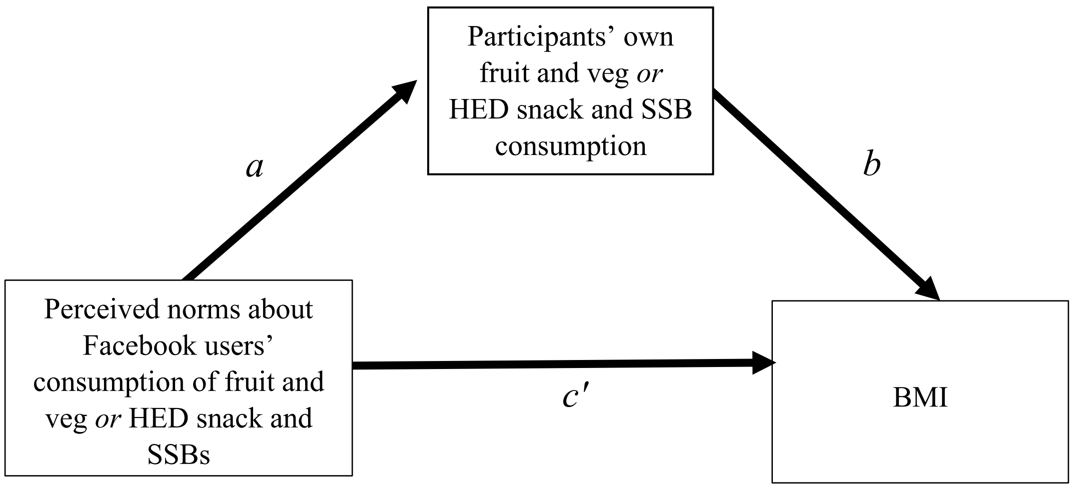

Figure 2. Mediation model of effect of perceived norms on BMI, via participants' food/drink consumption.

Analyses revealed that there were no significant indirect effects of any of the four perceived norms about Facebook users' or the UK population's fruit and vegetable consumption or HED snack and SSB consumption, on BMI, via participants' consumption of fruit and vegetables or HED snack and SSBs across the time points (all *p*s >.05).

3.4 Discussion

This study aimed to examine whether perceptions about Facebook users' and the UK population's fruit, vegetable, HED snack and SSB consumption predicted participants' own consumption over three time points, across one year. Replicating the findings from Chapter

2 and supporting our hypothesis, at T1 perceived descriptive norms (perceptions of how many portions Facebook users eat), predicted fruit and vegetable consumption, and perceived injunctive norms (perceptions about the number of portions Facebook users should eat) predicted HED snack and SSB consumption. As hypothesised, this was also true over time, with perceived descriptive norms at T1 predicting fruit and vegetable consumption and perceived injunctive norms at T1 predicting HED snack and SSB consumption for both referent groups over time. However, contrary to our hypothesis, liking norms about the UK population were also significant predictors of fruit and vegetable consumption, across time-points. Further, contrary to our hypotheses, perceived norms did not predict BMI over time for either referent group.

As with previous research (Robinson et al., 2014; Thomas et al., 2017), norms communicating what others actually do (perceived descriptive norms) predicted consumption of fruit and vegetables (i.e. LED foods), with participants matching their own consumption of fruit and vegetables to what they perceived others consumed. As before, the results from the large T1 sample replicate the findings in Chapter 2 that perceived descriptive norms predicted participants' consumption of fruit and vegetables. However, in addition, results from the longitudinal analysis show that this translates to predicting consumption over time, suggesting that descriptive norms, or perceptions about the number of portions others eat *consistently* predict consumption of LED foods, over the course of a year, for both referent groups. An explanation for this could be that it is clear that fruit and vegetable consumption is desirable and that a 'healthy' diet is approved of, however, it is less clear what others are actually eating in terms of fruit and vegetable consumption. Thus, it may be that when there is discordance or uncertainty in perceptions about what should be eaten and what is eaten, the descriptive norm, or the norm that provides us with information about what others are actually doing (i.e. informational social influence) becomes salient and thus influential. Indeed, this has also been found in previous research, where participants matched their choices to those they believed others had made (Burger et al., 2010). These results are important, as together they could suggest that descriptive norms are a reliable and consistent way of predicting behaviour, particularly for consumption of LED foods, with the potential to use this knowledge about these perceptions to understand and predict dietary choices into the future. Further, this means that these perceptions could also be amenable to change, giving potential targets for interventions, such as nudging food consumption towards healthier choices.

Further, as with the results from Chapter 2, perceived injunctive norms about how many portions of HED snacks and SSBs should be eaten by the different referent groups, but not descriptive norms, also predicted consumption of HED snacks and SSBs, in both the replication and longitudinal analyses. This builds upon the findings by Jones and Robinson (2017), who found that descriptive peer norms predicted consumption of HED foods, however, the present study suggests perceptions around *approval* may also be important in predicting consumption of these foods too. Although, in the present study this was more consistent across time for perceptions about Facebook users than members of the UK population, suggesting that we may be more likely to match our consumption of these foods in accordance with what we think social media peers approve of, possibly because such foods may come with negative connotations and desire for social approval is high in a social media environment (Clark et al., 2018). In addition, we may be more likely to know those in our social media circles personally and so if it is perceived as the norm for close others whom we identify with to consume a food, then perceptions about this behaviour may be more influential (Tajfel, 1986). However, we do note, that HED snack consumption was not predicted at T3 by perceived injunctive norms for either referent group, suggesting that while perceived injunctive norms may predict HED consumption over time, this association may not be as stable as that between perceived descriptive norms about Facebook users and fruit and vegetable intake.

This study also demonstrated that there are some associations between norms and consumption of LED foods which, however, seem specific to referent group. Extending our previous finding that perceived descriptive norms about Facebook users' fruit and vegetable consumption predicted participants' fruit and vegetable consumption (Chapter 2), in this study, participants' fruit and vegetable consumption was also predicted by perceived liking, injunctive and frequency norms about the UK population over the three time points. One explanation could be that for other norms (apart from descriptive norms) to predict LED consumption is dependent upon referent group. This is also supported by post-hoc analyses, which showed that there were significant differences in perceptions about fruit and vegetable consumption between the two referent groups, but not perceptions about HED snacks and SSBs. This therefore may explain why different norms for the two referent groups predicted fruit and vegetable consumption, and not HED and SSB consumption, as participants matched their consumption to the perceptions of the norm for each group over time. Indeed, as put forward by social identity theory, identifying heavily with individuals in a group makes their behaviour more influential. Thus, it would make sense that norms may be followed if they are similar to those of individuals that participants identify with. Here, contrary to expectations, affiliation was stronger with members of the UK population, compared to Facebook users. This suggests that for this sample, that Facebook may not form part of participants' in-group identity, or they may not have high collective self-esteem as a Facebook user (the strength of connection to a group or how positively they view it; Tajfel & Turner, 1986) compared to the UK population and so, perceived in-group norms about UK members may be more influential in predicting behaviour. Thus, it would follow that because participants perceived not only that members of the UK eat more fruit and vegetables, but that they approve of and like eating them too, that norms denoting approval for this group, but not Facebook users', were also likely to predict fruit and vegetable consumption.

Therefore, this study suggests that social media predicts food consumption in a different way to perceptions about a more general referent group, particularly for fruit and vegetable consumption. These differences appear to suggest that our social media circles could be highly influential in affecting this and that the differences in norms communicated on Facebook are pervasive and unique, with perceived descriptive norms and informational social influence consistently predicting consumption of LED foods and perceived injunctive norms consistently predicting consumption of HED foods over time. Interventions may benefit from harnessing social media and incorporating this knowledge to potentially try to nudge food consumption by encouraging this group to promote healthy, balanced meals, including LED foods as posts, or encouraging the use of social media to follow 'healthy eating' accounts to encourage consumption of LED foods.

In line with previous research and contrary to our hypotheses, norms in the regression model about Facebook users did not predict BMI over time (Hawkins et al., 2020). This may demonstrate that BMI is a stable construct and that perceptions about what others eat on social media do not influence BMI over time. However, perceptions about the general population's liking and frequency of consumption of fruit and vegetables did predict BMI, suggesting instead that norms surrounding food consumption may be an influential factor in predicting BMI, dependent upon referent group. Again, this could be because this sample identified with the UK population more so than with Facebook users and so these normative perceptions were more influential. This does however suggest that, at least at the point of measurement, norms about social approval may predict BMI via fruit and vegetable consumption.

Although, this study has extended previous research, reporting that norms do predict consumption over time, there are some limitations. While an initially large sample was obtained at T1, due to the longitudinal nature of this research these numbers significantly reduced over the course of the study, meaning that these results should be interpreted with some caution. However, there were no significant differences on key participant characteristics (age, BMI, SES, gender, smoke, alcohol) between those who completed the study and those who did not. Further research, retaining larger samples would be useful to test if these longitudinal associations can be replicated.

3.5 Conclusions

The present study has demonstrated that perceived norms about Facebook users and the UK population's consumption predict consumption of fruit and vegetables and HED snacks and SSBs over time. Replicating our previous results, social media appears to be a unique environment where perceptions about what others eat consistently predict fruit and vegetable consumption and perceptions of what others should eat influence consumption of HED snacks and SSBs over time. In contrast, perceptions denoting approval and liking of a more general group who we identify with may predict consumption of fruit and vegetables over time. Thus, interventions may wish to utilise this knowledge to inform interventions aiming to nudge food consumption towards healthier choices. Perceived norms about Facebook users did not predict BMI, how perceiving that the general population likes and frequently consumes fruit and vegetables did, although causality cannot be inferred. Future work will examine the effects of social media on actual food consumption.

CHAPTER 4: Does exposure to socially endorsed food images on social media influence food intake?

4.1 Introduction

Previous research has demonstrated that normative perceptions can influence eating behaviour (Ball et al., 2010; Pelletier et al., 2014), as well as the cross-sectional studies in the previous Chapters demonstrating that normative perceptions about social media users predicts the type of food consumed (Hawkins et al., 2020, Chapter 2). In addition, laboratory studies have demonstrated that exposure to social norms can increase actual consumption of LED foods and decrease consumption of HED foods (Robinson et al., 2014). However, these studies were context specific and less is known about whether exposure to social norms regarding our wider social circles, such as those on social media, can affect actual food intake. Thus, further experimental work is needed to establish the causal links between these variables, to test whether norms about social media have an effect on actual eating behaviour.

A crucial and growing intersection for social norms and eating behaviour is social media. In the current digital age, use of social media platforms has increased dramatically. Sites such as Facebook and Instagram are among the top five most popular social networking sites worldwide (Statista, 2021) and host an abundance of food posts, particularly of HED foods (Barre et al., 2016; Holmberg et al., 2016). With its focus on image sharing, a recent study reported that out of 1000 images on Instagram, up to 70% were images of HED food and only 21% of LED foods (Holmberg et al., 2016), making it an ideal platform to study how these images may affect our own eating behaviour. While the studies in Chapter 2 and 3 focussed on Facebook as a social media platform, to examine more general perceptions of social media users' food consumption, Instagram focusses solely on image-sharing. Thus it is plausible that these images, as well as other functions such as 'likes' communicate norms, which may be different to other types of posts available through Facebook. Further, many food posts and photos also include certain social contexts, such as eating with friends or in restaurants and so posts on Instagram may communicate norms around foods relating to context (Qutteina, Hallez, Mennes, De Backer & Smits, 2019). It is therefore important to examine how Instagram and this 'image-sharing' version of social media may affect actual food intake more directly.

In addition, sites such as Instagram enable sharing of pictures, as well as possible social validation functions, such as liking and commenting on these, which also communicates social endorsement. Some evidence has found that these social validation methods have no effects on credibility and persuasiveness of content (Hamshaw, Barnett & Lucas, 2018). However, this was used for those gathering information on food hypersensitivities and so this may be different for more generalised groups and social media usage. For instance, food adverts on Instagram with a medium or high number of likes (1000 - >10,000) were rated and engaged with more by adolescents, suggesting that others' explicit liking of foods on posts and the social functions these platforms offer, may influence behaviour (Lutfeali et al., 2020). Further, it has been found that personal norms and subjective norms (what others think I should do) affected how users interacted with adverts on Facebook via likes and comments (Kim et al., 2015). More specifically, we have also previously found that different perceived norms about Facebook users' eating habits predict self-reported food consumption of LED and HED foods differentially (Chapters 2 and 3) with descriptive norms predicting consumption of healthier foods. Social media therefore provides a new method of communicating norms about eating; our online social networks suggest what others eat, through pictures (descriptive norms), as well as what others enjoy eating via likes on social media posts (liking norms). Thus, it may be possible to take advantage of social validation methods to examine whether advocating certain foods can encourage healthier choices. Indeed, priming a descriptive social norm has been found to encourage users' attitude for creating food posts of healthy rather than indulgent foods (Coary & Poor, 2016), but no research to date has considered how experimentally manipulating social endorsement on social media can influence our actual food consumption.

One study has considered whether social media can affect the portion size of HED snack food consumption (Sharps et al., 2019), however further research is required to investigate the effect of social norms conveyed via social media on actual consumption of LED and HED foods. As social validation appears to be key in how social norms online may work (Guadagno & Cialdini, 2013; Harrow et al., 2018; Lutfeali et al., 2020), research investigating whether altering the numbers of likes can affect actual food consumption is important for determining if and how social media may influence eating behaviour.

Therefore, the present study aimed to test whether socially endorsed images of LED foods, HED foods, and interior design (as a control), in the style of Instagram posts, affected how much and what participants chose to consume. It was hypothesised that those who viewed socially endorsed images of LED foods (compared to control or HED foods) would consume more grapes, whereas those viewing socially endorsed HED foods (compared to control or LED foods) would consume more cookies.

4.2 Methods

Participants

Participants were undergraduate and postgraduate students, with a mean age of 20.9 years (SD = 4.02) who were recruited via posters or through the Aston University Psychology research participation system, where undergraduate students take part in research as part of their course. An opportunistic sample of 202 women from Aston University (Birmingham, UK) consented to taking part, however due to exclusions (see sample size section), only 169 were included in analyses. Participation was in exchange for course credits, or entry into a prize draw to win a £50 Amazon voucher. Ethical approval was granted by Aston University Life and Health Sciences Ethics Committee (#1263) and carried out in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants. Data collection took part from April 2018 – February 2019.

Sample size

Sample size was determined via power analysis (G-Power 3.1.9.2); to achieve significant main effects, with power set at 0.80, $\alpha = 0.05$ and $f = 0.25$, a minimum of 159 participants were required. We intended to recruit higher than this number to account for incomplete data provided by participants.

From the 202 participants who consented and took part, 33 were excluded, or their data removed due for the following reasons: current or previous history of eating disorder, food allergy or diabetes, not aged 18-65, having eaten <2 hours before the study, being a smoker (as this can impact taste/appetite), not consuming any food from the buffet, or correctly guessing the aims of the study. Only women were used in this study, as they are more likely to be affected by social influences than men (Robinson, 2015). Hence, 169 women successfully completed the entire study and were included in all analyses (control condition n = 57; LED condition n= 54; HED condition n= 58).

Design

A between-subjects design was used, with one factor: socially endorsed image, consisting of three levels: Control images (interior design), LED food images and HED food images. All participants were exposed to all images, but in their condition, the specific image set that was 'socially endorsed' had substantially more 'likes' (e.g. a participant in the control condition, saw all three sets of images, however, the control images appeared to have disproportionately more 'likes'). For good experimental control, all participants were shown all images so that they had the same experience apart from the manipulation and so that it was possible to make inferences about the effect of number of likes, unconfounded by exposure to different images. The dependent variables included: participants' total food intake (in grams and calories) and relative consumption of LED food (proportion of LED food consumed out of total intake) in both grams and calories.

Materials

The experiment was conducted using the online survey platform Qualtrics and comprised a series of questionnaires, along with the experimentally manipulated images, and a food buffet, presented in the order below:

Lifestyle Questionnaire: this was included to measure sample characteristics and exclude participants based on study criteria (e.g. smokers; Thomas et al., 2016; see Chapter 2).

Visual Analogue Scales (VAS): this scale assessed baseline, post-manipulation and post-buffet mood and appetite, to assess whether these changed throughout the study and needed to be controlled for in the main analyses (see Chapter 2 for details). Cronbach's for all subscales ranged from .64 - .85, so in an acceptable to good range.

Social Networking Use: This scale used 9 items that assessed Instagram and other social media use, to investigate whether this needed to be controlled for (Slater, Varsani & Diedrichs, 2017; see Chapter 2 for details). This questionnaire is yet to be validated.

Instagram Task: Participants were shown three sets of fictitious Instagram posts containing 20 LED food images, 20 HED food images and 20 control images (interior design). These were presented one at a time, in a randomised order. A VAS item was administered below each image, asking participants to rate how much they liked each one 0 (Not at all) to 100 (Very much). After completing the VAS they would proceed to the next image. Participants saw all 60 images, however, in order to induce a perceived norm for a particular set of images, one of these sets was 'liked' more than the other two sets of images (e.g. in the HED condition, the HED food posts appeared to receive substantially more 'likes' - see Figure 3). Images were piloted with a separate sample of participants from the same university (n=28) prior to the present study, to confirm that the images could be correctly identified as LED, HED or control images, by a significant majority of participants, which they were.

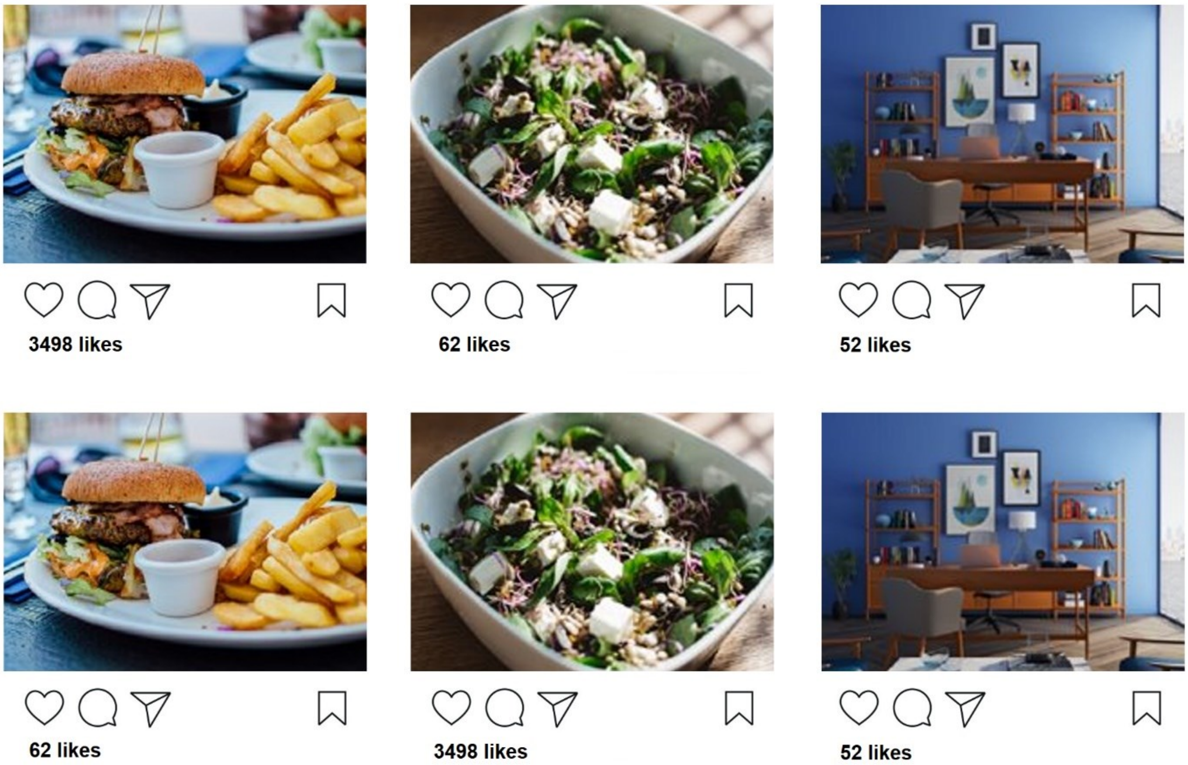

Figure 3. Example of socially endorsed images.

The top row illustrates how posts in the HED condition would appear to be the most 'liked' and the bottom row illustrates how posts in the LED condition would appear to be the most 'liked', by manipulating the number of 'likes'.
Images via Pexels (Creative Commons License).

Food buffet: this was provided to participants consisting of grapes (400g/264kcal per bowl) and cookies (200g/950 kcal per bowl); the latter were broken up into 4-6 pieces each, to make it difficult for participants to monitor their intake. These foods were chosen as they were palatable snack foods for participants and generally matched in terms of size once the cookies were broken up. The two bowls were filled equally so that they were matched in terms of visual presentation. All food was purchased from Sainsbury's plc. Each food was weighed (in grams) before each testing session, using digital scales and again after each testing session, to measure how much participants had consumed of each snack after viewing the images (as used in Robinson, Harris et al., 2013; Robinson et al, 2014; Thomas et al., 2016).

Three Factor Eating Questionnaire-R21 (TFEQ-R21): measured uncontrolled eating, cognitive restraint and emotional eating and was included to account for any effects dietary behaviours may have on participants eating behaviour Cappelleri et al., 2009; see Chapter 2).

The Usual Food and Drink Intake Questionnaire*:* measured participants' own habitual consumption, and liking of fruit, vegetables, energy-dense snack foods and sugar sweetened beverages (Hawkins et al., 2020; see Chapter 2). This was included as part of the randomisation checks and to check whether this should be controlled for. It is yet to be formally validated but measures used (e.g. combining fruit and vegetable consumption) were significantly correlated (r = .3, p<.001).

Demand and manipulation check*:* to complete the survey, participants were asked what they thought the purpose of the study was (demand check), using an open-ended response. Participants were also asked which set of images they believed had the most likes, as a manipulation check.

Height and weight*:* height (in metres) and weight (in kilograms) was recorded by the researcher using a stadiometer and digital weighing scales, in order to calculate BMI (kg/m^2).

Procedure

Participants were told that they were taking part in a study investigating the use of Instagram and Lifestyle. The true aims of the study were withheld until the end, in order not to bias behaviour. Participants were asked to attend a laboratory session and complete the majority of the study via Qualtrics on a computer. After reading a Participant Information Sheet and providing informed consent, they completed the following: Lifestyle Questionnaire, baseline VAS, UFDIQ and the social networking use questionnaire. Participants were then shown the randomised Instagram-style images, depicting the three different types of image (HED and LED foods and interior design as a control) and asked to rate how much they liked each image, one by one. They then completed the post-manipulation VAS. Two bowls of snack foods (one containing grapes, one containing cookies) were presented and participants were told that they could help themselves to these as a reward for taking part, and as a break in the study. The following measures were then administered: post-buffet VAS, TFEQ-R21 and demand awareness questionnaire. Participants' height and weight were then measured to calculate BMI and they were fully debriefed and thanked for their time. Each session took no longer than 35 minutes (see Figure 4 for an overview of the experimental time course).

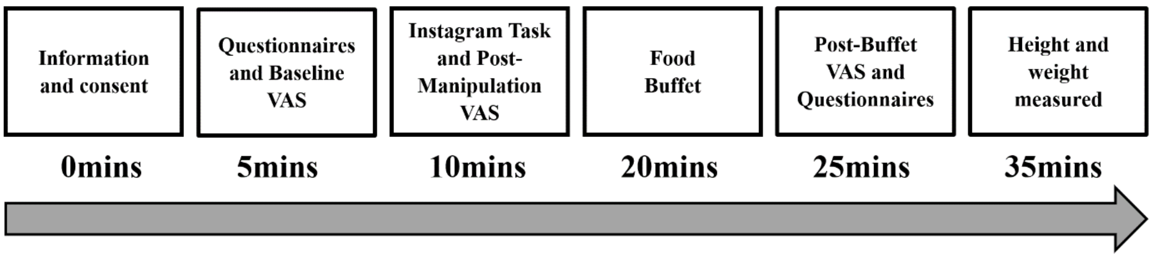

Figure 4. Time course of key procedural elements.

Analysis

Main analysis: One-way ANOVA was used to examine differences in consumption of each food (grapes and cookies, separately), and also, the relative consumption of the LED snack food (i.e. percentage of total intake that was derived from consuming grapes) between the 3 conditions. Planned t-tests were used to follow-up any significant main effects. Analyses were applied to grams consumed (to examine volume) and calories consumed (to examine the energy), separately. Finally, baseline appetite, a key variable that predicts consumption, was also controlled for in these analyses (entered as a covariate). Hypotheses were defined *a priori* before data collection, along with the above analytic strategy.

VAS: In order to analyse the mood and appetite data and check whether any factors should be covaried for, a principal components analysis (PCA) with Varimax rotation was carried out on the VAS items (mood and appetite). This yielded 3 factors with eigenvalues >1, which accounted for a total of 63% of the variance. Factors included 'Feeling Unwell' (alert (reverse coded), drowsy, light headedness, nausea, faint, withdrawn), 'Appetite' (hunger, thirst, full (reverse coded), desire to eat), 'Feeling Unhappy' (sad, happy (reverse coded), anxious). Once factors were identified, aggregate scores for each dimension were computed, inverting scores for items where relevant.

Additional covariate analysis: As planned, additional analyses were also carried out to check for possible covariates that needed to be controlled for and randomisation checks. For this, one way-ANOVA was used to investigate any differences in participant characteristics and eating styles (TFEQ) across conditions. A 3 (condition) x 3 (time: baseline, post-manipulation, post-buffet) mixed ANOVA was carried out for each VAS factor produced from the PCA (above) to investigate differences across the sample and whether any of the mood and appetite factors should be included as covariates. Chi-square analysis was used to examine baseline social media usage between the conditions as a potential covariate. Finally, a 3 (condition) x 3 (image type) mixed ANOVA was used to compare the liking ratings for the different images across the conditions, to examine if the manipulation was successful and if liking ratings of the images reflected the number of likes on the Instagram images. Covariates were included where they significantly correlated with both outcome measures.

4.3 Results

Randomisation checks

The following variables were theoretical covariates or checked to investigate differences across conditions and those that needed to be controlled for.

Participant characteristics. Participant characteristics were analysed by condition, using one-way ANOVA. There was no main effect of condition for: age, BMI, TFEQ-R 21 subscales, typical daily habitual fruit and vegetable consumption, vegetable liking and typical daily HED food consumption or liking (See Table 13).

Table 13. Means and standard deviations for baseline characteristics split by condition.

Measure	All participants M (SD) *N* = 169	Control Condition M (SD) *n* = 57	LED Condition M (SD) *n* = 54	HED Condition M (SD) *n* = 58	*P* Value
Age	23.2 (4.4)	21.5 (5.1)	20.7 (2.9)	20.7 (3.8)	0.393
BMI	20.9 (4.0)	23.3 (4.4)	23.4 (3.8)	22.9 (4.9)	0.837
TFEQ-21R UC	2.4 (0.5)	2.3 (.5)	2.3 (.5)	2.4 (.6)	0.929
TFEQ-21R CR	2.1 (0.6)	2.1 (.6)	2.1 (.7)	2.0 (.6)	0.616
TFEQ-21R EE	2.0 (0.7)	1.9 (.8)	1.9 (.8)	2.1 (.7)	0.509
FV consumption	3.4 (1.8)	3.2 (1.7)	3.8 (2.1)	3.3 (1.6)	0.268
Vegetable liking	66.2 (27.0)	64.8 (30.0)	71.3 (24.6)	63.0 (26.0)	0.232
Fruit liking	81.7 (20.6)	81.3 (23.5)	87.7 (16.4)	76.4 (19.9)	0.013
HED snack consumption	1.9 (1.1)	1.8 (1.0)	1.8 (1.1)	2.1 (1.1)	0.354
HED snack liking	80.5 (20.3)	83.9 (18.1)	77.9 (24.9)	79.5 (17.3)	0.267
SSB consumption	1.1 (1.0)	1.1 (.9)	0.9 (.9)	1.4 (1.2)	0.024
SSB liking	60.7 (30.6)	62.6 (33.5)	51.3 (31.4)	67.4 (24.5)	0.016

BMI = Body Mass Index; TFEQ = Three Factor Eating Questionnaire; UC = uncontrolled eating; CR - cognitively restrained eating; EE = emotional eating; FV = fruit and vegetable; HED = High energy-dense; LED = Low energy-dense; SSB = Sugar sweetened beverage

However, there was a main effect of condition for fruit liking ($F(2) = 4.44$, $p = .013$, partial eta square = .05), whereby independent samples t-tests revealed that those in the LED condition had a higher liking of fruit than those in the HED condition ($t(110) = 3.28$, $p =.001$). There was no significant difference between the control and the LED condition or HED condition (both *ps* >.05). There was also a main effect of condition for typical daily SSB consumption ($F(2) = 3.82$, $p = .024$, partial eta squared = .05), whereby t-tests revealed that those in the LED condition habitually consumed fewer SSBs than those in the HED condition ($t(108) = -2.63$, $p = .01$) but no significant difference between the control and the LED or HED condition (*ps* >.05). Finally, for SSB liking, there was a main effect of condition ($F(2) = 4.24$, $p = .016$, partial eta squared = .02); *t*-tests revealed significant differences between those in the HED and LED conditions, with those in the LED condition reporting lower liking of SSBs than those in the HED condition ($t(100.1) = -3.02$, $p =.003$), but no other significant differences (both *p*s >.05 - see Table 13). Measures of SSB consumption did not significantly correlate with the dependent variables and so were not considered further (*p*s > 0.05).

Visual Analogue Scales. For VAS Feeling Unwell, a 3 x 3 ANOVA revealed that there was a main effect of time ($F(1.87) = 44.33$, $p < .001$, partial eta sq = .21). Follow up t-tests showed there were significant differences between baseline and post-buffet ($t(168) = 6.72$, $p < .001$) and post-manipulation and post-buffet ($t(184) = 8.50$, $p < .001$), with higher scores of feeling unwell reported at baseline (mean = 18.9) and post-manipulation (mean = 18.7) than post-buffet (mean = 12.9). There were no other significant differences, for time, condition or interactions (all *p*s >.05; see Table 14 below for means). VAS feeling unwell items were checked to see if they correlated with the dependent variable; they did not and so were not included in the final model.

For VAS Appetite, there was a significant main effect of time ($F(1.55) = 141.54$, $p < .001$, partial eta sq = .46). Follow up t-tests showed there were significant differences between baseline and post-manipulation ($t(168) = -8.94$, $p < .001$), post-manipulation and post buffet ($t(168) = 15.07$, $p < .001$) and baseline and post-buffet ($t(168) = 9.28$, $p < .001$), with means indicating that appetite was highest at post-manipulation (mean = 74.9) compared to baseline (mean = 66.1) or post-buffet (mean = 50.6). There were no main effects of condition or significant interactions (all *p*s >.05; see Table 14 below). As baseline appetite significantly correlated with the dependent variable and this could be an important covariate, this was controlled for in the final model as a covariate.

Finally, for VAS feeling unhappy, there was a significant main effect of time ($F(1.8) = 34.35$, $p < .001$, partial eta sq = .17). Follow up t-tests showed there were significant differences between baseline and post-buffet ($t(168) = 6.87$, $p < .001$) and post-manipulation and post-buffet ($t(168) = 7.71$, $p < .001$), with participants reporting higher average scores for unhappiness at baseline (mean = 21.18) and post manipulation (mean = 20.30), compared to post-buffet (mean = 15.9). There were no other significant differences, main effects or interactions (all ps>.05; see Table 14 below). VAS feeling unhappy items were not significantly correlated with the outcome measures and so not included any other analyses.

Table 14. Means and standard deviations for mood and appetite scores, split by time and condition.

VAS Factor	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Feeling unwell			
Baseline	15.9 (16.8)	19.7 (16.7)	20.9 (16.5)
Post-manipulation	15.1 (16.4)	19.1 (14.4)	21.9 (17.4)
Post-buffet	9.9 (14.0)	12.9 (12.7)	15.8 (14.6)
Appetite			
Baseline	68.7 (22.3)	66.7 (19.7)	62.8 (20.3)
Post-manipulation	75.5 (23.3)	76.1 (18.4)	73.3 (19.9)
Post-buffet	52.3 (22.1)	51.8 (21.7)	47.9 (21.1)
Feeling Unhappy			
Baseline	19.6 (15.8)	21.7 (14.1)	22.3 (17.5)
Post-manipulation	18.6 (15.9)	20.3 (14.9)	21.9 (15.2)
Post-buffet	14.7 (14.5)	16.0 (14.4)	17.2 (14.5)

VAS = Visual Analogue Scale; HED = High energy-dense; LED = Low energy-dense

Social media use. The percentage of participants who used Instagram was not significantly different between the control and LED condition, ($X(1) = .59$, $p = .44$; 93% vs. 97%), LED and HED condition ($X(1) = 2.42$, $p = .12$; 97% vs. 90%) or control and HED condition ($X(1) = .70$, $p = .40$; 93% vs. 90%) and so not considered further as a covariate. The modal response for time spent on Instagram was between 31 and 60 minutes per day (32% of participants); the modal frequency of posting was once a month (45% of participants); the modal picture content was selfies/group selfies (56% of participants). The mean number of accounts followed was 389 (SD = 379.6), the mean number of followers was 463 (SD = 523.7), and on average participants had 2 (mean = 2; SD = .99) other social media accounts.

Instagram Task VAS Liking ratings. To check whether the manipulation and randomisation was successful, and if the liking ratings from the visual analogue scales presented with each of the images corresponded with the number of likes for each condition, liking ratings for the three types of images were compared across conditions. There was a significant main effect of the type of image ($F(2) = 13.5$, $p < .001$, partial eta sq = .08), with follow up t-tests revealing there were significant differences in average liking ratings between the control and HED socially endorsed images ($t(168) = -4.85$, $p<.001$) and the LED and HED food socially endorsed images ($t(168) = -4.14$, $p<.001$), with the HED images (mean = 63.8) rated as most liked, compared to the LED (mean = 56.9) and control (mean = 55.4). There was no other significant differences and no other significant main effects of condition or significant interactions (all *p*s >.05; See Table 15).

Table 15. Means and standard deviations for liking rating for each image type split by condition.

Image Type	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Control Image (interior design)	57.5 (15.8)	52.8 (15.3)	55.8 (15.5)
LED Food Image	56.7 (15.9)	58.1 (16.5)	56.0 (15.1)
HED Food Image	67.2 (14.5)	59.6 (20.3)	64.4 (14.5)

HED – High energy-dense; LED – Low energy-dense

Main analysis: Food consumed

One-way ANOVA, controlling for baseline appetite, revealed that there was no main effect of condition for grape consumption in grams ($F(2) = 1.67$, $p = .19$, eta sq = .02), or calories ($F(2) = 1.67$, $p = .19$, eta sq = .02), or for consumption of cookies in grams ($F(2) = 1.34$, $p = .27$, eta sq = .02). or calories ($F(2) = 1.34$, $p = .27$, eta sq = .02; see Table 16 for means). However, for participants' relative consumption of grapes in grams, there was a significant main effect of condition ($F(2) = 3.22$, $p = .04$, partial eta squared = .04). Planned comparisons revealed that those in the LED condition consumed a higher proportion of grapes compared to cookies, than those in the HED condition ($p = .02$), but there was no significant difference in relative consumption between those in the control and LED condition (p = .14), or the control and HED conditions (p = .29). There was also a significant difference in relative consumption of grapes in calories ($F(2)$ = 3.1, p = .048, partial eta squared = .04), whereby those in the LED condition consumed more calories from grapes than those in the control condition (p = .036) and the HED condition (p = .048), however, there was no significant difference between the HED and control conditions (p =.84; see Figure 5).

Table 16. Means and standard error for grape and cookie consumption and relative consumption split by condition.

Food consumed	Control Condition M (SE)	LED Condition M (SE)	HED Condition M (SE)
Grape consumption (grams)	79.0 (9.1)	101.9 (9.3)	84.9 (9.0)
Cookie consumption (grams)	21.0 (3.4)	19.9 (3.5)	27.2 (3.3)
Grape consumption (kcal)	52.2 (6.0)	67.3 (6.2)	56.0 (5.9)
Cookie consumption (kcal)	103.7 (16.6)	98.3 (17.0)	134.1 (16.5)
Percentage of grapes consumed (grams)	74.9 (3.4)	81.1 (3.4)	68.9 (3.3)
Percentage of grapes consumed (kcal)	42.8 (4.2)	54.3 (4.3)	40.1 (4.2)

LED = Low energy-dense; HED = High energy-dense

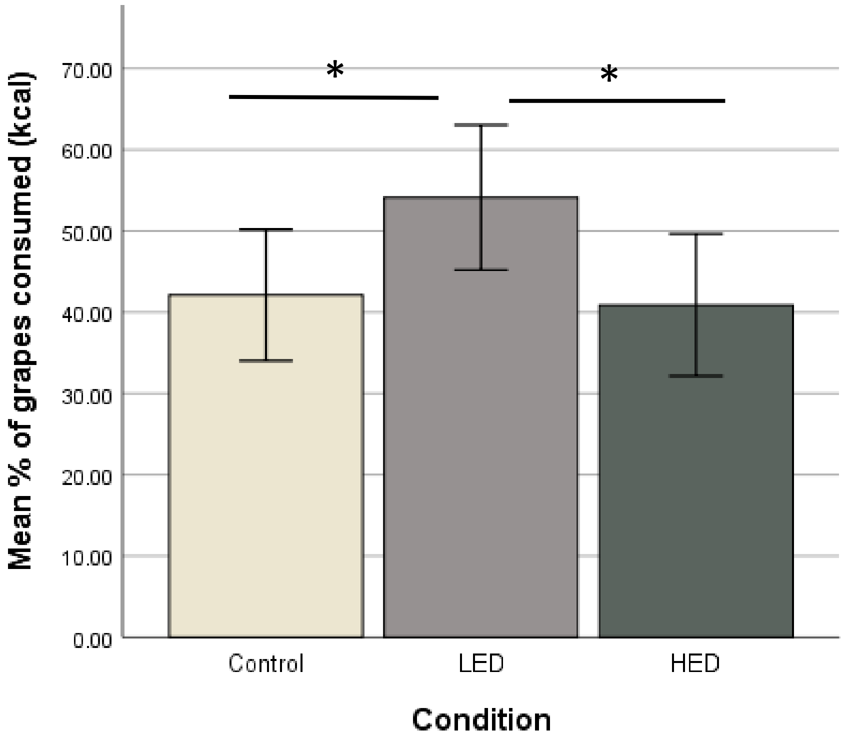

Figure 5. Mean percentage of grape consumption in calories (kcal) for control, low energy-dense (LED) and high energy-dense (HED) socially endorsed images (error bars indicate standard deviations). * $p < 0.05$

4.4 Discussion

This study aimed to investigate whether socially endorsed images, in the style of the social media site Instagram, affected the amount and proportion of grapes and cookies consumed by participants. After first checking to see if the randomisation was successful and examining potential covariates, baseline appetite was controlled for as part of the main analysis. Although the three types of socially endorsed images did not significantly affect participants' individual consumption of grapes and cookies, viewing socially endorsed images of LED foods (versus HED foods) led to participants consuming a higher proportion of grapes compared to cookies, in grams. Further, viewing the socially endorsed images of LED foods (versus both the HED foods and the control images) led to participants consuming a higher proportion of grapes compared to cookies, as calories. These findings suggest that exposure to socially endorsed LED food images may contribute to healthy eating, by nudging individuals to select and consume larger portions of LED food (such as grapes) relative to HED food (such as cookies).

These findings broadly support previous research on the effects of norms on eating behaviour, whereby exposure to social norm messages promote the consumption of fruit and vegetables (Robinson et al., 2014; Stok, de Ridder et al., 2014; Thomas et al., 2017). Importantly, exposure to the socially endorsed LED food images in this study was associated with a 12% and 14% shift towards consuming grapes (versus cookies) compared to the control and HED conditions, respectively. These are sizeable shifts in consumption, and if achieved at each meal, over time, could potentially produce sizeable effects on dietary nutrition and health. Interestingly, the effect of socially endorsed LED food images was observed for the proportions of food consumed, rather than individual consumption of each food. This may be an artefact of effect size, given that there was a small effect for consumption of each food in isolation, but this increased to a medium effect size when the foods were examined together (i.e. grapes consumed as a percentage of the total of both foods consumed). Thus, it may be that with a larger sample size, it would be possible to detect effects for each food, individually. Despite this, Robinson and colleagues (2013; 2014) also demonstrated that exposure to social norm messages nudged people to consume a higher proportion of LED compared to HED foods. While it is possible to examine the effect of healthy eating nudges on individual foods, it may be preferable to consider the relative contribution of foods consumed at a test meal. Further, the proportion of a meal consumed as nutritious low energy-dense calories is a useful outcome measure from a health perspective, as there is value in participants substituting a less nutritious energy-dense food with a more nutritious low energy-dense food.

We also observed that exposure to socially endorsed HED food images was not associated with participants consuming a significantly larger proportion of cookies (versus grapes) compared to the control condition. This is at odds with our hypothesis that these would enhance cookie consumption. However, a possible explanation is provided by the theory that being exposed to a norm corrects a misperception, which then leads to us matching the norm (Perkins, 2002). For example, if we think the majority consume lots of alcohol, but are then shown that the majority do not do this, our misperception is corrected, and our behaviour shifts to match the norm (Perkins, 2002). In the present study, it may be that there was no misperception to correct. Given that recent research has revealed that around 70% of food-related social media posts feature “unhealthy” food (Barre et al., 2016; Holmberg et al., 2016), it is quite possible that the socially endorsed HED condition *matched* participant perceptions and expectations, and hence, produced no effect. Conversely, as “healthy” food posts appear to be a minority (Barre et al., 2016; Holmberg et al., 2016), this may explain why the socially endorsed LED condition was effective, as it may have altered misperceptions of norms regarding healthy eating, though this was not examined here.

Whilst it was beyond the scope of this study to test how communicating norms via social media compares to other routes of delivery (e.g. posters or text messages), it is possible that social media and the social functions that it facilitates provides a unique environment in which norms about food choice and consumption may be communicated. Harnessing this knowledge could also contribute to understanding how the advertising and marketing industry impacts eating behaviour via social media (Lutfeali et al., 2020) and add to previous literature demonstrating the effect norms have within advertising (Kim et al., 2015; Lutfeali et al., 2020). Utilising social norms as part of interventions to correct misperceptions could be one way of harnessing this knowledge, or even having influencers communicate more about LED foods and validate each other's LED posts, rather than branded, HED foods (Holmberg et al., 2016; Kusumasondjaja & Tjiptono, 2019; Qutteina et al., 2019). However, further research is required to examine whether these acute effects persist, and can exert a long-term influence on eating behaviour, first.

To our knowledge, this research provides the first experimental evidence that social norms, communicated via social media, directly affects eating behaviour, measured objectively within laboratory settings. However, there are some limitations to this study. Firstly, while an effect was found within the controlled settings of the laboratory, we do not know whether this effect will withstand translation beyond, which limits the scope of these results. Although other social norm manipulations in the laboratory have successfully transferred to the field (Thomas et al., 2017), this remains to be tested here. Secondly, we note the inherent limitation of using a woman only student sample. Such samples are not unusual in eating behaviour studies, and indeed, it has been found that women are more prone to social influences around eating than men (Robinson, 2015), however, future work should examine whether the effects observed here extend to men, also. Thirdly, it may be argued that participants were simply being primed, rather than actually perceiving a norm. The former may be true if all likes were the same, however, we varied these across conditions, and showed the same images to all participants, to control for a simple priming effect.

4.5 Conclusions

This study has demonstrated that social media may implicitly affect our eating behaviour, by communicating social norms. Here, socially endorsed images of LED foods resulted in a higher proportion of grapes being consumed by participants, subsequently. This suggests that manipulating social norms through social media may be a fruitful avenue to nudge the consumption of healthy nutritious foods such as fruit and vegetables. Further work is required to explore whether it is possible to translate this work into useful guidance for using social media, or interventions delivered via social media.

CHAPTER 5: Do socially endorsed images on social media influence attention to and consumption of foods differently, according to body mass index?

5.1 Introduction

As the social norm literature suggests, our social networks and close others could have an impact upon food consumption, and consequently body weight. For example, the associations between social networks and unhealthy eating behaviours have predicted how likely it is for obese individuals to lose weight (e.g. Leahey et al. 2012), suggesting that if we perceive others around us to consume HED foods, in turn we are more likely to do the same and also find it harder to lose weight. A new avenue for exposure to these social norms relating to eating behaviour is social media. Indeed, in Chapter 4 it was demonstrated that exposure to experimentally manipulated posts (via the number of likes given to these pictures) of LED foods resulted in participants choosing a higher percentage of LED snack foods, compared to HED snacks, showing that social media may implicitly affect our actual eating behaviour via social norms. To understand the scope of this effect further, more research about how this affects different individuals, including those of different body weights is needed.

Indeed, one study has considered social media as a basis for an intervention to decrease the desired portion size of HED foods (Sharps et al., 2019), however, few other studies have considered the effects of social media on our LED and HED consumption. We also note that while we demonstrated an effect with one type of fruit in our previous study, this may not generalise to all LED foods such as vegetables. Thus, further research incorporating a wider selection of foods in needed to examine if these effects are also observed with a wider range of LED foods.

Additionally, less is known about the mechanisms of how norms shape behaviour, or specifically how posts on social media may affect individuals' food choices and consumption. Indeed, research has found that there may be a cognitive element to how we interact with food stimuli, such as social media posts of food. For example, both healthy restrained and non-restrained eaters showed enhanced attention to food stimuli over non-food stimuli (Werthmann, Roefs, Nederkoorn, Mogg, Bradley & Jansen, 2013), demonstrating that individuals may have enhanced attention towards food items in the environment, which could include social media. Indeed, 'unhealthy' food posts from advertising companies evoked more positive social responses from adolescents, compared to healthy and non-food posts (Murphy et al., 2020). Moreover, adolescents also remembered more and looked longer at unhealthy posts compared to healthy and non-food posts (Murphy et al., 2020), suggesting that there may be a cognitive element to how social media posts of food are used, particularly in terms of attention.

Another factor which may also affect the way that social media influences food intake is individual BMI. Indeed, BMI has previously predicted reactions to social media posts, with individuals with obesity reacting more to healthy food posts, compared to their healthy and overweight peers (Kinard, 2016). However, little research has directly investigated whether the effect of social norms communicated via social media, vary according to individual body weight and how this impacts our actual eating behaviour. Further, individuals with obesity paid more attention to food stimuli than non-food stimuli, and maintained this bias compared to lean individuals, suggesting attention to food cues may also be enhanced in obesity (Castellanos et al., 2009). Thus, together, these results could imply that there may be some interaction in how individuals of different body weights react towards different social media posts of food, in terms of attention. A key question to examine is whether social norms via social media interact with differences in weight status, whether these result in differences in actual food consumption and enhanced attention to certain foods. However, to date no study has investigated this.

Thus, the aims of this study were to (A) investigate whether exposure to social media posts about food affect subsequent consumption of food and if this varied according to body weight (i.e. do lean and overweight/obese individuals eat differently, after exposure to socially endorsed images of food?). A second aim (B) was to explore whether exposure to social media posts about food affects attention to subsequent food stimuli and whether this also varies according to body weight (i.e. do lean and overweight/obese individuals attend to food stimuli differently, after exposure to socially endorsed images of food?). Specifically, attention was measured via reaction time bias, which measures whether participants reacted to food images quicker than non-food images and also to LED food images quicker than HED food images. It was predicted that: (A1) exposure to socially endorsed images of LED foods and HED foods (compared to non-food control images) would result in all participants consuming more LED and HED foods, respectively. (A2) Overweight/obese participants would consume more LED and HED foods compared to lean participants. (A3) There would also be an interaction between body weight and type of socially endorsed image, whereby obese/overweight participants (compared to lean) will consume more HED foods, when they are exposed to socially endorsed HED food images, compared to LED food or control images. (B1) Exposure to socially endorsed images of LED foods and HED foods (compared to non-food control images) would result in all participants showing a greater reaction time bias towards low and high calorie foods (versus non-food images), respectively, that is they would react quicker to towards low and high calorie food images, compared to the non-food images. (B2) Participants with overweight/obesity would show a greater reaction time bias (be quicker to) towards low and high calorie foods (versus non-food images), compared to lean participants. (B3) There would also be an interaction between body weight and type of socially endorsed image, whereby participants with overweight/obesity (compared to lean) will show a greater reaction time bias (be quicker) towards high calorie foods, compared to low calorie foods or control images, when they are exposed to socially endorsed HED food images.

5.2 Methods

Participants

One hundred and twenty women participants consented to taking part. Participants were excluded, or their data removed if they: had a current or previous history of eating disorders, food allergies or diabetes, were not aged 18-65, had eaten 2 hours before the study, were smokers, did not consume any food from the buffet, or correctly guessed the aims of the study. Data from 10 participants were excluded using these criteria. Hence, 110 women successfully completed the entire study and were included in all analyses**,** with a mean age of 19.9 years (SD = 2.37). Participants comprised a community sample consisting of participants from the general public as well as students, recruited via posters in university buildings, shops, religious buildings, online through social media adverts, or a university research participation system. Participants were awarded course credits for their participation or entered into a prize draw to win a £50 Amazon voucher. Ethical approval was granted by Aston Life and Health Sciences Ethics Committee (#1413) and carried out in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants.

Sample size

Power analysis using G*Power 3.1 (power at 80%, alpha at 0.017 (Bonferroni correction) and an effect size based on our previous work, 0.8) determined a minimum sample of 174 was needed to ensure sufficient power. We aimed for the total sample to consist of at least 180 participants (30 participants per group), with any unusable data replaced by testing additional participants, up the to the limit. However, recruitment was prematurely terminated due to the global COVID-19 pandemic and lock- down restrictions preventing face-to-face contact.

Design

The study employed a 2 (BMI: lean vs. overweight/obese) x 3 (Condition: low energy-dense food (LED), high energy-dense food (HED), interior design as a control) between subjects' experimental design. For condition, all participants were exposed to a series of 60 images of both LED and HED foods and interior design images, but in their condition, to induce a norm for that kind of image, that specific image set was 'socially endorsed' with substantially more 'likes' (e.g. a participant in the control condition, saw all three sets of images, however, the control images appeared to have disproportionately more 'likes'). The dependent variables were the amount (in grams/calories) of the different types of foods consumed (LED: grapes and carrots and HED: cookies and tortilla chips), as well as the percentage of each type of food consumed out of each participants' total food intake (e.g. % of LED foods participant has eaten out of their total food intake) and reaction time bias scores to low calorie, high calorie and non-food stimuli (e.g. mean reaction time to non-food stimuli subtracted from the mean reaction time to low/high calorie food stimuli). Assignment to condition was randomised online via Qualtrics to ensure equal numbers across conditions.

Measures

The experiment comprised a series of questionnaires, along with the experimentally manipulated images and food categorisation task, delivered via Qualtrics. A food buffet was then presented as a taste test paradigm. Measures were presented in the order below:

Lifestyle Questionnaire (Thomas et al., 2016): this measured demographics and was used to exclude participants based on study criteria (e.g. smokers).

Visual Analogue Scales (VAS; Thomas et al., 2016): this scale assessed baseline, post-manipulation, post-food categorisation and post-buffet mood and appetite (see Chapter 2).

The Usual Food and Drink Intake Questionnaire (Hawkins et al., 2020): measured participants' own habitual consumption and liking of fruit, vegetables, energy-dense snack foods and sugar sweetened beverages (see Chapter 2).

Social Networking Use (Slater, Varsani & Diedrichs, 2017): This assessed Instagram and other social media use (see Chapter 2).

Instagram Task: participants were shown three sets of fictitious Instagram posts containing; 20 LED food images, 20 HED food images and 20 Control images (interior design). In order to induce a perceived norm for a particular set of images, one of these sets was ‘liked’ more than the other two sets of images (e.g. in the HED condition, the HED food posts appeared to receive substantially more ‘likes’ - see Figure 6; Chapter 4 for more details).

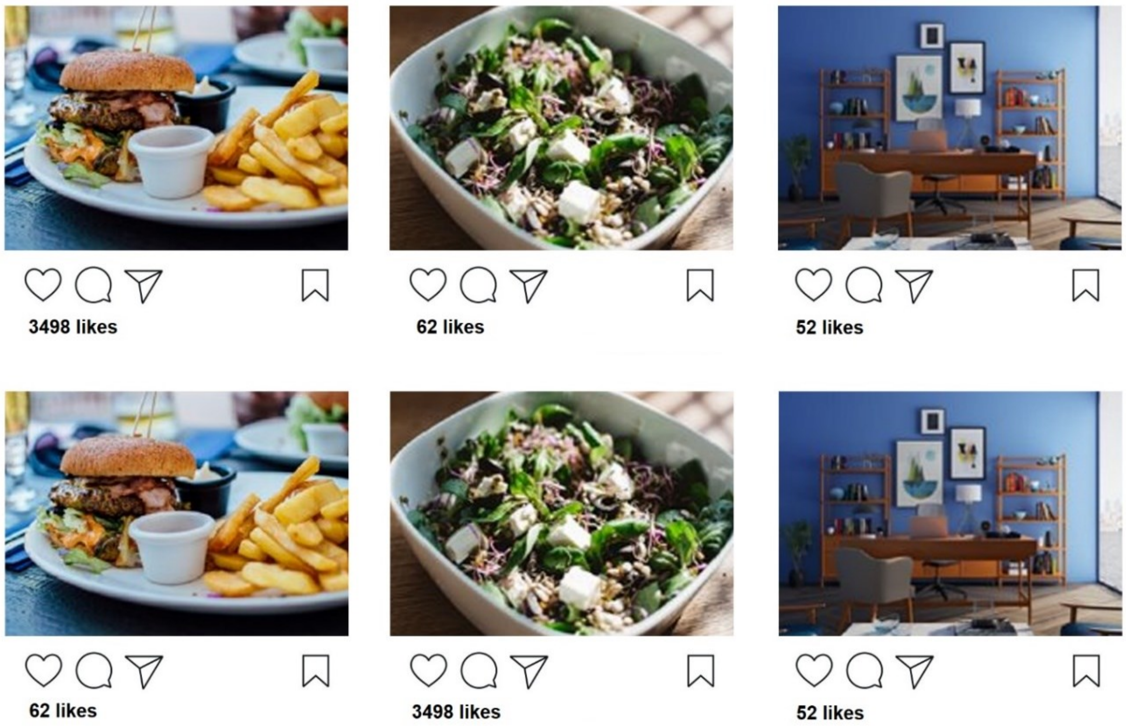

Figure 6. Example of socially endorsed images.

The top row illustrates how posts in the HED condition would appear to be the most ‘liked’ and the bottom row illustrates how posts in the LED condition would appear to be the most ‘liked’, by manipulating the number of ‘likes’.

Images via Pexels (Creative Commons License).

Food categorisation task: A food categorisation task was used to examine if the socially endorsed images evoked an attention bias towards low calorie foods vs high calorie foods vs non-food items, by measuring and comparing participants’ reaction times to these, separately. Images from a set of 20 high calorie foods, 20 low calorie foods and 40 non-food items (matched for general appearance in terms of size, colour and shape to the food items) were presented one at a time on a screen. Participants were asked to click one of two responses, as quickly as possible, in reaction to the image, to indicate whether it was a food or non-food item. This was then replaced with the next image for participants to identify. Reaction time bias was calculated by subtracting the mean reaction time (in milliseconds) to non-food stimuli from the mean reaction time to the low and high calorie food stimuli, separately. This task took no longer than 10 minutes and is based on a task used previously (Thomas, Khan and Nash, 2018).

Food buffet (Robinson, Harris et al., 2013; Thomas et al., 2016)*:* this was presented as a 'taste test' (presented in the following order: carrots, tortillas, cookies and grapes), where participants were asked to try one of each food , rate it on different qualities using VAS scales, take a sip of water and move to the next food and rate it in the same manner. Participants were then told they could help themselves to anything that was left as it would be thrown in the bin, to encourage them to eat what they wanted. The buffet consisted of grapes (400g/264kcal per bowl) and carrots (300g/87kcal per bowl), cookies (200g/950 kcal per bowl) and tortilla chips (70g/336 kcal per bowl); cookies were broken up into 4-6 pieces each, to make it difficult for participants to monitor their intake (see Chapter 4 for more details). These foods were chosen as they were highly palatable for participants and to provide common choices for both LED and HED sweet and savoury snacks, which participants were likely to be familiar with. Additionally, these choices made it easier to ensure consistent sizes and weights across the test foods.

The Student Food Attitudes Form was adapted from Thomas et al., (2016) to measure normative perceptions about Instagram users' consumption of different foods and drink (see Chapter 2).

Three Factor Eating Questionnaire-R21 (TFEQ-R21; Cappelleri et al., 2009): measured uncontrolled eating, cognitive restraint and emotional eating (see Chapter 2).

The Multicomponent In-Group Identification Scale (Leach et al., 2008) was adapted to measure whether participants identify as and affiliate themselves with Instagram users (see Chapter 2).

Identification with Instagram users was measured using Visual Analogue scales (as in Stok et al., 2014), to measure how strongly participants identify as and affiliate themselves with Instagram users (see Chapter 3).

Demand and manipulation check*:* to complete the survey, participants were asked what they thought the purpose of the study was (demand check), using an open-ended response. Participants were also asked which set of images they believed had the most likes, as a manipulation check.

Height and weight*:* height (in metres) and weight (in kilograms) was recorded by the researcher using a stadiometer and digital weighing scales, in order to calculate BMI (kg/m^2). Waist circumference was recorded in cm using a medical tape measure.

Procedure

Interested participants were required to email the researcher to express interest and were sent an eligibility questionnaire detailing basic demographic information and questions for the eligibility criteria (e.g. age, gender, amount of fruit and vegetables consumed, smokers etc). Eligible participants were asked to attend a laboratory session. After providing consent, they were first asked to complete a Lifestyle and eating questionnaire, then eligibility criteria were checked a second time and screened for. All eligible participants were then asked to complete the questionnaires, Instagram ratings task, food categorisation task, the food buffet and the final questionnaires. Participants were asked if their height, weight and waist circumference could be recorded by the researcher and were then fully debriefed with the true aims of the study, which had been withheld to minimise demand characteristics. Finally, participants were reimbursed with credits or vouchers and entered into the prize draw for the vouchers and thanked for their time. Each session was approximately 45 minutes and testing took part from November 2019 – March 2020.

Analysis

Main Analysis: a 2 (BMI: lean vs overweight/obese) x 3 (condition: control, LED, HED socially endorsed images) ANCOVA was used to examine differences in food consumption (in grams and calories) and participants relative intake (percentage of total intake consumed as either LED foods or HED foods) in grams and calories, as well as reaction time bias scores to non-food, low calorie food and high calorie food stimuli.

VAS: A principal components analysis (PCA) with Varimax rotation was carried out on the VAS items (mood and appetite). This yielded 4 factors with eigenvalues >1, which accounted for a total of 72% of the variance. Factors included 'Feeling Unwell' (light headedness, nausea, faint), 'Appetite' (hunger, thirst, full (reverse coded), desire to eat), 'Negative affect' (sad, anxious, withdrawn) and 'Arousal' (alert, happy, drowsy (reverse coded). Once factors were identified, aggregate scores for each dimension were computed, inverting scores for items where relevant. A 3 (condition) x 4 (time) mixed ANOVA was used to examine differences for each of the VAS PCA mood and appetite scores.

Additional covariate analysis: Pre-specified covariates were time spent using social media, baseline hunger (VAS appetite), habitual consumption of fruit, vegetables, 'junk' food and sugar sweetened beverages, and uncontrolled, cognitive restraint and emotional eating styles, as all of these can be confounding factors on food consumption and choice. As before, in Chapter 4, analyses to check for baseline differences and covariates included one-way ANOVA, to examine differences in baseline participant characteristics across conditions, as well as measures of affiliation. A mixed 3 (condition) x 3 (type of image liked) ANOVA was used to examine differences for VAS liking ratings in the manipulation task. Finally, chi-square was used to examine differences between conditions for social media use to confirm successful randomisation. Covariates were included in the model if they were significantly correlated with both outcome measures (food consumption and reaction times), thus baseline appetite was included as a covariate.

5.3 Results

Participant characteristics

The final sample consisted of 110 participants. Participants were all women, 53% (n = 58) were Asian, 25% (n = 28) were White, 16 % (n = 18) Black, 5% (n = 5) Mixed ethnicity and 1% (n = 1) reported Other. For SES and family income 27% (n = 30) earned between £25 000- £40 000, 26% (n = 29) earned over £40 000, 25% (n = 27) earned between £15 500 and £25 000 and 22% (n = 22) earned less than £15 000. Thirty-nine percent (n = 43) reported themselves as middle class, 36% (n=40) as lower-middle class, 14% (n = 15) as lower class, 10% as middle - upper class (n = 11) and 1% (n = 1) as upper class. See Table 17 for further participant characteristics.

Table 17. Means and standard deviations for participant characteristics across conditions.

Measure	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)	*P* Value
Age	20.3 (2.2)	19.5 (2.6)	19.9 (2.3)	.42
BMI	23.4 (3.7)	24.2 (4.8)	24.7 (4.9)	.51
TFEQ-21R UC	2.6 (.5)	2.5 (.4)	2.5 (.4)	.70
TFEQ-21R CR	2.5 (.3)	2.6 (.3)	2.6 (.3)	.24
TFEQ-21R EE	2.6 (.8)	2.9 (.8)	2.7 (.7)	.29
FV consumption	0.9 (0.6)	0.8 (0.4)	0.9 (0.5)	.09
Vegetable liking	62.8 (22.6)	48.5 (22.8)	61.1 (25.1)	.02
Fruit liking	72.3 (21.8)	70.8 (24.3)	73.9 (22.3)	.84
HED snack consumption	1.7 (1.0)	1.5 (0.8)	1.5 (0.7)	.44
HED snack liking	78.1 (22.4)	85.3 (16.1)	80.0 (15.8)	.22
SSB liking	66.2 (25.6)	68.4 (30.4)	65.2 (29.1)	.88

LED = Low energy-dense; HED = High energy-dense; BMI = Body mass index; TFEQ-21R UC = Uncontrolled eating style; TFEQ21R-CR = cognitive restrained eating style; TFEQ21R-EE = emotional eating style; SSB = sugar sweetened beverage

Visual Analogue Scales (mood and appetite)

As VAS appetite scores were significantly higher at post-manipulation and post categorisation and baseline appetite also significantly correlated with the outcome variables, this was included in the final model. All other VAS scores were not associated with the outcome measures. (see Table 18 for means).

Table 18. Means and standard deviations of mood and appetite scores across conditions.

VAS Factor	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Feeling unwell			
Baseline	8.4 (12.3)	10.8 (12.9)	13.3 (18.6)
Post-manipulation	9.2 (14.7)	10.4 (14.4)	13.7 (20.5)
Post categorisation	7.9 (13.2)	8.2 (12.2)	15.8 (22.7)
Post-buffet	5.6 (10.0)	5.8 (10.8)	7.9 (11.8)
Appetite			
Baseline	57.5 (23.7)	64.6 (19.5)	63.1 (20.2)
Post-manipulation	63.6 (25.1)	74.1 (20.9)	73.4 (17.9)
Post categorisation	60.6 (24.7)	73.3 (20.3)	72.7 (20.1)
Post-buffet	38.4 (22.8)	39.9 (26.1)	43.9 (22.6)
Negative affect			
Baseline	11.5 (13.5)	14.7 (16.8)	17.9 (18.6)
Post-manipulation	12.3 (15.1)	13.8 (16.8)	17.3 (18.9)
Post categorisation	14.1 (15.3)	10.4 (13.5)	19.9 (22.6)
Post-buffet	7.9 (11.6)	7.9 (13.2)	12.2 (15.7)
Arousal			
Baseline	72.7 (16.6)	67.8 (16.4)	64.6 (18.2)
Post-manipulation	65.4 (18.9)	64.2 (18.5)	64.5 (20.4)
Post-categorisation	65.0 (20.3)	65.7 (21.4)	61.3 (21.5)
Post-buffet	78.2 (15.5)	77.2 (14.0)	75.6 (13.3)

VAS = Visual Analogue Scale; LED = Low energy-dense; HED = High energy-dense

Social media use

The percentages of those who had Instagram accounts did not differ significantly in the control and LED conditions ($\chi^2(1) = .51$, $p = .58$; 94% vs 97%), LED and HED conditions ($\chi^2(1) = .40$, $p = .53$; 97% vs 95%) and control and HED conditions ($\chi^2(1) = .01$, $p = .93$; 94% vs 95%). The modal time spent on Instagram was over an hour per day (47%), the modal picture content was selfies/group selfies (76%) and modal frequency of posting was once a month (60%). Ninety-five percent of participants used other social media accounts. Participants on average followed 462 (SD = 358.7) accounts and on average had 513 (SD = 472.6) follow them.

Affiliation with Instagram users

While those in the LED condition had higher satisfaction (mean = 4.9, SD = 0.9) with being an Instagram user than those in the control condition (t (71) = -2.42, p =.02; mean = 4.3, SD = 1.2) and HED condition (t (74) = 2.39, p =.02; mean = 4.4, SD = 0.9), there were no significant differences between the HED and control conditions (t (69) = -0.45, p =.65). There were also no significant differences between conditions for the solidarity, centrality, self-stereotyping or homogeneity subscales of the Multicomponent In-group Identification scale, or for VAS measures of identification or connectedness with Instagram users (all *p*s >.05). See Table 19 for means.

Table 19. Means and standard deviations for affiliation with Instagram users across conditions.

Affiliation measure	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Multicomponent scale			
Solidarity	3.3 (1.2)	3.4 (1.2)	3.1 (1.1)
Satisfaction	4.3 (1.2)	4.9 (0.9)	4.4 (0.9)
Centrality	2.2 (1.1)	2.1 (1.4)	2.5 (1.3)
Self-stereotyping	3.6 (1.4)	3.6 (1.2)	3.6 (1.2)
Homogeneity	3.2 (1.5)	3.6 (1.2)	3.8 (1.5)
VAS			
Identification	36.9 (26.1)	38.5 (23.7)	38.9 (24.2)
Connectedness	29.4 (25.7)	35.0 (28.1)	24.2 (15.5)

LED = Low energy-dense; HED = High energy-dense; VAS = Visual analogue scale

Liking ratings

There was a significant main effect of image type ($F(2) = 33.2$, $p<.001$, $\eta p^2 = .25$), with follow-up t-tests showing that unhealthy food images were liked significantly more ($t(109) = -6.06$, $p<.001$; mean = 68.6) than control (mean = 56.9), or healthy food images ($t(109) = -8.01$, $p<.001$; mean = 52.7) and control images were liked significantly more than healthy food images ($t(109) = 2.04$, $p = .04$). There was no significant main effect of condition ($F(2) = 1.1$, $p = .34$, $\eta p^2 = .02$; means: control = 56.9, LED = 60.8, HED = 59.9) and no significant interaction between type of image and condition ($F(4) = 0.76$, $p = .55$, $\eta p^2 = .01$; see Table 20 for means).

Table 20. Means and standard deviations for image ratings across conditions.

Image Type	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Control Image (interior design)	53.2 (18.2)	59.5 (17.1)	57.4 (17.5)
Healthy Food Image	52.0 (15.1)	51.3 (17.7)	54.3 (16.5)
Unhealthy Food Image	65.7 (16.8)	71.5 (15.3)	68.1 (15.6)

LED = low energy-dense; HED = high energy-dense

Main analysis

Participants' relative consumption

For participants' relative consumption, there was a trend towards a main effect of BMI for percentage of LED foods consumed in grams ($F(1) = 2.08$, $p = .15$, $\eta p^2 = .02$) and calories ($F(1) = 2.13$, $p = .15$, $\eta p^2 = .02$), whereby individuals with overweight and obesity consumed a higher percentage of grams (70% vs 65%) and calories (26 vs 21%) from LED foods compared to lean individuals. However, there was no significant main effect of condition ($F(2) = 0.44$, $p = .65$, $\eta p^2 = .01$), or a significant interaction between BMI and condition ($F(2) = 0.70$, $p = .50$, $\eta p^2 = .01$) for percentage of LED foods consumed as grams. There was also no significant main effect of condition ($F(2) = 0.55$, $p = .58$, $\eta p^2 = .01$), or a significant interaction between BMI and condition ($F(2) = 0.25$, $p = .78$, $\eta p^2 = .01$) for percentage of LED foods consumed in calories.

Total food consumption

For participants' intake of LED foods in grams, there was no significant main effect of condition ($F(2) = 0.49$, $p = .62$, $\eta p^2 = .01$) or BMI ($F(1) = 0.004$, $p = .95$, $\eta p^2 = .00$), after controlling for baseline appetite. There was also no significant interaction between BMI and condition on participants' intake of food in grams ($F(2) = 0.44$, $p = .64$, $\eta p^2 = .01$). For participants' intake of HED foods in grams, there was no significant main effect of condition ($F(4) = 1.42$, $p = .25$, $\eta p^2 = .03$) or BMI ($F(1) = 0.57$, $p = .45$, $\eta p^2 = .01$) and there was no significant interaction between BMI and condition ($F(2) = 1.41$, $p = .25$, $\eta p^2 = .03$).

For intake of calories consumed of LED foods, there was no significant main effect of condition ($F(2) = 0.43$, $p = .65$, $\eta p^2 = .01$) or BMI ($F(4) = 0.01$, $p = .91$, $\eta p^2 = .00$). There was also no significant interaction between BMI and condition ($F(2) = 0.62$, $p = .54$, $\eta p^2 = .01$). For intake of calories of HED foods, there was no significant main effect of condition ($F(2) = 1.42$, $p = .25$, $\eta p^2 = .03$) or BMI ($F(1) = 0.57$, $p = .45$, $\eta p^2 = .01$) and there was no significant interaction between BMI and condition for HED food intake in calories ($F(2) = 1.40$, $p = .25$, $\eta p^2 = .03$). See Table 21 for means.

Table 21. Means and standard error for food consumption (G/kcal) across condition and weight status.

Food consumed	Control Condition		LED Condition		HED Condition	
	Lean n = 21 M (SE)	OW/obese n = 13 M (SE)	Lean n = 26 M (SE)	OW/obese n = 13 M (SE)	Lean n = 24 M (SE)	OW/obese n = 13 M (SE)
Grams consumed						
LED consumption	38.5 (7.2)	47.7 (9.2)	37.9 (6.5)	32.9 (9.1)	42.5 (6.7)	39.6 (9.1)
HED consumption	17.1 (2.3)	19.8 (2.9)	17.2 (2.0)	11.4 (2.9)	17.9 (2.1)	16.3 (2.9)
Calories consumed						
LED consumption	20.5 (4.4)	27.2 (5.6)	20.9 (3.9)	17.8 (5.5)	23.0 (4.1)	20.7 (5.5)
HED consumption	81.6 (10.8)	94.4 (13.8)	81.8 (9.7)	54.2 (13.7)	85.1 (10.0)	77.7 (13.7)
Percentage of LED foods consumed (grams)	66.3 (3.8)	69.5 (4.9)	63.5 (3.4)	74.2 (4.8)	64.4 (3.6)	65.6 (4.8)
Percentage of LED foods consumed (kcal)	22.5 (3.3)	27.2 (4.2)	21.0 (3.0)	27.8 (4.1)	20.5 (3.1)	22.1 (4.1)

OW = overweight; LED = low energy-dense; HED = high energy-dense

Reaction times

For reaction time bias, there was a trend towards a main effect of condition ($F(2)$ = 2.27, p = .11, ηp^2 = .04) for bias towards low calorie images vs non-food control images. Examination of the means suggested that those in the control condition had quicker response times to low calorie images vs non-food images than those in the LED or HED conditions (-960 vs -330 and -340ms respectively). However, there was no significant main effect of BMI ($F(1)$ = 0.06, p = .81, ηp^2 = .00) and no significant interaction between BMI and condition for bias to low calorie vs non-food images ($F(2)$ = 0.02, p = .98, ηp^2 = .00). For bias towards high calorie vs non-food images, there was a trend for a main effect of condition ($F(2)$ = 2.24, p = .11, ηp^2 = .04), whereby those in the LED condition were quicker to respond to high calorie images vs non-food, than those in the control or HED condition (-340ms v 230ms vs 240ms). There was no significant main effect of BMI ($F(1)$ =

0.20, p = .66, ηp^2 = .00) or a significant interaction between BMI and condition (F(2) = 0.36, p = .70, ηp^2 = .01).

For biases towards low calorie vs high calorie items, there was a trend towards a main effect of BMI (F(1) = 2.70, p = .10, ηp^2 = .03) whereby individuals with overweight and obesity reacted quicker (mean = -100ms) to low calorie images vs high calorie images, compared to lean individuals (mean = 60ms). Further, there was also a trend for an interaction between BMI and condition (F(2) = 2.16, p = .12, ηp^2 = .04), with the examination of the means suggesting that individuals with overweight and obesity in the LED condition were quicker to respond to low calorie images vs high calorie images, compared to lean participants (-134 ms vs -20ms). There was no significant main effect of condition (F(2) = 0.15, p = .86, ηp^2 = .00). For bias to high calorie vs low calorie images, there was a trend towards a main effect of BMI (F(1) = 2.63, p = .11, ηp^2 = .03), whereby lean individuals were quicker to respond to high calorie images vs low calorie images, compared to those with overweight and obesity (60ms vs 101ms). There was also a trend for an interaction between BMI and condition (F(2) = 2.80, p = .07, ηp^2 = .05), with examination of the means suggesting that lean participants were quicker to respond to high calorie vs low calorie images in the LED condition (20ms vs 140ms). There was no significant main effect of condition (F(2) = 0.06, p = .94, ηp^2 = .00).

Table 22. Means and standard error for reaction times to the different stimuli across condition and weight status.

Reaction times (ms)	Control Condition		LED Condition		HED Condition	
	Lean n = 21	OW/obese n = 13	Lean n = 26	OW/obese n = 13	Lean n = 24	OW/obese n = 13
	M (SE)	M (SE)	M (SE)	M (SE)	M (SE)	M (SE)
Non-food control	1118 (.05)	1205 (.06)	1145 (.04)	1275 (.06)	1162 (.04)	1077 (.06)
Low calorie	1040 (.04)	1123 (.06)	1098 (.04)	1178 (.06)	1116 (.04)	1033 (.06)
High calorie	1134 (.05)	1203 (.07)	1113 (.05)	1315 (.07)	1189 (.05)	1119 (.07)
Reaction time bias (ms)						
LC vs C	-95 (.03)	-98 (.04)	-31 (.03)	-34 (.04)	-27 (.03)	-41 (.04)
HC vs C	33 (.03)	13 (.04)	-47 (.03)	-23 (.04)	8 (.03)	40 (.04)
LC vs HC	-94 (.03)	-93 (.04)	-20 (.03)	-134 (.04)	75 (.03)	-86 (.04)
HC vs LC	94 (.03)	80 (.04)	15 (.03)	137 (.04)	72 (.03)	86 (.04)

LED = low energy-dense condition; HED = high energy-dense condition; OW = overweight; LC = low calorie stimulus; C = control stimulus; HC = high calorie stimulus

5.4 Discussion

This study aimed to investigate whether there were differences in food intake and reaction times to food stimuli, after viewing socially endorsed images of LED and HED foods and non-food, and if these varied according to body weight. Whilst there was no significant main effects of BMI or condition on participants' consumption of LED and HED foods, or their reaction times to high and low-calorie food images, compared to non-food, there were some trends to note. Contrary to our hypotheses, individuals with overweight and obesity consumed a larger proportion of their food as LED foods, and also had a tendency to react quicker to low calorie images vs high calorie images, compared to their lean counterparts. Further, whilst there was a trend for an interaction between condition and BMI this demonstrated that contrary to our hypotheses, there were no differences in reaction times between lean individuals and individuals with overweight and obesity in the control and HED conditions, but in the LED condition, individuals with overweight and obesity were quicker to low vs high calorie images, compared to lean individuals.

Thus, whilst there were no significant differences in how BMI and condition affected the amount of food consumed, these results suggest that there may be differences in the proportion of LED and HED foods which individuals of different weights consume, regardless of this manipulation. To an extent, this fits with the results of our previous study (Chapter 4); that there was no effect on the overall amount participants ate but there was for relative intake, suggesting there is potential for nudging consumption towards LED foods, in place of HED foods. However, contrary to our hypotheses and our previous study, in this study there was no effect of condition, with the different manipulated socially endorsed images having no effect on total or relative food consumption. It is unclear why the manipulation had an effect previously and not here and while this study was underpowered, the effect size was also very small for condition. This is also contrary to previous social norm literature, suggesting that descriptive social norms have resulted in an increase in fruit and vegetables and at the same time, a compensatory decrease in HED foods (Robinson et al., 2014), as well as liking norms predicting vegetable consumption (Thomas et al., 2016). One explanation could be that the stimuli presented here may not have induced a perceived norm in this sample and participants may not have noticed the manipulation (number of likes on a post). Thus, participants would have been less likely to alter their behaviour to be in line with the presented norm, if they were not aware of it (Robinson, 2015). Further research using stimulus that highlights the number of likes or utilising real social media posts as stimuli to gain further insight into whether social media posts do have a more consistent effect would therefore be beneficial.

However, there was a potential main effect of BMI, which instead may suggest that body weight can affect food consumption over and above the effect of social norms on social media and that food consumption is more directly affected by an individual's weight status. One reason for this is the differences in eating habits that may occur between lean and individuals with overweight or obesity. For example, it may be that the individuals with overweight and obesity in this study were trying to diet, or lose weight and, as found by

Leahey et al. (2015), in social networks, unhealthy eating habits have been associated with participants finding it harder to lose weight. Thus, it may be that if participants with overweight and obesity were trying to lose weight, they may be more likely to include a higher proportion of LED foods, compared to HED foods in their diet, whereas it seems lean participants may have been more disinhibited and so consumed a higher proportion of HED foods.

In addition, there was also a trend for a main effect of condition on reaction times to the different stimulus, suggesting that norms on social media may affect how we interact and attend to food posts and food cues in our environment. Our hypotheses that viewing socially endorsed images of food would result in quicker reaction times to food, compared to non-food stimuli was partially supported, with those in the control condition reacting faster to low calorie images compared to those in the LED or HED conditions. Further, those in the LED condition also reacted faster to high calorie images, compared to non-food stimuli, however there was no effect of BMI. Thus, social norms on social media may implicitly affect reactions to foods in our environment via cognitive processes such as enhanced attention, although further fully powered research is required to test whether this is a mechanism, as the effect was also small. Nevertheless, these results fit with previous findings that participants had enhanced attention towards food stimuli vs non-food stimuli (Werthmann et al., 2009) and could suggest that social norms may amplify the likelihood of enhanced attention to both low and high calorie foods vs non-food stimulus, regardless of individual differences such as weight.

Additionally, when comparing reaction times to low and high calorie images, there was a trend for a main effect of BMI, but not for condition, with participants with overweight and obesity reacting quicker to low vs high calorie images. Further, there was also a trend for an interaction between BMI and condition, whereby individuals with overweight and obesity were quicker to low calorie vs high calorie food stimulus compared to their lean counterparts, in the LED condition, compared to the HED or control conditions.

In addition, despite the study not being fully powered, a small-medium effect size was also achieved, suggesting this could be a sizeable effect, with increased power. These results partially support our hypotheses that participants would be quicker to food stimuli vs non-food stimuli, after viewing socially endorsed LED and HED food images but is contrary to the hypotheses that for individuals with overweight and obesity this would be pronounced for those who had viewed socially endorsed HED foods. It does, however, demonstrate that individuals with overweight and obesity may interact and be affected by social media posts differently to their lean counterparts and as a result, may be more sensitive to LED food cues in the environment. This also fits with previous research that individuals with obesity reacted to healthier posts more than other types of posts on Instagram (Kinard, 2016) but suggests further that social norms could impact upon this effect. One explanation for this could be social desirability (Kinard, 2016), with participants with overweight and obesity feeling a pressure to fit into the norm when LED foods were highly liked, thus these kinds of posts may result in LED foods being more salient in the environment for these individuals.

Taken together with the results that participants with overweight and obesity consumed a higher proportion of calories of LED foods, these results do suggest that it may be possible to nudge consumption towards healthier eating habits via social media for those with obesity and overweight. Thus, interventions aimed at targeting obesity and encouraging healthy eating as one way of doing this, may wish to consider how individuals with obesity interact with their environment, including social media and potentially harness the potential social media may have in nudging consumption for this group of individuals. However, it is acknowledged that a significant interaction between body weight and type of socially endorsed images on actual food consumption was not demonstrated here, hence, further research with sufficient power is required.

Thus, we acknowledge the primary limitation to this study is that, due to the unforeseen circumstances relating to the global COVID-19 pandemic, data collection had to be terminated early for this study. As a result, power was not reached for this study and so results should be interpreted with caution. However, we do demonstrate that there are promising trends which allude to novel and interesting results. Further research is needed with equal groups of lean individuals and individuals with obesity and overweight to examine these differences with sufficient power.

5.5 Conclusions

The present study suggests that individuals of different body weights may interact with social media posts and food cues in the environment differently, potentially suggesting that individuals with overweight and obesity may have enhanced attention to LED foods in the environment which can be amplified by social norms. Thus, it could be possible to nudge these individuals to consume more LED foods. Further research with sufficient power is required, and interventions may wish to consider the use of social media as a way of exposing participants to LED foods and encouraging healthy eating.

CHAPTER 6: Can social media be used to increase fruit and vegetable consumption? A pilot intervention study.

6.1 Introduction

Low fruit and vegetable consumption has been linked to various poor health outcomes including heart disease, cancer and stroke, whereas higher fruit and vegetable consumption has been linked to improved well-being and may help to prevent weight gain (Oyebode et al, 2014; World Health Organization, 2019). Thus, it is important to find ways to promote and encourage consumption of these foods, especially for young adults.

Indeed, norms have frequently been used as a basis for interventions aiming to reduce alcohol consumption (e.g. Neighbors et al., 2011; Ridout & Campbell, 2014; Vallentin-Holbech, Rasmussen & Stock, 2018), but less attention has focussed on using social norms as a basis for healthy eating interventions. One study demonstrated that viewing socially endorsed images of healthy or unhealthy foods (versus no social endorsement) lowered participants' preferences for HED foods over the course of three days, but not the amount of HED foods selected (Templeton, Stanton & Zaki, 2016). Additionally, a social norm-based intervention in workplace canteens also demonstrated that over a 6-week period, social norm posters stating that 'most people here choose to consume vegetables with their lunch' increased the number of meals bought with vegetables post-intervention (Thomas et al., 2017), suggesting that social norms could be one way of encouraging fruit and vegetable consumption in real life settings. However, there is very little additional evidence utilising social norms as a basis for encouraging consumption of LED foods, this is important as the experimental and cross-sectional evidence demonstrates their usefulness in encouraging healthier food choices.

One novel avenue through which norms may be communicated is social media, which is now highly prevalent within many people's lives. One study (Sharps et al., 2019) has considered whether a social media intervention using portion size norms could decrease portion sizes of HED snacks, through posting of 'other peers' snacks (and hence also the portion size of the snacks). Whilst the first intervention reduced participants' desired HED portion size in a within subjects' design, a second intervention, when compared to a control condition, had no effect on desired portion size. However, only confederate accounts were used which, as with our previous studies, may not reflect the activity of real-life accounts and so interventions utilising real social media accounts are needed, to see if these effects can be improved upon and improve the external validity of such approaches. Further, only HED foods were considered and so further research is needed to also investigate the effect of norm interventions on LED food consumption.

Less is also known about social norms on social media and whether these affect intentions to consume foods. This may be important as health behaviour models, such as the Theory of Planned Behaviour (TPB; Ajzen, 1991) suggest these can also predict our behaviour. The TPB focuses on the *intention* to carry out a behaviour, to predict if an individual will engage in the target behaviour, suggesting that this is determined by behavioural beliefs (an individual's attitude towards the behaviour and intentions to carry out the behaviour), perceived behavioural control (beliefs about one's ability to carry out the behaviour) and subjective norms (how others will think of engagement in the behaviour). Thus, the stronger these three components are in predicting the intention to carry out the behaviour, the more likely the actual behaviour is to be carried out (Ajzen, 1991). Indeed, the TPB has been applied to healthy eating behaviour (Conner, Norman & Bell, 2002) as well as healthy eating interventions with success (Louis, Davies, Smith & Terry, 2007) and could suggest the importance of also focussing on whether an intervention affects participants' intentions to consume fruit and vegetables. However, in these studies other social influence variables, such as social norms (descriptive and injunctive) resulted in increased intentions to consume fruit and vegetables, in addition to the TPB variables (Louis et al., 2007), suggesting there may be a role for social norms in affecting intentions to consume LED foods. Indeed, intentions to consume fruit and vegetables have previously been found to be affected by social norms (Stok, de Ridder et al., 2014) but to our knowledge this has not been investigated in the context of social media, or as part of an intervention, and so warrants investigation.

The present study

This intervention pilot study aimed to nudge healthy eating by encouraging fruit and vegetable consumption in low fruit and vegetable consumers as this is where an intervention is most likely to be beneficial. Also, previous studies have reported success when using norms to increase low consumers consumption of fruit and vegetables (e.g. Robinson et al., 2014). This involved asking participants who were low habitual consumers of fruit and vegetables to follow healthy eating accounts (e.g. accounts in which over half of the social media posts contained photos of fruits or vegetables) or interior design accounts (as a control) on the social media site Instagram, from a pre-approved list (see Materials section) by the research team. To ensure scalability for individual participants, they were asked to add 5% of the number of accounts that they were currently following. So, if for example, a participant followed 300 accounts, they were asked to follow 15 extra healthy eating or control accounts.

Aims

The first aim of this pilot study was to investigate whether exposure to the healthy eating intervention accounts (via different Instagram accounts) would increase participants' intentions to consume fruit and vegetables, as well as their self-reported consumption of fruit and vegetables, across a two-week period. Secondly, we aimed to investigate whether following the healthy eating accounts shifted perceptions about other Instagram users' fruit and vegetable consumption and whether this directly affected participants' self-reported consumption of LED and HED foods. It was hypothesised that exposure to additional healthy eating accounts would result in higher intended and self-reported consumption of fruit and vegetables, compared to exposure to additional control accounts. Further, it was also predicted that the perception of descriptive norms would mediate the effect of the intervention on participants' LED consumption, such that the intervention would increase participants' LED consumption as a result of an increase in normative perceptions. For example, that by following the intervention accounts, this would increase the perceived amount of fruit that Instagram users eat and consequently increase participants' own consumption of fruit.

6.2 Method

Participants

A total of 60 undergraduate and postgraduate students (62% women; 38% men; mean age = 22.0, SD = 2.3), completed the study. Participants were recruited via a Psychology Research Participation System and through social media and emails sent to students via departmental administrators. Participants were screened from taking part in the study if they did not meet the following criteria: low habitual consumers of fruit and vegetables (consumed less than 3 portions of fruit and vegetables a day), aged 18-65, non-smokers, current Instagram users and check their Instagram account regularly (more than 3 days a week; assessed via the question 'How many days a week do you check your Instagram account?'), and not follow more than 500 accounts. Additionally, participants with a BMI outside of 18.5- 40.0 or those who reported having eating disorders, food allergies or diabetes, were excluded from the final sample, as these participants are more likely to have atypical eating patterns; thus 8 participants were removed, leaving a final sample of 52. Participants were awarded course credits for their participation or entered into a draw to win one of three £100 Amazon vouchers. Ethical approval was granted by Aston Life and Health Sciences Ethics Committee (#1512) and carried out in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants.

Sample size

Based on our previous laboratory study investigating the effect of social media posts of food intake on low consumers of fruit and vegetables (Chapter 4), with alpha at 0.05, a medium to large effect size (f = 0.86), and power at 80%, the required sample size was 36. However, based on research suggesting a minimum of 20 participants per group (Robinson, Bevelander, Field & Jones, 2018), we aimed to collect data from a total of at least 50 participants completing the entire study.

Design

The study employed a 2 (Between subjects factor Condition; intervention or control) x 2 (Within subjects factor Type of Food; LED or HED) mixed factorial design. Condition consisted of asking participants to follow certain Instagram accounts (see Materials for details), which either contained a high proportion of highly liked posts of LED foods for those in the intervention condition, or highly liked posts of interior design, to act as a control condition. The dependent variables were changes in intentions to consume LED foods (fruit and vegetables) and HED foods (HED snacks and SSBs) and changes in self-reported consumption of LED and HED foods, across the two-week period between baseline and post- intervention.

Additionally, we also used a mediation model to examine whether a change in normative perceptions about other Instagram users' fruit and vegetable (or HED) consumption mediated the relationship between healthy eating intervention accounts (vs control) and participants' own fruit and vegetable (and HED) consumption. This was carried out with condition as the independent variable, normative perceptions of Instagram users' consumption of LED/HED foods as the mediating variables and participants own LED/HED consumption as the outcome variable.

Materials

The intervention was conducted using the online survey platform Qualtrics and comprised a series of questionnaires presented in the order below:

Visual Analogue Scales (VAS; Thomas et al., 2016): this scale assessed baseline and post-intervention mood and appetite (see Chapter 2).

The Usual Food and Drink Intake Questionnaire (Hawkins et al., 2020): measured participants' own habitual consumption and liking of fruit, vegetables, energy-dense snack foods and sugar sweetened beverages (see Chapter 2).

Lifestyle Questionnaire (Thomas et al., 2016): this was collected only at baseline and to measure sample characteristics and exclude participants based on study criteria (e.g. allergies).

Height and weight. Post-intervention, participants were asked to report their height in metres and weight in kilograms. This information was used to calculate BMI.

Intentions to consume LED and HED foods were measured using two questionnaires. The first, as used in Stok, de Ridder et al. (2014), measured intentions to consume fruit and vegetables over the following 2 weeks, using four items (e.g. I [intend/plan/want/expect] to eat sufficient fruit and vegetables over the coming time.') These were rated on a 5-point likert-type scale from 'completely agree' (5) to 'completely disagree' (1). A second questionnaire adapted the UFDIQ (Hawkins et al., 2020; Robinson, Harris et al., 2013), to ask how many servings of vegetables, fruit, HED snacks, SSBs participants intended to consume per day, over the two-week period. Participants responded with an open-ended response, giving a number to indicate their response. This scale, adapted from the UFDIQ, demonstrated reasonable reliability, considering it was based on a small number of participants, Cronbach's $\alpha = .59$.

Identification with Instagram users was measured using Visual Analogue scales (as in Stok, de Ridder et al., 2014), to measure how strongly participants identify as and affiliate themselves with Instagram users (see Chapter 3).

Social Networking Use (Slater, Varsani & Diedrichs, 2017): This assessed Instagram and other social media use (see Chapter 2).

Three Factor Eating Questionnaire-R21 (TFEQ-R21; Cappelleri et al., 2009): measured uncontrolled eating, cognitive restraint and emotional eating (see Chapter 2).

The Student Food Attitudes Form: measured normative perceptions about Instagram users' consumption of different foods and drink (Thomas et al., 2016; see Chapter 2).

Instagram accounts: A database of 50 Instagram accounts was compiled (25 healthy and 25 interior) by searching Instagram using hashtags (#healthyeating, #healthyrecipes, #healthyfood and #interiordesign, #interior), from which participants were asked to follow 5% of the total they reported following. Accounts were excluded if posts contained people eating, if the healthy eating accounts promoted a specific diet, photos of kitchens or dining scenarios, to discount these factors from biasing behaviour. The maximum number of accounts that participants could report following to take part was 500, so that adding 5% of accounts did not become burdensome and reduce compliance. To try to represent the social media environment and range of accounts participants may organically follow, accounts had a range of the number of followers, the minimum being 28400, the maximum was 5.1 million and the average was 1,517,207. Similarly, accounts were only selected for inclusion in the database if posts typically received at least 1000 likes. Participants were randomised to condition by the researcher using randomiser.org in the order that they expressed interest to the researcher and were emailed a list of accounts which they were instructed to follow within 24 hours.

Demand and compliance check*:* Post-intervention participants were asked what they thought the purpose of the study was (demand check), using an open-ended response. Participants were also asked at baseline for their Instagram name, so that the researcher could check if they appeared in the list of followers for their specified accounts. At the end of the whole study, participants were also asked how many of the accounts they had followed from the list they had been sent, to verify how likely participants were to be exposed to the intervention. Results of the compliance check are reported in the 'Results' section.

Procedure

Participants were told that the study was aiming to investigate Instagram use and lifestyle habits. After completing a screening questionnaire via email, including basic demographic information and inclusion/exclusion criteria stated above, participants were invited to complete the online survey through Qualtrics. Participants completed the questionnaires and were then assigned to a condition and provided a number of accounts to follow (from the pre-specified list by the research team) via email, with instructions to follow these accounts within 24 hours, for a two-week period. After this two-week period, participants were contacted, or booked a time-slot, and invited to complete a second shorter survey with the questionnaires, as well as report their height and weight (for BMI), demand awareness and compliance check. Participants were then fully debriefed as to the exact aims of the study, thanked for their time, and either credited or entered into the prize draw to win one of the vouchers. Each part took no longer than 15 minutes. Data collection took place from April 2020 – June 2020.

Analysis

For the main analysis, ANCOVA was used to examine differences between the control and intervention conditions for intentions to consume and self-reported consumption of LED foods (fruit and vegetables) and HED foods (HED snacks and SSBs), across time points, using change scores. Change scores between time points (e.g. post-intervention scores minus baseline scores) were calculated for each of these metrics.

A planned mediation analysis using PROCESS 16.3 v2 (Hayes), with Bootstrapping at 5000 was also carried out to further examine the mediating role of a change in normative perceptions about what social media users consume (perceived descriptive, injunctive, liking and frequency norms) on the effect of each condition and the change in participants' own LED and HED consumption. Change scores for normative perceptions and self-reported food consumption between baseline and post-intervention were calculated and used in analysis.

Covariates: theoretical covariates including baseline consumption, baseline VAS mood and appetite, TFEQ-21R eating styles, BMI, time spent using social media and affiliation with Instagram users were examined using correlations and examining baseline differences, as these may all affect food consumption and choice. Variables were included in the model if they significantly correlated (p<.05) with both LED and HED consumption outcome measures.

VAS: A principal components analysis (PCA) with Varimax rotation was carried out on the VAS items (mood and appetite) to use in analyses to check for covariates. This yielded 4 factors with eigenvalues >1, which accounted for a total of 72% of the variance. Factors included 'Feeling Unwell' (light headedness, nausea, faint), 'Appetite' (hunger, thirst, full (reverse coded), desire to eat), 'Negative affect' (sad, anxious, withdrawn) and 'Arousal' (alert, happy, drowsy (reverse coded). Once factors were identified, aggregate scores for each dimension were computed, inverting scores for items where relevant.

6.3 Results

Participant characteristics

The final sample comprised 52 participants (28 in control condition, 24 in intervention condition). Average BMI was within a healthy range (mean = 23.7, SD = 3.6). Forty two percent (n = 22) of the sample were Asian, 31% (n=16) were White, 17% (n=9) were Black and 9% (n = 5) were mixed race. For income, 48% (n = 25) reported their total family income as between £25,000 - £40,000, 25% (n = 13) as between £15,500 and £25,000, 15% (n= 8) as above £40,000 and 11% (n = 6) as below £15,500. For SES, 62% (n = 32) of the sample classed themselves as middle class, 29% (n = 15) as lower-middle class and 9% (n = 5) as lower class. Forty eight percent (n = 25) of the sample drank alcohol. For further baseline characteristics see Tables 23 and 24 for means. There were significant differences for fruit and vegetable consumption, as well as normative perceptions about how frequently participants consumed fruit and vegetables (all ps <.05). Baseline consumption of fruit and vegetable and HED snacks and SSBs were included in the final model as they were also highly correlated with both outcome variables.

Table 23. Baseline characteristics across conditions (means and standard deviations).

Measure	Control Condition M (SD)	Intervention Condition M (SD)	*T-test P* Value
BMI	24.1 (3.5)	23.8 (3.7)	.77
TFEQ-21R UC	2.3 (.4)	2.2 (.6)	.40
TFEQ-21R CR	2.3 (.5)	2.2 (.6)	.67
TFEQ-21R EE	2.2 (.8)	2.0 (.9)	.29

BMI – Body Mass Index; TFEQ – Three Factor Eating Questionnaire; UC – Uncontrolled eating; CR – Cognitive restraint; EE – Emotional eating

Table 24. Means and standard deviations for eating behaviour related measures across conditions.

Measure	Control Condition		Intervention Condition	
	T1 M (SD)	T2 M (SD)	T1 M (SD)	T2 M (SD)
Food preferences				
Vegetable liking	54.5 (25.5)	60.2 (32.1)	37.4 (31.2)	70.9 (23.2)
Fruit liking	58.9 (32.1)	64.4 (36.7)	61.6 (32.8)	79.5 (27.1)
HED snack liking	80.2 (20.3)	80.0 (22.2)	77.3 (20.1)	75.0 (19.4)
SSB liking	73.0 (33.5)	70.1 (32.5)	77.2 (24.7)	63.6 (26.8)
Normative perceptions				
FV Descriptive norm	2.6 (1.2)	2.2 (1.0)	2.9 (1.3)	3.2 (1.8)
FV Injunctive norm	2.9 (1.2)	2.5 (1.1)	3.7 (1.1)	3.3 (1.5)
FV Liking norm	58.5 (22.4)	62.5 (31.0)	63.7 (20.0)	75.2 (21.9)
FV Frequency norm	4.6 (0.4)	4.4 (0.9)	4.8 (0.5)	4.7 (0.4)
HED Descriptive norm	2.4 (1.1)	2.4 (1.0)	2.1 (1.3)	2.0 (1.1)
HED Injunctive norm	1.6 (1.0)	1.8 (1.0)	1.6 (0.8)	1.4 (1.0)
HED Liking norm	78.3 (19.6)	73.0 (22.2)	73.1 (24.8)	65.1(31.3)
HED Frequency norm	4.6 (0.6)	4.6 (0.5)	4.1 (1.2)	4.1 (0.9)

HED – High energy-dense; SSB – Sugar sweetened beverage; FV – fruit and vegetables

VAS mood and appetite scores

For VAS appetite items, thirst items, negative affect items and arousal items there were no significant main effects of time, condition, or a significant interaction between time and condition (all *p*s > .05) and so these were not included as covariates (see Table 25 for means and standard error).

Table 25. VAS mood and appetite scores across time points and condition

VAS Factor	Control Condition		Intervention Condition	
	T1	T2	T1	T2
	M (SD)	M (SD)	M (SD)	M (SD)
Appetite	48.5 (5.5)	54.1 (6.1)	56.1 (5.9)	40.7 (6.6)
Thirst	63.6 (5.4)	59.2 (6.2)	62.0 (5.8)	63.4 (6.6)
Negative affect	18.4 (3.1)	18.9 (3.3)	26.8 (3.3)	19.3 (3.5)
Arousal	23.4 (4.1)	26.9 (4.7)	30.3 (4.5)	25.4 (5.1)

VAS = Visual Analogue scale

Social media use

All participants had an Instagram account (100%) and used Instagram on average for more than 3 days a week (as stated in inclusion criteria). The modal time spent on social media was over an hour per day (46%) and 94% of participants also used other social media but there were no significant baseline differences between conditions for number of hours spent on Instagram ($p > .05$). The mean number of followers at baseline was 261 (SD = 274.4) and the number of accounts participants followed was 251 (SD = 230.9). Those in the control condition followed significantly more accounts (mean = 334, SD = 278.1) than those in the intervention (mean = 155, SD = 97.8) at baseline $t(50) = 2.99$, $p = .004$ and post-intervention $t(50) = 2.94$, $p = .005$ (control condition: mean = 296, SD = 166.3; intervention condition: mean = 175, SD = 120.8). There were no significant differences for number of followers (all *p*s >.05).

Affiliation with Instagram users

As participants in the intervention condition reported higher identification and connectedness with Instagram users, affiliation with Instagram users was entered as a covariate in the main analysis (see Table 26 for means).

Table 26. Mean VAS scores for affiliation with Instagram users.

VAS Factor	Control Condition	Intervention Condition
	M (SE)	M (SE)
Identification with Instagram users		
Baseline	46.4 (5.0)	60.4 (5.4)
Post-intervention	30.4 (5.1)	57.7 (5.5)

Connectedness to Instagram users		
Baseline	35.9 (5.5)	46.9 (5.9)
Post-intervention	26.6 (5.4)	50.8 (5.9)

VAS = Visual Analogue scale

Compliance

From the 85% who responded, for self-reported number of accounts participants followed, 80% (n= 40) reported following the correct number of accounts given to them for the intervention. There were no significant differences between condition, $X(1) = 1.62$, $p = .20$.

Main analysis

Based on significant correlations ($ps<.05$) with both outcome variables, baseline habitual consumption of fruit and vegetables (combined) for analyses with change scores for consumption of LED foods and habitual consumption of HED snacks and SSBs (combined) for analyses with change scores for consumption of HED foods were included in the model as covariates, along with identification with Instagram users.

Intentions to consume: results from the ANCOVA revealed that there were no significant differences between conditions for intentions to consume LED foods $F(1) = 0.36$, $p = .55$, $\eta^2 = .01$ over the 2 weeks, or intentions to consume HED foods $F(1) = .58$, $p = .45$, $\eta^2 = .01$. See Table 27 for means and standard deviations.

Self-reported consumption: ANCOVA revealed that there were significant differences between conditions for self-reported consumption of LED foods $F(1) = 6.34$, $p = .02$, $\eta^2 p = .12$ whereby those in the intervention condition significantly increased their consumption by an average of 1.37 servings of fruit and vegetables per day across the two week time period, compared to the those in the control condition who increased their consumption by .34 (see Figure 7). However there were no significant differences between conditions for self-reported HED consumption $F(1) = .57$, $p = .45$, $\eta^2 = .01$. See Table 27 for means and standard deviations.

Table 27. Means and standard deviations for intentions to consume and self-reported consumption across conditions.

Consumption (servings)	Control Condition			Intervention Condition		
	T1	T2		T1	T2	
	M (SD)	M (SD)	Change score	M (SD)	M (SD)	Change score
Intentions to consume						
LED consumption	2.6 (2.0)	4.0 (4.4)	1.42 (3.09)	1.8 (1.2)	2.9 (1.1)	1.10 (1.38)
HED consumption	3.5 (4.1)	3.5 (4.8)	.04 (4.4)	2.6 (3.5)	1.1 (0.7)	-.96 (2.15)
Self-reported consumption						
LED consumption	1.3 (0.8)	1.6 (0.9)	.34 (.93)	1.0 (0.6)	2.4 (0.9)	1.37 (1.02)
HED consumption	1.9 (0.9)	1.7 (0.9)	-.19 (.85)	2.2 (1.2)	1.4 (0.7)	-.81 (1.26)

LED = Low energy-dense; HED = High energy-dense

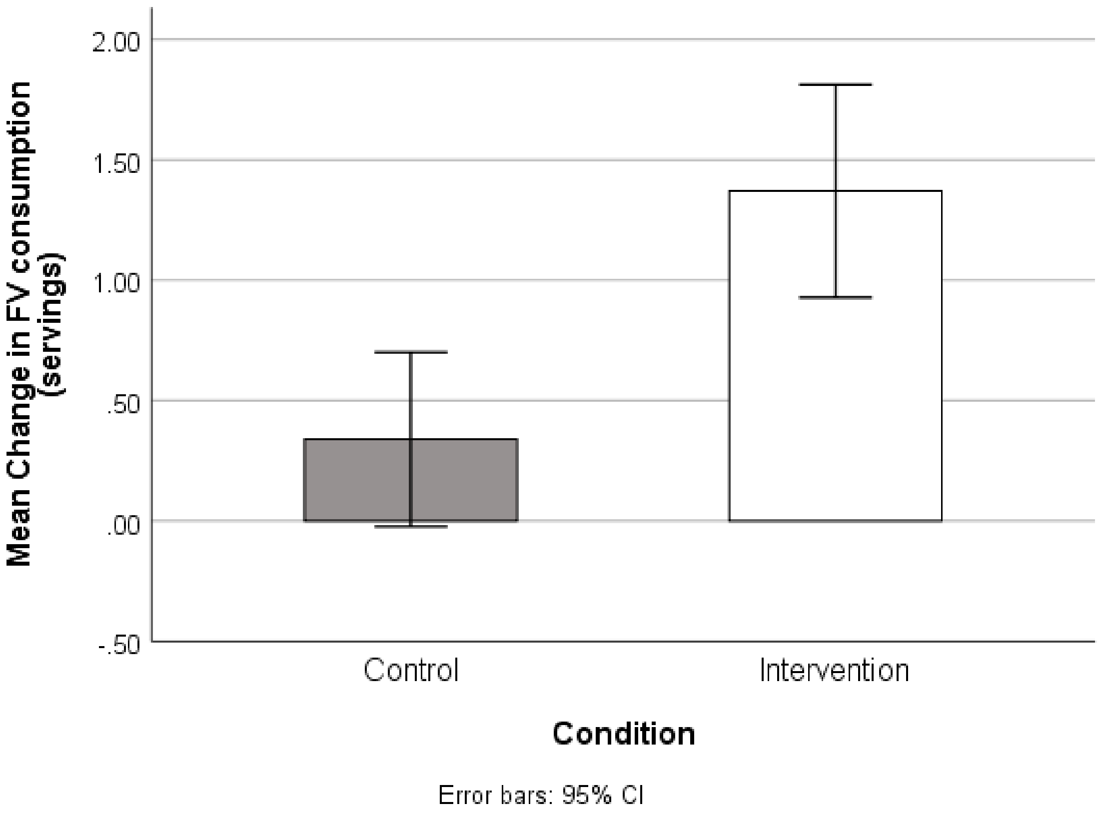

Figure 7. Differences in servings of LED foods consumed over the two-week period by those in the control condition and intervention condition

Mediation analysis

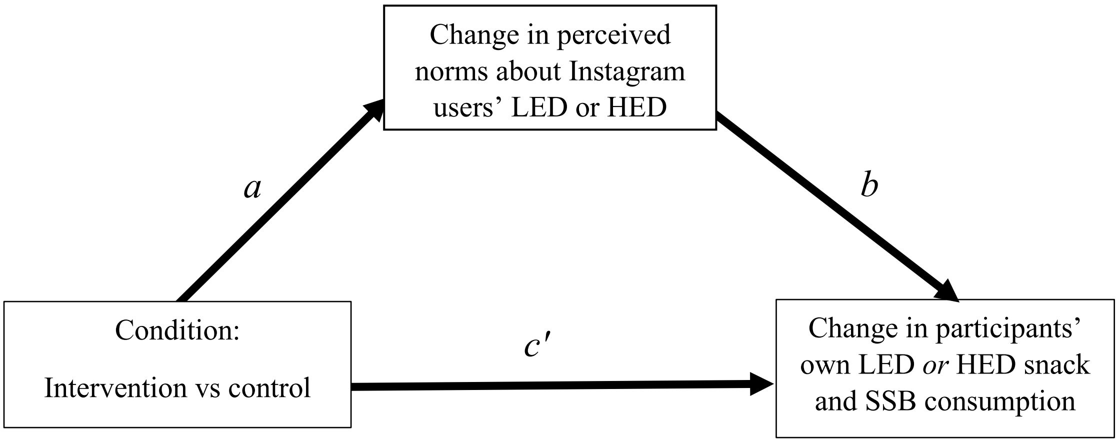

Figure 8. Mediation model of effect of intervention on the change in participants LED consumption via perceived norms about Instagram users' consumption of LED/HED food across the 2-week period.

For both LED and HED consumption, there were no significant indirect effects of intervention (versus control) via normative perceptions on participants' LED or HED consumption (all *p*s >.05).

Post hoc analysis

Given that there were significant differences between the conditions on measures of affiliation with Instagram users (identification and connectedness), and these have previously been found to be important within social norm effects (Liu, Thomas & Higgs, 2019), exploratory mediation analysis with Bootstrapping at 5000 samples was carried out to investigate if these were significant mediators of the effect of the intervention on self-reported consumption.

The was a significant effect of the intervention on identification with Instagram users (a path), B = 19.4, $p = .002$ and a significant effect of identification with Instagram users on change in fruit and vegetable consumption (b path) B = 0.02, $p = .003$. There was also a significant positive direct effect of the intervention on change in fruit and vegetable consumption (c' path), B = 0.74, $p = .02$. Further, there was a significant indirect effect of the intervention on change in fruit and vegetables consumed via identification with Instagram users, *ab* = 0.29, BCa CI [0.11; 0.59], so that those in the intervention (vs. control) condition increased their fruit and vegetable consumption, the more they identified with Instagram users. Identification explained around a third of the variance, $P_M = .28$. Additionally, there was a significant effect of the intervention on connectedness with Instagram users (a path), B = 16.11, $p = .02$ and a significant effect of the connectedness with Instagram users on the change in fruit and vegetable consumption (b path), B = .01, $p = .02$. Further there was also a significant direct effect (c' path) of the intervention on change in fruit and vegetable consumption, B = .85, $p = .007$. There was also a significant indirect effect of connectedness with Instagram users, on the relationship between the intervention and change in fruit and vegetable consumption, *ab* = 0.18, BCa CI [0.02; 0.47], so that those in the intervention (vs. control) condition increased their fruit and vegetable consumption the more connected they felt to Instagram users. Connectedness explained around a fifth of the variance, $P_M = .17$.

For change in HED consumption, there was significant effect of the intervention on identification with Instagram users (a path), B = 18.2, $p = .005$. There was also a significant negative indirect effect of the intervention on change in HED food consumption via identification with Instagram users, *ab* = -0.27 BCa CI [-0.81; -0.02]. For this, participants in the intervention condition ate less HED foods than those in the control condition, the more they identified with Instagram users. Identification with Instagram users accounted for around half of the variance, $P_M = .44$. There was no significant effect of identification with Instagram users on change in HED and SSB consumption (b path), or direct effect of the intervention on change in HED and SSB consumption (both *p*s >.05).

6.4 Discussion

This study aimed to test experimentally whether following ‘healthy eating’ Instagram accounts compared to interior design accounts, affected participants’ intentions to consume LED and HED foods, as well as their self-reported consumption of these. It was found that as hypothesised, over two weeks, those in the intervention condition who followed the ‘healthy eating’ accounts significantly increased their self-reported consumption of LED foods. However, their intended consumption of LED foods did not significantly increase. There were no significant effects of intervention or control for intentions to consume HED foods or self-reported HED consumption. Further, mediation analyses showed that, contrary to predictions, changes in perceptions of how much Instagram users consume, what they should consume and how much they liked to eat fruit and vegetables did not mediate the effect of the intervention and increased participants’ LED consumption. There was also no significant mediation of a change in perceptions for HED consumption. However, post hoc analyses revealed that measures of affiliation (identification and connectedness with Instagram users) did significantly mediate the effects of the intervention on increased fruit and vegetable consumption, and identification with Instagram users significantly mediated the effect of the intervention on the decrease in HED consumption.

Following the healthy eating accounts resulted in a large increase in reported fruit and vegetable consumption, over the two-week period. This is a substantial improvement to previous educational and social media-based interventions also trying to nudge healthier consumption (Rekhy & McConchie, 2014; Sharps et al., 2019). While exposure to the healthy eating accounts did not test a specific norm directly, in that posts may have portrayed a number of norms, which may have been interpreted differently by different participants, this fits with previous research suggesting that norms about others’ fruit and vegetable consumption have also encouraged participants’ consumption of these foods (Hawkins et al., 2020, Robinson, Harris et al., 2013, Robinson et al., 2014; Thomas et al., 2017).

However, mediation analyses showed that a change in perceived descriptive, injunctive, liking and frequency norms did not mediate the effect of the intervention on participants’ LED consumption or HED consumption. This suggests that perceptions about what others eat, like and approve of may not predict changes in actual behaviour. This could be for various reasons, for example it may be that participants may not have consciously picked up on the normative element of the intervention, suggesting that rather than having a more explicit effect on shifting perceptions, that the effects of social media and social norms may be implicit. Another explanation could be that perceptions instead may be static and not subject to change across time, which was also reflected in the means of normative perceptions in this study across the two weeks, indicating that consumption is not a consequence of a shift in perceptions. Of course, it could be that the time frame of this pilot intervention was too short to instigate such change, however post-hoc mediation analysis also demonstrated that other factors such as affiliation with Instagram users may also explain the intervention effects. Indeed, it is thought that wanting to be affiliated and liked by a group also leads to following the norm (Higgs 2015; Robinson et al., 2011). In this study, those in the intervention condition reported high affiliation with Instagram users and thus this may explain why following the accounts in the intervention was more likely to lead to changes in food consumption, as participants felt more affiliated with Instagram users and so were more inclined to follow the norms (e.g. number of likes/types of food consumed in posts) conveyed by the accounts in the intervention condition. This demonstrates that identification with the referent group could be an important mechanism through which norms on social media may be followed and that possibly targeting perceptions directly may not be as important when considering norm-based social media interventions.

Nevertheless, this suggests that social media can affect our own eating behaviour and demonstrates that social media could provide a viable method of encouraging LED consumption. While the long-term effects are not known those in the intervention condition increased their consumption by 1.37 servings, over just 2 weeks by following the healthy eating accounts, suggesting this sizeable effect can be achieved beyond a 24-hour period. Thus, if young adults who are low habitual consumers of fruit and vegetables were encouraged to follow just 5% additional healthy eating accounts, this could have significant implications for shifting their own fruit and vegetable consumption towards the recommended 5-a-day.

There were no significant effects of the intervention on HED consumption, which is unsurprising given that the target of the intervention was not to decrease consumption of HED foods. However, examination of the means suggests that it is possible that there may be an undetected compensatory effect of the intervention, with those in the intervention condition decreasing their HED consumption by nearly 1 serving (0.8 servings) a day over the two weeks, which again is a large effect in terms of shifting eating behaviour. It could be that this was undetected due to the small sample size used, which may not have detected this difference, as previous norm research has demonstrated that there may be compensatory effects of norms about fruit and vegetable consumption, whereby presenting a healthy eating norm can decrease consumption of HED foods (Robinson et al., 2014). The present study's results suggest that while the intervention did not directly affect HED consumption, when accounting for the mediating effect of identification with Instagram users', this was associated with a blunting of their HED consumption across the two weeks. This suggests that there is potential for healthy eating interventions to have positive indirect effects, although this appears to be dependent upon affiliation with the referent group, which also fits with previous research investigating the role of identity in norm effects on eating behaviour (Liu et al., 2019). A potential avenue for consideration is whether social media posts and accounts discouraging, or with low likes of HED foods have similar affects in blunting consumption of these foods, and potentially, indirectly enhance the consumption of LED foods.

Notably, there was also no effect of the healthy accounts on intentions to consume LED or HED foods, despite examination of the means suggesting an undetected effect of a decrease of nearly a serving in intentions to consume HED foods, for those in the intervention condition. This lack of significant effect is contrary to the TPB which suggests that intentions are highly important in predicting actual behaviour (Ajzen, 1991) and that previous health interventions utilising the TPB have successfully increased intentions to consume fruit and vegetables (Louis et al., 2007). However, the TPB uses different constructs to predict intentions and actual behaviour, and despite subjective norms being one of these, this may not be comparable with the present study. Instead, the present study suggests that we perceive others' behaviour as influential and this may have a stronger influence on actual behaviour than participants' own intentions or how they think they will be perceived by others (subjective norms). This does fit with research suggesting that additional social influence variables, such as social norms may be important when using the TPB as a basis for intervention in healthy eating (Louis et al., 2007). Thus, it may be that, as in the present study, social norms may be more useful predictors of actual behaviour, rather than intentions, as with the TPB and subjective norms. From a practical point of view, while intentions may be a good predictor of behaviour, they may also be more susceptible to self-presentation biases when self-reported, compared to actual behaviour. Additionally, there may be a disconnect between intentions and behaviour, meaning that intentions may not always predict behaviour, as found for other behaviours such as physical exercise (Sniehotta, Scholz & Schwarzer, 2005) and ethical consumption (Hassan, Shiu & Shaw, 2020). For example, one may not intend to eat fruit or vegetables but may also opportunistically consume these if they are available. Thus, if social norms are a more reliable predictor of actual behaviour then this may be more useful than predicting or trying to alter intentions to consume LED foods. However, further work is needed to see if these results can be replicated and are reliable.

Limitations and Future Work

While this study provides initial evidence that social media could be a highly useful tool for encouraging positive eating behaviour by young adults, there are a number of limitations. The first is that self-reported measures were used, and while these are an established and validated method of measuring food consumption (e.g. Robinson et al., 2016; Stok et al., 2014), they are subject to inaccuracies and social desirability bias in reporting. Thus, it would be useful to objectively examine consumption to confirm that these effects translate to actual eating behaviour (e.g. via measurement of intake in the laboratory). Second, as this was a pilot study, the sample in this study was reasonably small, and while large effect sizes were detected, it would be useful to confirm that these effects can be replicated with a larger, community sample. Thirdly, although these results demonstrate an effect at two weeks, further data are required to clarify whether this intervention can produce a long-term change in behaviour that is sustained and also to investigate precisely which norms may have resulted in the effects seen. Finally, from a manipulation of 5% additional accounts followed, we produced a reasonable increase in LED food consumption in low consumers. However, it is possible that stronger manipulation (10%) could produce an even greater behavioural change, and this is worth exploring, to better establish the parameters of the effect size that can be achieved.

6.5 Conclusions

The present pilot study demonstrated that a novel social media-based intervention asking participants to follow healthy eating accounts on the social media site Instagram over two weeks, resulted in an increase in self-reported fruit and vegetable consumption by 1.17 servings. However, this was not mediated by a shift in participants' perceptions about what they believed Instagram users eat, should eat and like to eat but by affiliation with the referent group. Although the intervention decreased intended servings and self-reported servings of HED snacks and SSBs by a portion, these differences were not significant for this sample. There were no significant effect or for intentions to consume LED and HED foods. However, this study does provide initial evidence that social media could be a useful tool with which to encourage healthy eating by young adults, who are low consumers of fruit and vegetables. Further research is now required to see if these results can be replicated in a larger, more diverse sample.

CHAPTER 7: GENERAL DISCUSSION

The aims of this thesis were to investigate the extent to which social media affects our food consumption and choice, within a social norm framework. The first aim was to investigate and compare whether different normative perceptions predicted food consumption, both acutely and over time using cross-sectional methods. A further aim as part of Chapter 3 was to examine if there were differences in how referent groups predicted consumption of different foods. A second overall aim was to extend this work, to examine the effect of social norms communicated via social media on actual food intake and to use experimental methods to understand how social norms on social media may explain our food consumption and choices via individual differences such as body weight and potential cognitive mechanisms, such as attention. A final aim was to examine whether social media can be used as a tool to encourage healthier eating. How each of these aims have been met will be addressed in the overview of findings (section 7.1). The strengths and limitations of each study, as well as the implications of these findings will be discussed in section 7.4 and 7.5.

7.1 Overview of findings

Previous literature had demonstrated that perceived norms about different groups and to an extent, different norms, could predict food consumption (e.g. Lally et al. 2011; Robinson et al. 2016; Schuz et al., 2018). This thesis, however, aimed to investigate the extent to which social norms within social media groups, affect and predict food consumption and some of the possible mechanisms behind this. The first two Chapters (2 and 3) aimed to examine how different and novel types of perceived norms predicted food consumption, both acutely as well as over time. The findings from the first study (Chapter 2) demonstrated that perceived descriptive and frequency norms for Facebook users' consumption of fruit and vegetables predicted an increase of 0.2 of a serving in participants' fruit and vegetables consumption and perceived injunctive norms predicted an increase of 0.35 of a serving in participants' consumption of HED snacks. Thus, norms about what others actually do predict consumption of LED foods, and norms about what others approve of predict consumption of HED foods. These novel findings, considering four types of norms within one study, provide new evidence that norms may selectively predict consumption of different foods, furthering previous evidence considering either descriptive or injunctive norms in isolation (Robinson, Harris et al., 2013; Stok et al., 2012; Stok de Ridder et al., 2014). Further, this study demonstrated for the first time that perceptions about social media circles do indeed influence what we eat. Additionally, this was also replicated in Chapter 3, where perceived descriptive norms were found to predict consumption of LED foods both at the point of measurement but also over the long-term. Similarly, injunctive norms about our social media circles were also found to predict consumption of HED foods, both at the point of measurement and over the long-term, demonstrating that there may also be lasting effects of norms about our social media circles.

Through experimental studies, another aim of this thesis was to investigate the effect of social norms communicated via social media on actual food consumption, as well as the possible mechanisms behind this and whether this effect varied according to body weight. It was demonstrated in Chapter 4 that socially endorsed social media stimulus can nudge actual consumption towards LED snacks by up to 12% to 14%, when considering energy intake, suggesting that norms about these wider circles may not only predict self-reported consumption but also affect actual consumption acutely. The exact mechanisms behind social norm effects, were largely unknown and so in Chapter 5 whether this varied according to body weight and whether social endorsement enhanced reaction times to different foods was investigated. While there were no significant findings, possibly due to insufficient power for this study, there were some promising trends suggesting that the socially endorsed images of LED foods resulted in individuals with obesity reacting quicker to low calorie stimulus, compared to high calorie or control stimulus. Thus, while further work is needed to replicate this with sufficient power, this may indicate that social norms and validation communicated via social media could enhance reactions to food cues within the environment for those with obesity. This may suggest that cognitive mechanisms could have a role in explaining how social norms have an effect.

A final aim was to test whether social media can be used as an intervention, utilising social norms in a more ecologically valid way. It was demonstrated in Chapter 6 that a pilot intervention using real social media accounts also significantly increased fruit and vegetable consumption by 1.37 servings a day over a two-week period. To investigate mediators of social norms further, the mechanisms behind this were also investigated and while a shift in perceptions did not appear to be a significant mechanism, identification with the referent group was a significant mediator.

Together, these results suggest that social norms communicated via social media may have an effect on what we eat both acutely and over time, encouraging LED food consumption in four out of the five studies. Additionally, this suggests that social media could be a useful tool with which to encourage LED food consumption and may have implications for social norm-based interventions. The key findings of this thesis are now discussed in more detail.

Expanding on pre-existing literature demonstrating associations between descriptive and injunctive norms and food consumption (Lally et al., 2011; Mollen et al., 2013; Robinson et al., 2014; Stok, Verkooijen et al., 2014), one of the aims of this thesis was to see if these associations expanded to perceptions about social media users' food consumption, as well as if these persisted over time. In both the cross-sectional and longitudinal studies (Chapters 2 and 3) LED consumption was predicted by perceived descriptive norms about Facebook users' consumption and HED consumption was predicted by perceived injunctive norms about Facebook users' consumption of HED foods were replicated. Thus, one major finding from this thesis is that, at least at the point of measurement, perceived descriptive and injunctive norms about social media users' consumption predict consumption of different types of food. However, additionally, the findings from Chapter 3 demonstrated that norms about Facebook users' consumption at baseline also predicted consumption over time. This is a relatively novel finding and only one study previously has examined the associations of peer norms with self-reported food consumption (Jones & Robinson, 2017). Specifically, from the results of this thesis, the associations between social norms about what Facebook users actually eat are consistent in predicting consumption of LED foods, which again may be a useful finding when considering implications for intervention.

However, while these were novel findings, there was no association of any of the perceived norms with BMI. In Chapter 2, it was hypothesised that this could be because BMI is more likely to be a consequence of longer-term intake, and so this association may not have been apparent in a cross-sectional study. However, this was also not found in the longitudinal study, for norms relating to social media. This could therefore suggest that perceptions about social media users' consumption do not predict BMI directly, either acutely or over time. Of course, if norms do have the predictive ability to alter participants' food consumption over time, this may have an indirect effect on participants BMI, although in this study this was not found through mediation analysis.

Additionally, in the longitudinal study in this thesis (Chapter 3), while there were differences between referent groups in perceptions of consumption of the different foods, there were no differences in perceptions over time for each of the groups, which suggest that perceptions are stable but can predict behavioural changes over time. However, there was a significant interaction between changes in perceptions over time for perceived liking of fruit and vegetables between the two groups, where the UK population were perceived to like fruit and vegetables more than Facebook users over time. Combined with the results that perceived liking norms predicted participants' fruit and vegetable consumption at T2 and T3, this novel finding does add to the current literature to suggest that liking norms may also persistently predict consumption of LED foods over a longer period of time. However, the lack of associations with other norms also hints at the inconsistent or selective effects that social norms about our social media circles may have and that over time, this may be less consistent.

As well as adding to the current literature on the effect of previously studied descriptive and injunctive norms the studies in this thesis, especially in Chapters 2 and 3 also aimed to examine the role of less frequently studied types of norms, such as liking norms in predicting and affecting food consumption in more depth. To date, only one study (Thomas et al., 2016) has explicitly examined liking norms and less is known about whether these have a consistent effect on food consumption. Over the course of all of the studies outlined in this thesis, there has been a mixed effect of liking norms, especially when studying them directly. For example, liking norms did not significantly predict self-reported food consumption in Chapter 2 when included in a model with other norms. This was also contrary to Thomas et al.'s findings that liking norms increased vegetable consumption. However, it is noted that actively presenting a persuasive liking norm, as in Thomas et al.'s study, is different to passively measuring perceptions and this may also explain the lack of an association with liking norms in Chapter 2.

However, when examining the predictive ability of liking norms over the course of 5 months and a year, this was more nuanced, with liking and injunctive norms also predicting consumption of LED foods over time, in addition to the other norms. This adds to the limited evidence (e.g. Thomas et al., 2016) that liking norms are associated with the consumption of vegetables in addition to a perceived descriptive norm, and further adds to the evidence that this could be sustained over a period of time. However, one difference to note is that liking norms positively increased consumption in Thomas et al.'s study, however in this study, liking negatively predicted consumption of fruit and vegetables. It is unclear why participants consumed less fruit and vegetables when they perceived the UK population to like them. However, one explanation could be, as noted in Thomas and colleagues' previous work (2016), that there is often a disparity between liking and consumption. For example, in Thomas et al.'s study, participants ate more of the broccoli even though they liked it less, reminding us that we may eat foods that we do not like because of health reasons, and vice versa, we may not consume a food, although we like it, for health or other reasons. Thus, in Chapter 2, the lack of association between participants' perceptions of how much others like a given food or drink and their own consumption, may reflect the fact that other factors such as health and liking predict consumption of a food. For instance, we may accurately perceive that most people like HED snacks, but liking may not be the most important factor in determining whether we consume them ourselves. Additionally, here in the longitudinal study, it may also explain the inconsistent associations with liking norms and why for some these increase consumption of fruit and vegetables but for others consumption is decreased.

In the experimental studies, while liking wasn't explicitly examined, manipulation of 'likes' was used, which had a significant impact on the proportion of LED snacks consumed. This is also conceptually similar to exposing participants to liking norms, which have also been shown to nudge healthy eating (Thomas et al., 2016). Taken together, this approach is a deviation from previous research, however, it achieved similar outcomes, and more importantly, the findings suggest that social media is a plausible method by which social norms are transmitted on a day-to-day basis, by posts and pictures of food that are socially endorsed. Further work exploring the precise nature of whether these norms were conveyed implicitly or explicitly is needed to understand fully how the manipulation exerted an effect. These results do however suggest that norms conveying social approval and liking and descriptive norms about what others eat may have an impact upon actual food consumption, providing additional evidence for the impact of others' liking on food consumption.

7.2 Mechanisms

Another aim of this thesis was to explore the potential mediators or moderators of social norm effects on food intake. One of these was measures of affiliation with the referent group (social media circles), which appeared to be a consistent factor as to whether social norms had a significant effect. For example, this was most directly studied in Chapter 3 where perceptions of social media users' food consumption and perceptions about the UK population's food consumption predicted participants' own consumption differently. There were key differences in which perceived norms about each group predicted participants' consumption, however perceived descriptive norms consistently predicted consumption of fruit and vegetables within both groups, again demonstrating that this is a stable association. However, perceived injunctive, liking, and frequency norms were also predictors of fruit and vegetable consumption but only when the norm referent group was the UK population. According to Social Identity Theory (Tajfel & Turner, 1986) identifying heavily with a group makes their behaviour more influential. Participants had higher scores of affiliation to the UK population than Facebook users and so this could explain why they were more likely to follow other norms for this group more so than for the Facebook group. In addition, this demonstrates that when we affiliate with a group, norms around their liking and approval (i.e. normative social influence) also becomes influential, as well as informational social influence and knowledge of what they do or eat. Of course, these groups may not be entirely different from each other, as social media users will consist of those who are also members of the UK population, but these proximal and more distal referent groups give an insight into how much participants may identify with social media users' and how this is associated with intake.

While significant associations were found over time for intake, perceptions about social media circles' eating behaviour did not predict BMI over the long-term and this was also not mediated by consumption, suggesting instead that there may be little relationship between norms around social media users' food consumption and BMI. Of course, it is important to note that measures of BMI were self-reported and so may have been open to bias, producing different results to measured BMI. However, norms about the UK population did predict BMI, indicating that instead this may be dependent upon referent group. Again, this could be because this sample identified with the UK population more so than with Facebook users and so these normative perceptions were more influential. Taking these results together demonstrates that that are differences between referent groups, in whether participants match their food consumption to those of Facebook users' or the UK population. However, it seems that while norms about social media circles can predict consumption consistently for fruit and vegetables and for HED snack and SSB consumption over the short-term, for long-term influence for other variables such as BMI, this may depend on how strongly we affiliate with the norm referent group, which in these studies was more in line with the general populations' behaviour, than social media users. This is useful as it may have implications for interventions, if one referent group is more important than the other and may demonstrate the areas where social norms can be most useful.

Additionally, in the other experimental studies in this thesis, participants had low affiliation with Instagram users and there were also null effects found for the socially endorsed images on food intake in Chapter 5. Again, one reason for this could be that social norms are more likely to be followed if individuals identify with the referent group (Cruwys et al., 2015; Higgs 2015; Stok, Verkooijen et al., 2014). As found previously with different referent groups, such as students, identifying strongly with the norm referent group can increase the effects of norms on food intake and has been found to increase vegetable consumption (Stok, Verkooijen et al., 2014). Indeed, there is also evidence that in the laboratory, identification with the norm referent group has moderated the relationship between descriptive norms and fruit and vegetable intake (Liu et al., 2019). However, in Chapter 5, identification with Instagram users was low, and so, participants may have been less likely to follow the manipulation and norm that was portrayed because they were not trying to fit in with this group (Tajfel & Turner, 1986). This also follows the lack of affiliation with social media users as compared to the UK population in Chapter 3.

Thus, it seems that identification with the referent group may be a moderator for whether social norms on social media predict and have an effect on food intake. In line with focus theory of normative behaviour (Cialdini et al., 1991), this may be because norms associated with the referent group may be made more salient and so focussed upon more, if participants identify strongly with the referent group. Further, and as found in other studies (e.g. Cruwys et al., 2015) if this is the case, they may then be more likely to want to fit in with the norms of the referent group, and so these norms have an amplifying effect on behaviour. This needs further formal testing, however this suggests that identification with the referent group could be a key moderator as to the extent to which norms, including more novel types of norms about social media users have an effect on and predict food consumption. Additionally, it may also explain the differences seen across the studies in this thesis, as to when social norms are likely to influence food consumption.

Further, as our initial post-hoc analysis in Chapter 6 demonstrated, when participants did identify with Instagram users, there were significant indirect effects of affiliation with Instagram users for the intervention on LED food intake, suggesting that identification is a mediator of social norm effects. Thus, it appears to also be an important mechanism within social norm effects. Further work is now required to establish the extent of this as a mechanism within social norm effects.

While some of the other social influences such as identification with the referent group have previously been considered as moderators and mediators of social norm effects (e.g. Cruwys et al., 2012; 2015), a further aim was to investigate whether other psychological processes, such as cognitive processes, as well as individual differences such as body weight, also impact social norm effects, as less was known about these processes. Whilst not fully powered, Chapter 5 demonstrated some promising trends with regards to these outcomes. Firstly, contrary to our hypothesis and previous laboratory study (Chapter 4), there were no significant effects of the socially endorsed images on food consumption. Given that the effect size was small, this may indicate that social norms about social media users are inconsistent in their effects upon food intake. However, those with overweight and obesity did consume a higher proportion of LED foods compared to their lean counterparts. This may reflect the dieting tendencies of those with overweight and obesity and BMI may be a factor that affects consumption over and above social norms. Thus, although not significant, it may be important to consider BMI and weight status as a variable to control for when studying the effects of social norms on social media.

In addition, there were differences in how quickly participants reacted to food stimuli after viewing the different socially endorsed images, with participants reacting faster to low-calorie food images after viewing socially endorsed control images, and to high calorie food images after viewing the socially endorsed LED food images. Further, individuals with obesity had quicker reactions to the low-calorie vs high calorie foods and were also faster to react to low calorie foods when viewing socially endorsed LED images, compared to lean individuals and those in the control and HED conditions. As argued previously (Kinard, 2016), this could be due to social desirability and the potential for those with overweight and obesity to want to fit in with the perceived norm, especially when this is endorsing low energy-dense foods. Nevertheless, these results could suggest that this social endorsement enhances attention to foods, especially for individuals with overweight and obesity. Thus, interventions aiming to change social media from an environment endorsing HED foods, to endorsing LED foods may be able to implicitly encourage consumption of LED foods.

While a major limitation was that it was not possible to reach the numbers needed to be fully powered (due to the COVID-19 pandemic), these results suggest that norms may enhance attention towards LED foods, especially for those with overweight and obesity. This suggests that norms may operate via cognitive mechanisms, such as attention and that if social media posts are socially endorsed this may enhance our attention towards the kinds of foods in these posts. This adds to the literature, which has previously established a connection between social media and cognitive mechanisms, such as attention and memory for foods (Murphy et al., 2020) but furthers this to suggest that this may also be enhanced by social norms. This also seems amplified for those with overweight and obesity, suggesting that it may be possible to nudge healthier consumption for these individuals via socially endorsed social media pictures. Of course, further work with a larger sample size is needed to establish whether these effects are achieved when fully powered. In addition, it was the aim of this study to also investigate whether the reaction times to the different food stimuli mediate the effects of the socially endorsed images on food consumption, to see if this is a mechanism. However, as the study was underpowered, it was not feasible to do this and therefore future work could investigate this further.

7.3 Social media as an intervention

Across all of the studies outlined in this thesis, there have been some positive and promising effects, demonstrating the utility of social norms in nudging behaviour via social media. For example, while socially endorsed social media posts did not affect the total consumption of LED and HED foods in Chapter 4, those viewing socially endorsed LED foods did eat a higher proportion of their intake as LED foods. These findings built on Chapters 2 and 3, demonstrating that social media can nudge actual eating behaviour, in addition to predicting self-reported consumption. Further, this also demonstrated that social norms communicated via social media can nudge the proportion of LED foods consumed vs. HED foods, which may be a preferable outcome for encouraging healthier eating, compared to changing total intake. Additionally, the results from this study, that the manipulation did not affect HED consumption, combined with the results from Chapters 2 and 3 that perceptions about our social media groups predicted consumption, suggests that norms may have an effect via a shift in our perceptions. For example, this manipulation may have worked for LED consumption, as a result of correcting participants' misperceptions, as in previous work (Perkins, 2002), whereas it may have been that participants already consume HED foods and so there was no norm to correct. Thus, social norms may have an effect on eating behaviour via a correction or shift in misperceptions and motivating participants to alter their behaviour to be in line with the norm referent group.

Indeed, this was focussed upon in the last Chapter (Chapter 6), using a pilot intervention. This aimed to build on the previous studies to investigate if additional social media accounts containing posts of fruits and vegetables can nudge participants' eating intentions and actual consumption via a shift in their perceptions. Additionally, a key aim of this study was to also to test whether social norms can be used in more ecologically valid ways, using social media to encourage healthier eating. The findings that following additional healthy eating accounts (vs interior design accounts) resulted in an increase in self-reported fruit and vegetable consumption extend the above findings and previous research to suggest that real social media accounts can encourage fruit and vegetable consumption. These findings also build on the previous studies' results, as well as previous research (e.g. Sharps et al., 2019) which have aimed to use social media as an intervention, demonstrating that social media can be a simple but effective tool to nudge consumption. However, contrary to predictions the effect of the intervention on increasing self-reported LED consumption was not mediated by a shift in perceptions. This could be for several reasons. One is that, as seen previously in Chapter 3 for perceived norms predicting BMI, perceptions may be a relatively stable construct and therefore may also not predict a change in consumption. Additionally, the finding that identification with the referent group was a significant mediator of the intervention effects shows that instead this may be the key mechanism through which social norms produce a significant change to food intake. Another possibility, is that when looking at the changes in normative perceptions for this study, liking perceptions were the only perceptions to appear to change over the course of the two-weeks. Thus, it may also be that liking of the foods may also be a mediator of intervention effects. This would also fit with the findings found in Chapter 3 that liking norms were significant predictors of LED food consumption over time.

Another explanation for the null effects of a shift in perceptions as a mechanism and one point to reflect on with the studies throughout this thesis, is that the studies and manipulations used did not explicitly state a norm to participants and participants did not explicitly note the number of likes or guess the aims of the study. Thus, despite participants appearing to match to the norm presented (e.g. number of likes in Chapter 4), or in line with the real-life accounts in Chapter 6, it was not possible to determine precisely which norms in these studies resulted in an effect. This is because a social media post could feasibly communicate a descriptive norm about what others actually eat, through the contents of the image, as well as liking and approval norms related to the number of likes. Therefore, it is hard to determine which of these specifically is behind the significant effects of the intervention or manipulation presented in the studies here. Thus, further research is required to examine this possibility. Nevertheless, this seems to suggest that the manipulations and interventions implicitly conveyed normative information. This is similar to previous work that implied a norm via the presence of empty wrappers, signalling a particular food choice (Prinsen et al. 2013). It is also supported by the findings that perceptions were found to directly predict LED and HED consumption in Chapter 2 and 3, which suggests that certain perceptions about social media users and consumption of different foods could be implicitly communicated, particularly about fruit and vegetables on social media. Therefore, by deviating from previous more explicit measures using posters (e.g. Robinson, Harris et al., 2013), it appears that it is possible to nudge eating behaviour with these simple implicit factors, using social media.

Although it is hard to determine whether descriptive or liking, or other norms were responsible for the effects seen in the intervention and manipulation, these results build on the previous social norm literature (see Robinson, Blisset & Higgs, 2013; Higgs et al., 2015 for reviews) to suggest that norms on social media may affect consumption through either informational social influence, via images of what others eat, or normative social influence via the number of likes, denoting others' approval and liking of foods. Thus, social media may be an effective and useful but also easily administered intervention to help encourage consumption of LED foods. It is important to note that participants were low consumers of fruit and vegetables in this study and these findings are contrary to the findings of Chapter 5, where manipulated social norms did not have an effect. This may suggest that an intervention using real social media posts may be more effective, than a laboratory setting, as the study in Chapter 5 had little effect on actual food consumption in low consumers. This may therefore highlight that it could be important to ensure social media interventions are ecologically valid. Finally, this intervention study also fits with the previous studies in this thesis to suggest that affiliation with the norm referent group is a key mediator in this, as those in the intervention condition scored highly on the identification with Instagram users' measures.

Interestingly following the real social media accounts had no significant effect on intentions of participants to consume more fruit and vegetables, this is contrary to the TPB and previous health interventions using the TPB as a model (e.g. Louis et al., 2007). However, given that the TPB uses attitudes, subjective norms and perceived behavioural control to predict intentions and behaviours and the intervention study only focussed on social norms, it is somewhat unsurprising that these have resulted in different findings. Further, as Louis et al., (2007) also found, additional social influence variables such as social norms as studied here, rather than subjective norms and other behavioural factors, also predicted intentions and behaviour and so social norms, rather than subjective norms may also predict intentions and behaviour but perhaps in a different or more selective way. This may be especially true given the difference in intention to consume nearly a portion less HED snacks and SSBs at post-intervention, by those following the healthy eating accounts, suggesting that there may have been an effect but that numbers in this pilot study were too small to detect a significant difference. If this is the case, according to the Theory of Planned Behaviour (TB; Ajzen, 1991), these intentions are also likely to predict actual behaviour, which in this case would also result in a decrease in HED snack and SSB consumption for those in the healthy eating condition. Taken together these results suggest that social norms are a distinct and potentially more useful construct in predicting actual behaviour and intentions and demonstrate that social media may be a viable tool by which to nudge consumption towards healthier choices.

7.4 Summary of findings

The findings of this thesis have tested the model displayed in Figure 9 below, that exposure to social media can alter behaviour via identification with the referent group. Further work is now required to test this assertion with a larger and more diverse sample, as well as using this to measure actual food consumption in addition to the self-reported measures used in the intervention study. Further, it would also be useful to establish whether the intervention can sustain a long-term effect past the two-week intervention period tested here.

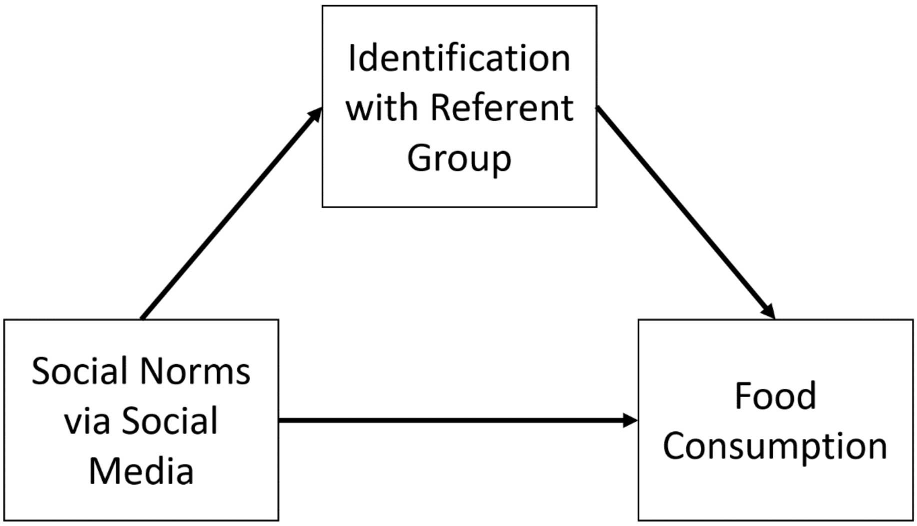

Figure 9. Proposed model for effect of social media on food consumption, with identification with the referent group as a potential mechanism

Overall, the findings from this thesis have demonstrated a number of ways in which social media can influence our perceptions about what social media users eat and consequently what we eat. Firstly, perceptions of the norm about social media circles consumption of fruit and vegetable appear to consistently predict fruit and vegetable consumption, at the point of measurement but also over a period of 5 months and for as long as a year. It has also been demonstrated that perceived norms about social media users' approval can predict consumption of HED snacks and SSBs over both the short-term and up to 5 months. This therefore shows that perceptions can predict consumption directly (Figure 9). However, as in Chapter 4 when testing the effects of social media stimulus and manipulating a norm, this only translates to nudging proportions of LED foods actually consumed. Further, as demonstrated across the studies, whether we identify highly as a social media users can also determine if we are likely to follow the norms set by this wider social circle, demonstrating that identifying with the referent group is a mediator of social norm effects (Figure 9). Additionally, as demonstrated in Chapter 5, individual factors such as body weight may be moderators which affect this. Similarly, attention to social norms and social media may be a key mechanism in how social norms have an effect, although this requires further work to formally test this as a mediator, with a bigger sample. Finally, as demonstrated in Chapter 6, social media can result in a change to what we self-report eating, and as demonstrated here, shows the potential that social media may have in nudging healthier eating. This may be particularly useful for targeting low habitual consumers of LED foods, however further work is required to compare this group within a more diverse sample and establish who this intervention would be most useful for.

7.5 Implications

The implications of these findings suggest that perceptions about our wider social circles can nudge eating behaviour towards healthier options. This suggests that social media may be a simple but effective tool with which to nudge healthier choices, especially for those who are low consumers of LED foods and where there is substantial opportunity to correct misperceptions and alter behaviour. Although further studies are needed, a simple but effective intervention in this thesis has been to ask social media users to increase the amount of healthy eating accounts they follow. If this kind of intervention is effective with a more diverse sample, this could have useful implications for public health and inform social media-based interventions to encourage healthier eating. Further, there are also implications for industries which may use social media widely to advertise and market their food products, with the need to consider these findings on how social validation and others' behaviour and approval may be implicating the types of foods consumed, particularly given that a lot of advertisers use celebrities to market big brands and HED foods via social media (Kusumasondjaja & Tjiptono, 2019). Interventions could involve having influencers communicate more about LED foods and validate each other's LED posts, rather than branded, HED foods (Holmberg et al., 2016; Kusumasondjaja & Tjiptono, 2019; Qutteina et al., 2019). These findings could also inform policy around the ways in which advertisers market their products. Further, given that different norms may predict consumption of different foods, the findings of this thesis could also be used to develop marketing strategies and encourage more healthy options, particularly using descriptive norms, as found in

Chapter 2. Nevertheless, as much of the population now uses social media (UK Office for National Statistics, 2019), the findings of this thesis demonstrate the utility social media could have in altering eating behaviour towards healthier options.

Further, these findings also suggest the importance that social influence could have within a modern environment. For example, in the current obesogenic environment, and given that there are a high proportion of HED foods posted on social media (e.g. Holmberg et al., 2016), informing individuals of the ways that they can harness social influence to their advantage and choose their own wider social circles, and who they are likely to be influenced by, could be highly beneficial. While helping those with obesity is multifaceted and further work needs to be carried out, the results of the intervention study suggest that if individuals were to follow more accounts which focus on LED foods and which are also highly endorsed by others this may also have beneficial effects in shaping their food consumption. Using this kind of a nudging technique within their own social environment, even just by being aware of the accounts or kinds of foods and diets they observe being liked and endorsed by others, could potentially have an effect on an individual's eating habits. It also demonstrates the potential for individuals to shape their wider environment from one which is potentially 'unhealthy' and obesogenic, towards one which may implicitly guide them towards healthier choices. This does need to be tested further with larger studies, but it might present a way in which social influence could be used to support navigating the modern and obesogenic environment in wider online social circles, as well as wider social circles offline, by re-shaping the environment to encourage and support a more balanced lifestyle.

7.6 Strengths, limitations and future work

This body of work has aimed to examine key questions about whether and how social media may affect our eating behaviour. A key strength of this is that by using various methodologies and by studying various norms, it has been possible to not only establish various associations but also examine whether social norms on social media have an effect on actual eating behaviour. Within this, strengths of this work include studying the influence of lesser-studied types of norms such as liking and frequency norms, and including these in a novel model, to consider the associations these have with food consumption. Another strength includes studying various co-variates and variables and controlling for appropriate ones, resulting in confidence when attributing the effects demonstrated to the manipulations and associations studied. Additionally, whilst further research is needed to robustly test this with larger samples, this thesis demonstrates some of the potential mechanisms by which social norms exert their effects, furthering the research in this field. Further, these novel findings have led to piloting an easy to administer, potentially scalable and reasonably accessible pilot intervention, which has demonstrated positive results in terms of changing eating behaviour.

However, there were inevitably some limitations. For example, while studies were designed to incorporate a representative sample, this was not always achieved, and a majority of the samples used within these studies were women, who were often undergraduate students. While females are more likely to be affected by social influences around eating (Robinson, 2015), future work would benefit from recruiting more men into these kinds of studies. Although, an attempt was made at including a more diverse sample in some of the studies, further, larger and more diverse samples would make it possible to robustly and formally test the usefulness of social media as an intervention and replicate some of the results seen within the intervention and experimental chapters. Taken together, the findings from Chapters 2 and 3 suggest that social media circles may have an implicit effect by affecting our perceptions of what others eat and that this is consistent at the point of measurement and over the short term. However, one limitation which may affect the longitudinal results is that the sample sizes for the longitudinal analysis of this study were reasonably small and so may limit the conclusions. Thus, it is important to try to replicate this with a larger sample also, to see if these associations with social media users are retained.

As the above pilot intervention study (Chapter 6) suggests, social media shows promising potential for a simple but effective tool by which to nudge healthier food consumption. Whilst it has been demonstrated that social media can affect eating behaviour in a variety of different ways, many of the above studies use either self-reported consumption or BMI methods, which can be subject to bias or inaccuracies, or experimentally manipulated stimuli, limiting the ecological validity and knowledge of whether this can affect actual eating behaviour. While self-report measures are typical of cross-sectional studies (Lally et al., 2011; Robinson et al., 2016), it would be beneficial to establish the extent to which social media can be used as a basis for a social norm intervention in more realistic and everyday settings, using real life accounts. Initially, this may also mean testing it with a larger, more diverse sample, however it would also be beneficial to study whether these effects translate to real life settings and actual eating behaviour. Further, while the study in Chapter 3 suggests that social media can predict consumption, as well as BMI over several months, this may be different when providing actual accounts. Thus, it would be useful to know the long-term effects of these interventions to understand the parameters within which social media may exert an effect.

Additionally, while perceptions appear to be a key part of how social media can predict eating behaviour, due to a-priori predictions, some cross-sectional studies in this thesis did not account for a potential false-consensus effect (Robinson, 2015), where participants' own behaviour may also inform their normative perceptions about others' eating behaviour. While the experimental and pilot intervention studies in this thesis suggest that norms do inform behaviour, it would also be useful to consider the bi-directional nature of these associations.

Further, although in many studies, including the pilot intervention, it was a requirement for participants to be a social media user, for some studies such as those using the experimental manipulation this was not the case. Given that it has been demonstrated in the above studies that identification with the norm referent group is important in how social media has its effects, these studies may be producing different results than if only social media users had been recruited. Thus, while a significant proportion of the population do use social media (Statista, 2021), it may be useful for future studies to ensure that those that form part of intervention studies are social media users. Although many of the participants in our studies were social media users, future work might also further explore whether the perception of norms in a social circle that one does not reside within (i.e. an out-group), does not influence or predict consumption, or whether the unique properties of social media and digital social circles circumvents this, such that the norms of an out-group are influential.

Finally, while the study in Chapter 5 aimed to establish potential mechanisms behind the effects of norms and also the individual factors which may interact with norms, such as body weight, due to limited power it is hard to make firm conclusions about this. Research with larger samples and equal groups of those with obesity and lean individuals is therefore required.

7.7 Conclusions

This thesis has demonstrated that social media can predict and affect eating behaviour in different ways, through our perceptions. As demonstrated by the findings in Chapters 2 and 3, social norms about social media users' consumption significantly predict consumption in different ways, with different normative perceptions predicting consumption of different foods. This was also the case over time. Further, in Chapter 4, exposure to socially endorsed social media posts of LED food can nudge the proportion of LED foods that are subsequently consumed, suggesting that norms communicated implicitly on social media, can affect our food choice as well as consumption. In Chapter 5, the findings, although not reaching significance, suggested that there may be differences in how those of different weight statuses are affected by social norms communicated via socially endorsed social media posts. Additionally, attention may also be enhanced towards LED foods, in those with overweight and obesity, which may be amplified by social norms, however, further work with a fully powered sample is required to establish this. Finally, in Chapter 6, it was demonstrated that a simple, ecologically valid intervention, asking participants to follow additional healthy eating accounts encouraged low consumers of fruit and vegetables to consume an extra 1.4 portions of fruit and vegetables a day, via identification with Instagram users. This is a substantial increase and suggests that social media may have an effect on food consumption, with identification with the referent group a key mechanism of this effect. This has the potential for significant implications, for both public health interventions and policy, as well as other sectors such as marketing and advertising industries. Further work is now required to examine whether these effects of a social norms-based social media intervention can be replicated with larger and more diverse samples, and also, with actual eating behaviour.

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