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BMI and explicit-implicit cues on food choice: The fake food buffet in the United Kingdom and Indonesia

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ABSTRACT

We examined whether people with high BMI sampled from two different countries were more susceptible to behavioural change via an implicit, rather than explicit, intervention. We measured BMI and used three types of cue interventions (implicit vs explicit healthy lifestyle cue vs neutral cue) to examine their impact on our participants' food choice using the Fake Food Buffet. Healthiness of the meal chosen was measured by the percentage of healthy food items in the meal. Portion size of their chosen meal was operationalised by the total number of food items chosen and its total calorie content was also estimated. Participants were recruited from the United Kingdom ($N = 264$) and Indonesia ($N = 264$). Our results indicated that while explicit food cues were overall more effective, implicit cues were a more effective strategy to change food choice behaviours among individuals with high BMI. Participants with high BMI were more likely to regulate the healthiness of their meal and less likely to regulate its portion size or calorie content. The efficacy of our healthy eating interventions was cross-culturally generalizable. Our study supports previous research that implicit cues of a healthy lifestyle might be a more effective behavioural change strategy for individuals with high BMI.

The obesity epidemic has been reported to be present in both developed countries and developing countries (Boutari & Mantzoros, 2022; Prentice, 2005). In the United Kingdom, between 2021 and 2022, the percentage of overweight adults was 38.6% while obesity prevalence was 25.2% (Timpson, 2023). In Indonesia, overweight prevalence increased from 17.1% in 1993 to 33% in adults in 2014 (Oddo et al., 2019) and obesity prevalence has been reported to be 35.4% in 2018 (UNICEF, 2019). Overconsumption of food has been found to be an important factor in obesity (Blundell & Cooling, 2000; Upadhyay et al., 2018).

Obesity is related to both quantity and perceived healthiness of dietary choice. Many studies found that participants who were overweight were more likely to choose high-calorie food and preferred both healthy and less healthy foods compared to people who were not overweight (Dressler & Smith, 2013; Howarth et al., 2007). Maskarinec et al. (2000) found that BMI was positively associated with daily meat intake and negatively associated with the consumption of vegetables, beans, and frozen foods (Kanciruk et al., 2014; Rouhani et al., 2014). Teenagers who were overweight or with obesity have also been reported to eat more red meat, processed meat, and cheese than teenagers with a healthy weight (Gaylis et al., 2017; Konieczna et al., 2019). Nevertheless, the relationship between BMI and food decision-making behaviour has not been found consistently (Murakami et al., 2022): BMI has also been reported to not correlate with a high fat diet (Keskitalo et al., 2008), dairy, meat, grain, fruit, and vegetables consumption (Kant et al., 1991), nor energy dense and nutrient-poor food (Kant, 2000) while other researchers reported an association between BMI and fast-food, sweetened beverage consumption, and larger food portion sizes (Lemamsha et al., 2022). In addition, energy density of food consumed is not the only factor, specific type of food consumed also matters. For instance, olive oil and nuts have high energy density but were found not to be associated with weight gain (see Romieu et al., 2017, for a review). Hence, one reason for these inconsistent research findings is that people make food choices based on whether they categorize the food item as healthy or not, and quantitative (e.g., portion size) characteristics of food. Though caloric density is important for overall body weight management, research has found that most people under-estimate caloric density (Burrows et al., 2019). Hence, it is important to examine the impact of psychobehavioural interventions on both quantity and perceived healthiness of the food chosen among individuals who

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are overweight and those with healthy body weight.

Another possible explanation for the association between BMI and food choice might involve the dual processes underlying food choice decision, namely spontaneous and deliberate decisional processes (Cervellon et al., 2007; Perugini, 2005). According to the reflective-impulsive model (Strack & Deutsch, 2004), a spontaneous process tends to be automatic, impulsive, and effortless. In contrast, a deliberate process arises from more reflective, effortful, controlled, and thoughtful processes (Shiv & Fedorikhin, 2002; Strack & Deutsch, 2004; Yang et al., 2012). Previous studies claimed that people who used spontaneous processes were more likely to make poor food decisions and ate larger food portions (Davis, 2013; Hofmann et al., 2008). Schiff et al. (2016) reported that people with higher BMIs had a higher sensitivity towards immediate reward for food while a meta-analysis reported a positive association between obesity and impulsivity (Robinson et al., 2020). Conversely, people with a healthy BMI engaged in more deliberate processes to make healthy food choices for long-term health goals (Hofmann et al., 2008). Considerable evidence suggested that people who were overweight or with obesity were more sensitive to external cues towards food (Tetley et al., 2009; Kaisari et al., 2019). These cues might have altered their food choice without their awareness (Vartanian et al., 2008). Subtle cues, such as the appearance of delicious food, could easily evoked desires to shape behaviour by arousing simulations of past pleasures from the consumption of similar food (e.g., Papies & Barsalou, 2015; Stroebe et al., 2013).

External cues can be presented as implicit or explicit stimulus. Individuals exposed to implicit stimuli are consciously alerted to the priming stimulus, but not the purpose behind the primes (Bargh & Chartrand, 2000; Hollands et al., 2016). For example, the exposure of fruit odours increased fruit and vegetable selections (Gaillet et al., 2013, 2014) and exposure to oranges reduced unhealthy snack consumption (Buckland et al., 2013). Similarly, a poster depicting a slim person reduced food consumption (Ohtomo, 2017; Papies & Hamstra, 2010), and a set of scrambled words priming a healthy goal (i.e., healthy, non-fat, fit) influenced participants' choice for healthier snacks (Walsh, 2014). In contrast, an explicit stimulus priming strategy is where the individual is consciously aware of the specific characteristics of the cues and its purpose to elicit the target behaviour. For instance, a phone message and three mailings of pamphlets and advertising materials that promoted the consumption of fruit and vegetables increased their consumption (Williams-Piehota et al., 2004). Robinson et al. (2013) used a message that highlighted the health benefits of reducing fast food intake reduced people's high-calorie snack consumption. Hence, both implicit and explicit cues have been shown to be capable of persuading people to choose healthier foods.

People with high BMI were found to be more susceptible to implicit cues rather than explicit cues (Mas et al., 2019). For example, non-attentively high caloric dense food odour increased the attention bias for high caloric dense food among adults with obesity (Mas et al., 2019). Children with obesity who were exposed to fruity odour selected more fruit (Marty et al., 2017) and another implicit cue such as a healthy recipe flyer reduced unhealthy snack purchasing behaviour among shoppers who were overweight (Papies et al., 2014). The study reported in this manuscript investigated whether implicit cues could induce a healthy food choice among participants who were overweight or with obesity when compared to individuals with healthy weight. We also expanded our investigation through a cross-cultural comparison of this intervention between WEIRD (i.e., participants from White, Educated, Industrialised, Rich, and Democratic societies) and non-WEIRD samples.

Culture is a significant determinant of food choice (Landman & Cruickshank, 2001) but most research on obesity has been conducted in high income countries rather than low- and middle-income countries like Indonesia (Romieu et al., 2017). The few cross-cultural studies have focused mainly on food related attitudes such as weight concern and positivity towards food (e.g., Rodríguez-Arauz et al., 2016; Rozin et al., 2003; Sproesser et al., 2018). However, less research has been done on how a cue-based food intervention would affect food choice across cultures. Though in our study we standardized the same food items tested in the United Kingdom and Indonesia, the food items differed in familiarity in different cultures. For example, muffins are less common as a dessert in Indonesia than the United Kingdom: cultural familiarity for specific food items (e.g., neophobia) can influence food choice (Jaeger et al., 2021). Moreover, a cross-cultural examination of food choice is important because the wealth of a country is associated with food security (Baer-Nawrocka & Sadowski, 2019) and food security has been found to influence healthy food choice (Shi et al., 2021). Hence, we examined the cross-cultural efficacy of our intervention in a high-income country (UK) and a middle-income country (Indonesia) where these countries have different levels of food insecurity: interventions to change food choice might be less efficacious in less wealthy nations with a higher prevalence of food insecurity when compared to wealthier nations.

Based on the inconsistent research evidence, BMI could predict an increased likelihood of healthy or unhealthy food choice. Hence, we hypothesized a non-directional relationship between BMI and its relationship with the healthiness of food choice. That is, participants with higher BMI could predict healthier food choice or unhealthier food choice compared to participants with lower BMI. We also hypothesized that participants would be most likely to choose healthier food after viewing implicit or explicit health related cues as compared to non-health related cues. In addition, we also predicted the interaction effect of the type of cues and BMI on the participants' healthy food choice. Specifically, we hypothesized that implicit cues would be more effective in eliciting healthy food choices among individuals with high BMI.

1. Method

1.1. Participants

The sample size was determined via power statistical analysis using the software G*Power 3.1 (Faul et al., 2009). Rodriguez et al. (2015) used a cue that reduced their participants' selection of high-calorie snacks and reported a medium effect size of OR = 2.42. Using this effect size at 95% power and $\alpha = 0.05$, our power analysis yielded a target sample size of 264 participants for each country with a total sample of 264*2 = 528. Participants recruited were born and raised in their respective countries and international students were excluded from the study. UK ($n = 264$) and Indonesian ($n = 254$) undergraduates were recruited for this study. Those on medically or non-medically prescribed dietary restrictions (e.g., vegetarian, vegan, lactose-free, Celiac Disease) and those with significant visual impairments were not eligible for this study. Participants were given a choice of receiving course credit or a drink voucher for participation. The cost of the voucher was £2.40 (UK) and £1.80 (Rupiah 35,000; Indonesia). The UK sample had 68 male participants (25.7%) while the Indonesian sample had 132 male participants (50%), $X(1, N = 528) = 32.97, p < 0.001, \phi = 0.25$. Gender was entered into the analysis as a covariate. The research ethics for this study was approved by the Faculty Research Ethics Board in the UK (reference number: FHS78) and the Indonesian University research ethics committee in the Psychology Department. Data collection was done between April 2019 to January 2021.

1.2. Procedure

Before their arrival to the laboratory, each participant was instructed not to eat in the 4 h before their participation. Participants were randomised into the implicit, explicit, or control cue intervention groups. Participants were not told of the hypotheses for the study nor the interventions. They were informed that the study was about BMI and food choice and that they would be asked to 'serve themselves a meal that they would typically have for lunch'. After obtaining informed consent, gender, age, self-rated hunger, and BMI were recorded. Participants were then shown the cues relevant to their assigned conditions. Next, the participants completed the Fake Food Buffet (FFB; Bucher et al., 2013).

1.3. Materials and measures

1.3.1. Cue conditions

There were three between-subject cue conditions: implicit, explicit, and neutral cue. Each cue condition had 264/3 = 88 UK participants, and similarly, 264/3 = 88 Indonesian participants. The implicit and explicit cue conditions used the same printed adverts for both UK and Indonesian participants (see supplementary materials Appendix 1), but participants in each of these cue conditions were tasked to evaluate different aspects of the same material (i.e., the instructions given to participants in these two conditions differ; Appendices 5 and 6). The materials used in both the implicit and explicit cue conditions were three adverts featuring photographs of slim figures to increase the motivational value of achieving an ideal weight. Prior studies showed that such ideal weight stimulus have successfully promoted participants to make healthier food choices (see Fishbach et al., 2003; Papies et al., 2014). Our adverts displayed health-related activities (e.g., exercising, eating healthy foods) along with six words related to body image such as *diet, healthy, slim, fit, weight,* and *slender,* presented as hand flyers. Each advert was shown to each participant on a printed half A4 sized paper.

In the implicit cue condition, participants in both countries were instructed to evaluate the adverts' aesthetic quality on four attributes for 10 min: picture attractiveness, word spelling, colour attractiveness, and layout design. For this purpose, the adverts contained an intentional spelling error for participants to identify. Participants answered six yes-no questions and provided qualitative feedback on paper (Appendix 6). The content of their evaluation focused only on the aesthetics of the adverts (e.g., attractiveness) rather than its message (e.g., persuades people to exercise). This method is similar to that done by Forwood et al. (2015).

In the explicit cue condition, participants in both countries were instructed to evaluate the same materials as shown in the implicit cue condition (Appendix 1) but with different instructions (Appendix 5): participants in this condition were instructed to evaluate the materials, not for aesthetics as was done for the implicit priming condition, but for their effectiveness in changing health behaviour. In this cue condition, participants scored each advertisement using a seven-point scale, from 1 *(not at all)* to 7 *(very)* on six criteria on how persuasive each advertisement was in changing their health behaviour: fun (i.e., convincing the participant that it is fun to engage in the behaviour), off-putting, effective, memorable, plausible, and uninformative.

In the neutral cue condition, participants for both countries were asked to read adverts related to a book cover for a novel that would soon be published and was irrelevant to the research topic (i.e., non-health related; Appendix 2). Participants evaluated the adverts by answering identical questions presented to them in the implicit cue group (i.e., picture attractiveness, word spelling, colour attractiveness, and layout design; Appendix 6).

1.3.2. The fake food buffet

The Fake Food Buffet (FFB; Fig. 1; Bucher et al., 2013) was used to provide a more naturalistic method of assessing food choice. The FFB is a reliable and valid assessment; Butcher et al.'s (2012) first study found that the 2-week test-retest reliability for four food items in the FFB ranged from 0.77 to 0.89 with good external validity as well: $r = 0.76$ to 0.87. In this study, FFB provided very authentic looking food replicas with some real foods that used the same primary ingredient cooked in a healthy and an unhealthy process (e.g., roasted chicken versus fried chicken). The healthy option was one with a lower caloric content, better nutritional content, and/or less fat than the unhealthy option (see supplementary material Appendix 4). A combination of real (e.g., packs of crisps) and realistic fake food items (e.g., fried chicken) in the FFB were used. The FFB consisted of 26 different foods placed on serving

Fig. 1. The Fake Food Buffet consisted of 15 replica foods and 10 real foods.

plates and arranged on a table to resemble a buffet. Specifically, for our FFB, the 13 healthy items were boiled beef ball, roasted chicken, boiled cauliflower, boiled carrots, boiled potatoes, steamed plain rice, banana, apple, mineral water, 2 types of fruit juice (raspberry/guava, orange), sugar-free tea, and sugar-free coffee. The 13 unhealthy food items in our FFB were fried beef sausage, fried chicken, fried cauliflower, fried carrots, chips, fried rice, 2 types of crisps, 2 types of muffin, 2 types of soda drink (lemon-lime, cola), tea with sugar, and coffee with sugar. The same food replicas were presented to participants in both the United Kingdom and Indonesia except for one bottled fruit juice: a bottle of raspberry juice in the UK was replaced with a Tetra Pak of guava juice in Indonesia. This was because of country differences in the choice of pre-packaged fruit juice availability. The food categories were chosen based on the Indonesian Health Ministry and NHS dietary intake and the realistic food replicas were made by Replica Ltd Company, London. A range of food items were also selected that were common in one country. For example, we included potatoes, which is a more common staple in the United Kingdom, and rice, which is a more common staple in Indonesia, in our FFB. The food labels were displayed in both English and Bahasa Indonesia. The FFB used in this study was for a single participant testing session. Hence, the quantity of food presented reflected that. We conducted a pilot study of 62 UK participants prior to this study to gather qualitative feedback and found that participants were satisfied with the quantity and range of food/drinks available. One large (27 cm diameter) and one small (19 cm diameter) plate, placed in a serving tray (38 cm × 30 cm), were provided for each participant. Participants were free to pick the menus and portions of the foods. After the participants had left the laboratory, the experimenter photographed the foods chosen by each participant (see Fig. 2 and Appendix 3). The

Fig. 2. The meal selected by Indonesian participant number 79 (see in text explanation for how this meal was assessed).

food choices were scored in three ways: (i) the percentage of healthy food items selected, (ii) the overall estimated calories for the food chosen, and (iii) portion size was calculated from the total number of food items selected. The calories of the FFB food items were estimated from real foods equivalents (see Appendix 4). For example, Iceland American Southern Fried Thigh has 241 calories/100g and the average weight of a fried chicken thigh used in our FFB had a comparable weight of 148g obtained from this real food item equivalent. Thus, one piece of fried chicken thigh in our FFB was estimated to have 357 kcal. Using Indonesian participant 79 as an example (Fig. 2), this participant chose 5 healthy food items (apple, 3 boiled beef balls, guava juice) with a total of 11 food items. Hence, for this participant, the percentage of healthy food items is 5/11 = 45% (outcome variable [i]), the portion size is 11 (outcome variable [iii]), while the estimated calories for this chosen meal is (see supplementary material for calorie equivalents for FFB food items) = (apple: 71 kcal*1)+(boiled beef balls: 62 kcal*3)+(guava juice: 220 kcal*1)+(fried carrots: 9.7 kcal*3)+(fried beef sausage: 95 kcal*1)+(fried rice: 216 kcal*1)+(fried chicken leg: 125 kcal*1) = 893 kcal (outcome variable [ii]).

1.3.3. Body mass index

BMI was computed by the ratio of weight (kg) to the squared of height (m). A Class III scale, SECA-213 was used to measure height and SECA-875 was used to measure weight. The SECA-213 has 1 mm precision and SECA-875 flat scale is medically approved for its accuracy (precision 0.05 kg; SECA, 2017).

1.3.4. Hunger

Participants indicated their hunger level via a five-point Likert Scale from 1 (*Not hungry at all*) to 5 (*Extremely hungry*). We examined whether Hunger was a significant covariate in our analyses by entering its main effect and interactions into our statistical models tested. None of the effects involving Hunger were significant, *p*'s 0.34 to 0.99. For example, the multivariate main effect for Hunger was, $F(2, 478) = 0.056$, $p = 0.98$, partial $\eta^2 < 0.001$. Hence, Hunger was not entered as a covariate in our analyses.

2. Results

The intercorrelations among the three dependent variables were examined: Percentage of healthy food options in the chosen meal was not correlated with the total number of food items in the meal, $r(526) = -0.07$, $p = 0.10$. Percentage of healthy food options in the chosen meal was, however, negatively correlated with its estimated calories, $r(526) = -0.38$, $p < 0.001$. Total number of food items chosen by the participants (i.e., portion size) was correlated with total calories, $r(526) = 0.405$, $p < 0.001$. Hence, multivariate General Linear Model (GLM) was conducted to assess the impact of Gender (covariate), BMI, Country, and the three different types of cues intervention (implicit, explicit, and neutral cues) on the three dependent variables. If the multivariate result was significant, the univariate result for the three dependent variables were interpreted. Overall, participants had slightly more than 50% of healthy food items in their meal (Table 1): Mean = 55.78%, 95%CI [53.43%, 58.13%]. Average (*SD*) total number of food items chosen in a meal was 17.20 (7.18) and Mean (*SD*) Calories of the meal was 891 kcal (339).

Gender as a predictor. Gender multivariate main effect was significant, $F(3, 513) = 5.80$, $p < 0.001$, partial $\eta^2 = 0.033$. Univariate analyses indicated significant Gender main effect for all three dependent variables: (i) Total Calories, $F(1, 515) = 16.99$, $p < 0.001$, partial $\eta^2 = 0.032$, (ii) Percentage of Healthy Food items in the chosen meal, $F(1, 515) = 3.96$, $p = 0.047$, partial $\eta^2 = 0.008$, and (iii) Portion Size, $F(1, 515) = 5.19$, $p = 0.023$, partial $\eta^2 = 0.01$: Compared to women, men chose a meal that had higher calories, B = 127.41, lower percentage of healthy food items, B = −5.03, and a larger portion sized meal, B = 1.44.

Country of origin as a predictor. Country of origin multivariate main effect was also significant, $F(3, 513) = 3.15$, $p = 0.025$, partial $\eta^2 = 0.018$. Univariate analyses showed that this Country of origin main effect was only significant for one dependent variable - Portion Size, $F(1, 515) = 5.10$, $p = 0.024$, partial $\eta^2 = 0.01$: UK participants chose more food items than Indonesian participants, B = 11.50. No other multivariate effects involving Country of origin (i.e., Country of origin X BMI, Country of origin X Cues, Country of Origin X Cues X BMI) were significant, *p*'s 0.11 to 0.52. These indicated that there were no significant cross-cultural differences for the results we found for BMI and Cues as predictors.

BMI and Cues intervention as predictors. The multivariate main effect for Cues was significant, $F(3, 514) = 3.40$, $p = 0.019$, partial $\eta^2 = 0.019$. Univariate analyses indicated that Cues main effect was significant only for one dependent variable - Percentage of Healthy Food items chosen, $F(2, 515) = 3.56$, $p = 0.014$, partial $\eta^2 = 0.014$. Participants shown the explicit cue chose more healthier foods than the neutral cue group, $p = 0.025$ (see Table 1).

In addition, a significant BMI multivariate main effect was found, $F(3, 513) = 3.64$, $p = 0.013$, partial $\eta^2 = 0.02$. Univariate analyses found that this was significant for 2 dependent variables – (i) Percentage of Healthy Food items selected, $F(1, 515) = 7.02$, $p = 0.008$, partial $\eta^2 = 0.018$, $\beta = 0.172$, and (ii) Total Calories, $F(1, 515) = 5.49$, $p = 0.02$, partial $\eta^2 = 0.011$, $\beta = 1.234$; participants with higher BMI chose more healthy food items but had a meal that had more calories. The Cues X BMI multivariate interaction was also significant, $F(3, 514) = 3.38$, $p = 0.018$, partial $\eta^2 = 0.019$. Univariate analyses indicated that this was significant only for one dependent variable - Percentage of Healthy Food items chosen, $F(2, 515) = 4.26$, $p = 0.015$, partial $\eta^2 = 0.016$. Participant with higher BMI in the implicit cues group choose more healthier foods compared to the explicit and neutral cues groups (Fig. 3). No other significant results were found: *p*'s 0.31 to 0.52.

3. Discussion

When we differentiated the food choices made by our participants in terms of the percentage of healthy food items chosen, the portion size,

Table 1
Mean (SD) of BMI, Hunger, Healthy Food choice, and Total Number of Food Item selected by Type of Cues and Country.

Cue Condition	BMI, kg/m^2	Hunger	Healthy Food Items Chosen, %	Total Number of Food Items Chosen	Estimated Total Calories of Food Items Chosen, kcal
	UK, Indonesia, Total *N*'s = 264, 264, 528	UK, Indonesia, Total *N*'s = 264, 264, 528	UK, Indonesia, Total *N*'s = 264, 264, 528	UK, Indonesia, Total *N*'s = 264, 264, 528	UK, Indonesia, Total *N*'s = 264, 264, 528
Explicit, *N* = 176	25.5, 22.3, 23.9, (6.2, 4.0, 5.4)	2.77, 3.00, 2.89, (1.04, 1.18, 1.11)	57.5, 60.5, 59.0, (30.3, 26.7, 28.5)	19.6, 14.9, 17.3, (7.7, 6.4, 17.3)	815, 948, 882 (297, 397, 356)
Implicit, *N* = 176	26.3, 22.8, 24.6, (6.1, 4.4, 5.6)	2.69, 2.97, 2.83, (1.01, 0.99, 1.01)	54.9, 57.4, 56.1, (28.3, 27.0, 27.6)	18.9, 14.3, 16.6, (7.2, 5.9, 7.0)	891, 905, 898 (310, 399, 356)
Neutral, *N* = 176	25.4, 22.4, 23.9, (6.7, 5.7, 6.4)	3.02, 3.32, 3.17, (0.98, 0.94, 0.97)	52.6, 51.8, 52.2, (28.4, 23.8, 26.2)	20.2, 15.2, 17.7 (7.6, 5.7, 7.1)	866, 923, 895 (312, 298, 306)
Total, *N* = 528	25.8, 22.6, 24.1, (6.3, 4.7, 5.8)	2.83, 3.09, 2.96, (1.02, 1.05, 1.04)	55.0, 56.6, 55.8, (29.0, 26.0, 27.5)	19.6, 14.8, 17.2, (7.5, 6.0, 7.2)	857, 925, 891 (307, 367, 339)

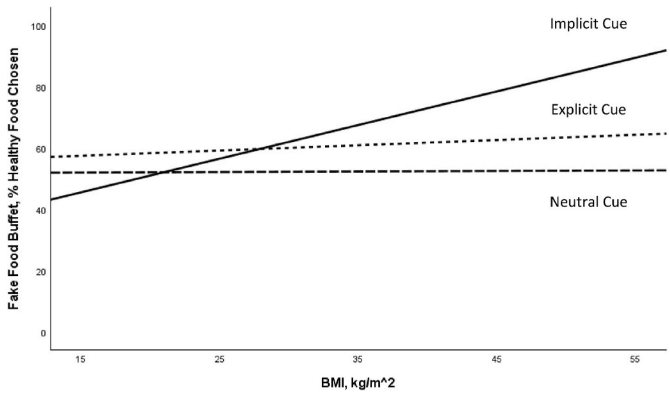

Fig. 3. The interaction of BMI and type of cues on healthy food choice. N = 528.

and total calories of the meal, we isolated the impact of our intervention and predictors. Specifically, our cue intervention had an impact on the number of healthy food items selected but did not have an impact on participants' portion size nor total calories of their meal. While explicit cues were more effective for most participants, implicit cues had a more effective impact for participants with higher BMI. However, this was true only for their proportion of healthy food items chosen but not for the overall portion size nor its estimated calorie content of their meal.

Our result support the efficacy of a non-conscious process in changing healthy food choices particularly among individuals with higher BMI (Marteu et al., 2012; Papies et al., 2014). We propose two reasons why our implicit cues might be more effective for people with higher BMI. Firstly, impulsivity among people with high BMI might had increased the effectiveness of implicit cues via non-conscious processes in our study (Nederkoorn et al., 2006; Schiff et al., 2016). Individuals with higher BMI have been found to engage in impulsive eating that often used system 1 processes (Guerrieri et al., 2008; Nederkoorn et al., 2006) so that the implicit health-related cues might have nudged them towards healthier choices without their awareness (Kroese et al., 2016; Marchiori et al., 2017). Secondly, individuals with higher BMI might have an attentional sensitivity towards environmental stimuli congruent with the pursuit of an ideal weight (Kruger et al., 2004). For example, Papies et al. (2014) reported that participants who were overweight or with obesity bought less unhealthy snacks when exposed to a health and diet prime. Once a goal has been activated by relevant goal cues, a healthy behaviour could be triggered without relying on conscious awareness (Fishbach et al., 2003). Our implicit health-related cues might have activated the weight control goal that inhibited the eating enjoyment goal and increased the preferential processing of healthy food stimuli (Stroebe et al., 2008, 2013), subsequently facilitated healthy food choices among individuals with high BMI. This explanation concurs with previous evidence that dieting primes led to healthy food choices among dieters (Papies & Hamstra, 2010; Papies & Veling, 2013; Stämpfli & Brunner, 2016).

Regardless of BMI status, our explicit health-related cues increased healthy food choices (Malle et al., 2001; Strack & Deutsch, 2004). Strack and Deutsch (2004) found that explicit cues were more likely to trigger healthy behaviour through both conscious and non-conscious processes. The cues might have triggered a healthy food choice through activating conscious intention that transformed beneficial dieting goals into concrete action (Strack & Deutsch, 2004; Smith & DeCoster, 2000; Malle et al., 2001, Stämpfli, Stöckli, Brunner, & Messner, 2020). At the same time, these cues might had worked through a non-conscious process by activating a healthy schema that had been developed from prior experiences. In the dual-processing theory of cognitive process, the non-conscious process is always active in every decision but the conscious process might or might not be active (Evans, 2008). Furthermore, both conscious and non-conscious processes might also work synergistically at the same time to influence healthy food choices (Strack & Deutsch, 2004). Since our study did not measure the participants' awareness towards food choice behaviour, future study might examine which conscious or non-conscious cognitive process is dominant in our explicit cue intervention.

We found that our participants with higher BMI chose healthier food options but chose a larger portion sized meal with higher calories. Previous research reported that people who were overweight or with obesity experienced social pressure to make healthy food choices (Higgs, 2015; Renner et al., 2012) because they were socially stigmatised as less fit, less active, and overeating (Puhl & Brownell, 2006; Teachman et al., 2003; Vartanian, 2015). Our study is in line with Schüz et al. (2017) who also found that participants who were overweight tried to make a good impression by making healthier food choices. Our examination of the healthiness and quantitative aspects of our participants' food choice mirrors the results reported by a large grocery chain in London: the geographical distribution of overweight and obesity prevalence was related to overall calories of items purchased but fat intake was related to overweight prevalence but not to obesity prevalence (Aiello et al., 2020). A meta-analysis reported that dietary fat, as measured by fried food in our FFB, was related to overweight and obesity though the effect sizes had high heterogeneity (Qin et al., 2022). This heterogeneity was also found in the food type (i.e., instant noodles, fast food, soda, and fried snacks) that predicted obesity among Indonesian adults (Oddo et al., 2019). The heterogeneity of results can be explained by how individuals with high BMI regulated the perceived healthiness of their meal and its portion size or calorie content differentially: in our study, participants with high BMI regulated the perceived healthiness of their food intake better than the portion size and total calories of their meals.

There are a few limitations for our study. Firstly, it is difficult for our participants to estimate caloric intake accurately particularly when individuals who are overweight or obese tend to underestimate their food intake (Wehling & Lusher, 2019); We estimated the energy density of our participants' chosen meal objectively, but we did not ask our participants for their estimated caloric content of their chosen meal to determine its role in their food choice. Nevertheless, our caloric estimations were consistent with some previous research: for example, an observational study of food purchases at fast food restaurant chains found that the average calories of meals purchased was 836 calories (Block et al., 2013), which is close to our estimate (891). However, another observational study reported that the average meal purchased had an average of 977 kcal (Robinson et al., 2018). Secondly, our study employed undergraduates as participants who might have better self-regulation (Zimmerman, 2008). Individuals with better self-regulation have been found to be better at inhibiting their impulses or delay gratification for convenience and unhealthy food (Reinert & Barkin, 2013). We suggest that future studies might wish to investigate the efficacy of our interventions with participants from a more diverse socioeconomic profile. Thirdly, participants had their height and weight measured before making their food choices and this sequence could had resulted in motivating participants with high BMI to make more healthy food choices particularly when they were aware that a researcher was present. However, we think this is unlikely to have occurred in our study: if people with high BMI made healthier food choices because they had their weight measured beforehand, then this effect would be present for all our intervention conditions – implicit, explicit, and neutral cue conditions. If the argument is that this effect would only occur when a healthy cue was given, then it should had manifested for both the implicit and explicit cue conditions. However, our interaction showed that it only occurred for the implicit cue condition. Hence, it is difficult to explain why participants with high BMI, after having their weight measured, would choose a healthier meal only in the implicit cue condition and not do the same in the explicit cue nor neutral cue condition. Another limitation of our study is that we did not examine the role of dietary restraint nor external eating behaviours. There is research to suggest that such eating behaviour patterns are associated with weight gain (van Strien et al., 2020). Future research might examine such psychological processes involved in the relationship between BMI and our cue-based interventions on food choice. Fourthly, we did not examine impact of typicality, food neophobia, and variety of the food items available in our Fake Food Buffet on cross-cultural differences in food choice. There is research evidence to support the importance of these factors (Bucher et al., 2011; Jaeger et al., 2017). Future research might investigate how these factors interact with UK and Indonesian samples to predict food choice. Lastly, the effect sizes that we have found were small though our study's sample size had sufficient statistical power to detect a medium effect size. Therefore, our failure to find a medium effect size was not because we did not have a large enough sample. Rather, we think that our study would provide a better effect size estimate of the impact of our cue-based intervention interacting with BMI in predicting food choice. Our effect sizes would help contribute to future meta-analysis when estimating the 'true' effect size.

An implication based on the results from our study would be to use implicit health-related cues to promote healthy eating behaviour among individuals with higher BMI. For example, the exposure of implicit cues such as distributing healthy recipes, flyers, or posters have been found to be effective for individuals with high BMI (Papies et al., 2014). It is uncertain whether the increased use of implicit interventions might also contribute to psychological resistance among people with high BMI over time that might also reduce its efficacy in changing their food choice. The long-term consequence of using implicit interventions warrants investigation. Secondly, regardless of BMI, explicit health related cues are still effective strategies to improve healthy food choices for the general population. Hence, implicit cues and explicit cues might be two strategies that can be used in ways that target at a specific subpopulation (i.e., individuals with high BMI) and the general population simultaneously.

In conclusion, our study provides cross-cultural evidence for the effectiveness of implicit and explicit health-related cues to increase healthy food choices using the FFB in a laboratory setting. Given that most individuals with higher BMI try to lose weight (Kruger et al., 2004), the implicit cues approach could be more efficacious to activate their dieting goal into behavioural change. Hence, the implicit cue approach would be more suitable to reduce the food behaviour disparity between individuals with high versus low BMI.

Ethics

The research ethics were approved by the Faculty Research Ethics Board in UK (reference number: FHS78) and Indonesian research ethics, Psychology Department.

Author note

Anna Undarwati was responsible for data curation, funding acquisition, investigation, project administration, resources, visualization, and writing the original draft. Felix Yong Peng Why was responsible for supervision. Both authors were responsible for conceptualization, formal analysis, methodology, and writing (review & editing).

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CRediT authorship contribution statement

Anna Undarwati: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Felix Yong Peng Why:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

We have no known conflict of interest to disclose. This research was funded by Indonesia Endowment Fund for Education scholarship (LPDP), Ministry of Finance, Republic of Indonesia.

Data availability

Uploaded as supplementary material.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107617.

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