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Whitelock V, Robinson E. Remembered Meal Satisfaction, Satiety, and Later Snack Food Intake: A Laboratory Study. Nutrients. 2018 Dec 3;10(12):1883.

What We Know, Think We Know, or Are Starting to Know

The vast majority research we tend to read is focused on what to eat, nutritional determinants of health outcomes at the level of whole diets, foods, or specific nutrients. This is, of course, an important part of the evidence-base, but may also be distinct from the question of *how* we eat.

And once we start picking at the question of *how*, a Gordian Knot of the complex neurobiological, social, and environmental influences on food intake begins to unravel. Social facilitation, for example, may exert significant influence on the amount of food consumed at a meal [(1)]. Energy intake has been shown to increase in relation to the number of people present; the greater the number, the more food that is consumed [(2)].

The proverbial 'Gordian Knot'.

Environmental factors such as portion size, visibility and availability can trigger eating as an automatic behaviour, occurring without awareness or control over the eating episode [(1-3)]. One factor which may, in part, explain some of these social and environmental influences on diet, is distraction - and as a corollary - attention. For example, one study served participants the same lunch, but divided into two groups: one of which ate lunch with no distractions, and the other ate lunch whilst playing computer games [(4)]. Both groups were presented with a snack of biscuits 30 minutes after the lunch: compared to the non-distracted group, the group that ate while distracted reported being less full after lunch, consumed significantly more biscuits after lunch, and had difficulty recalling the order in which the lunch courses were served [(4)].

Environmental factors such as portion size, visibility and availability can trigger eating as an automatic behaviour, occurring without awareness or control over the eating episode [1-3]. One factor which may, in part, explain some of these social and environmental influences on diet, is distraction - and as a corollary - attention. For example, one study served participants the same lunch, but divided into two groups: one of which ate lunch with no distractions, and the other ate lunch whilst playing computer games [4]. Both groups were presented with a snack of biscuits 30 minutes after the lunch: compared to the non-distracted group, the group that ate while distracted reported being less full after lunch, consumed significantly more biscuits after lunch, and had difficulty recalling the order in which the lunch courses were served [4].

The research of psychology Professor Suzanne Higgs [University of Birmingham] has been formative in understanding the role of attention in eating behaviour. Early studies from her research group sought to establish the effect of distraction at one meal on subsequent food intake. They found that attention given to consuming a lunch meal correlated with increased or decreased snack energy intake later in the day, relative to the level of attention given to an earlier meal [5,6]. Interestingly, these findings suggested that the *subsequent* reductions in energy intake were not due to fullness from the lunch meal, but due to *memory* of the meal.

One factor which could relate the effect of attention is meal satisfaction. 'Satisfaction' from food has been described as a 'generalised appreciation of the food within some broader situational context' [7]. There is some literature to suggest that, during a meal, satisfaction may influence stopping eating [8]. However, the question remains as to whether memory for satisfaction of a past meal has similar effects as satisfaction during a meal itself. The present study sought to build on the previous literature by testing the effects of memory for meal satisfaction and memory for satiety from the meal, on subsequent energy intake.

The Study

The study tested the hypothesis that rehearsing the satisfying or dissatisfying effect of a lunchtime meal influences energy intake from subsequent snacks. These conditions were compared to a neutral control condition. 138 male and female participants aged 18-60yrs were recruited. Participants were randomised to either condition, stratified by gender to ensure equal distribution of gender across all experimental conditions.

'Rehearsing' in this context meant a recall prompt. For example, in the satisfaction rehearsal condition the participants were instructed as follows:

'Please write down your thoughts on what you found satisfying about the meal you just ate. Consider the following things: what did you like about the taste/flavour, appearance, smell, texture, and how the meal made you feel?'

The dissatisfaction condition was the same instruction, only expressed as 'dissatisfying'. The control condition were asked to describe their journey to the University campus. Participants were given 6mins to write.

Participants were provided with a fixed 600kcal ASDA pasta -ready meal for lunch. After lunch, participants rehearsed either the satisfying aspects of the meal, dissatisfying aspects of the meal, or the neutral control. 3hrs later, participants were provided with an array of weighed and measured commercial biscuits broken up into pieces, and told they were participating in a 'taste test'. The amount of energy eaten were calculated by subtracting the weight of biscuits remaining post-test, from the pre-test weight, and converting the value into calories. They also underwent a memory measure of the lunchtime meal, using a 100mm visual analogue scale*.

Thus, the intervention proceeded as follows:

- Standardised Lunch
  - **Intervention 1:** Satisfaction rehearsal
  - **Intervention 2:** Dissatisfaction rehearsal
  - **Control:** Neutral rehearsal
- Snack Test

The study was single-blinded, i.e., the researchers running the study were blinded to the experimental condition participants were in. However, the participants were not told the actual purpose of the study they were participating in: they were told they that the lunch and biscuit snacks were to study sensory perceptions of food.

It was hypothesised that the satisfaction rehearsal would result in increased memory for meal satisfaction of the lunch, while the dissatisfaction rehearsal would result in decreased memory for meal satisfaction, and these effects would result in increased and decreased, respectively, subsequent snack intake.

*Geek Box: Visual Analogue Scales

Visual analogue scales [VAS] are common psychometric tools in both psychology and nutrition research, used to measure a particular preference, attitude, or characteristic that may have a range of potential values. For example, hunger and fullness are both subjective, and may differ across a range of responses depending on time of day, fed or fasted, time since last meal, etc. The simple form of VAS used is a straight, horizontal line, commonly around 100mm [10cm] in length. The far left will generally represent the lowest end of the variable being measured, i.e., with fullness 0mm could be 'not at all' while 100mm could be 'extremely'. Participants are asked to make a vertical line with a pen/pencil/marker across the horizontal measurement line, at a point which represents for them how they feel in response to that question. This is then turned into data the old-fashioned way: by getting out a ruler, and measuring the point at which the participant made their line crossing the horizontal measurement line. For example, on a 100mm [10cm] hunger scale it could be 70.6mm [7.6cm] - this is therefore the data point for that time. Now, imagine that was pre-meal, and then you measure the participant again 30mins later: now it could be 20.3mm [2.3cm], indicating a shift to a more satiated state following the meal. VAS can be useful for certain measures that exist on a subjective continuum, rather than using, for example, Likert scales where participants could have a 1-5 score of pre-defined values, e.g., 'mild', 'moderate', 'severe'. In this regard, VAS can be more sensitive to smaller, incremental changes in a particular measure than other categorical scales They are also very simple to use and time-efficient for research purposes. They do have certain disadvantages or things to consider, however. They are primarily subjective, which is not limitation per se, but an important point to bear in mind when the outcome is a variable that could also have physiological measures. They are also validated in very specific contexts, which may not always be generalisable to every circumstance in which they are used. So it is important to think about the validation of a particular VAS, the context in which that validation occurred, and how that context relates to its use in another study.

Results: 128 participants completed the study, 71% female, and equally matched with 44 participants in the control group and 43 and 41 in the satisfaction and dissatisfaction intervention groups, respectively.

- ***Memory for Meal Satisfaction:*** There was no significant effect of the interventions on general meal satisfaction, however, there was a significant effect of rehearsal condition on memory for satiety satisfaction. The dissatisfaction group recalled being less satisfied with the satiation from lunch, while neither the satisfaction or neutral control groups recalled any significant difference.
- ***Ad Libitum Snack Intake:*** There was no significant effect of rehearsal condition on ad libitum snack intake.

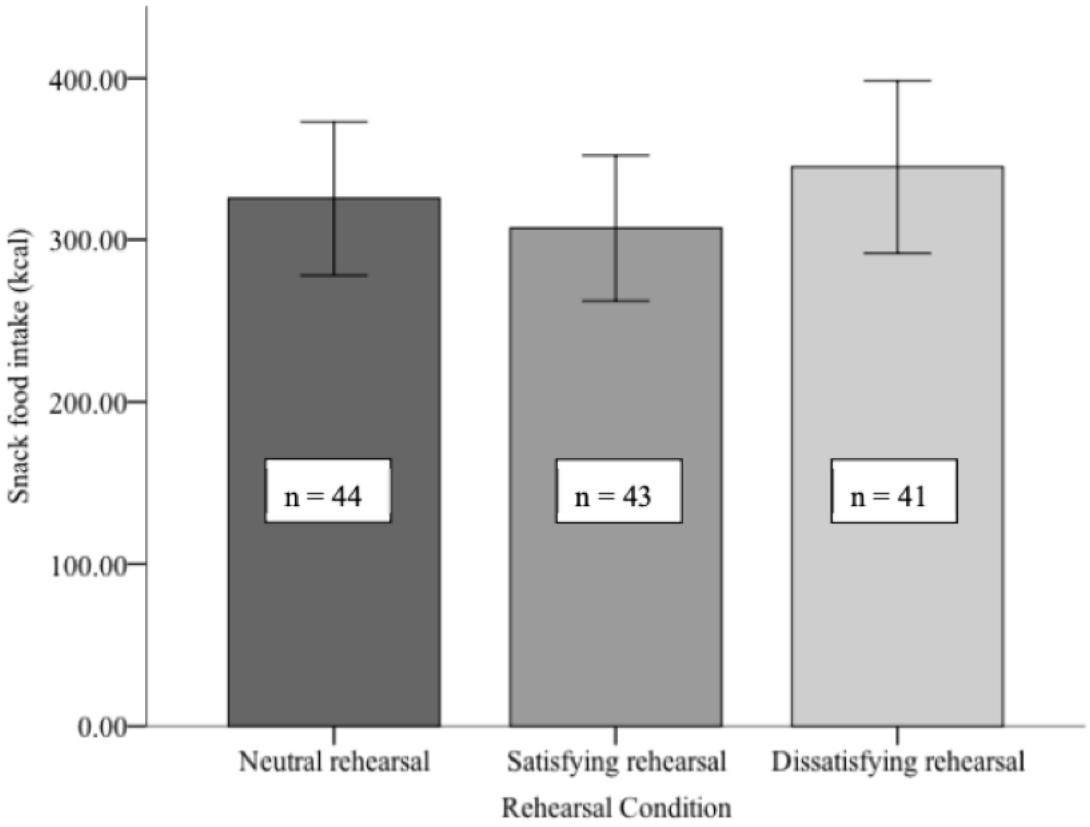

Figure *from paper illustrating the amount of calories consumed from biscuits in response to the test meal presented 3hrs after lunch.*

The Critical Breakdown

Pros: Researchers running the study were blinded to treatment allocation. While the participants were not blinded to participating in an intervention, the purpose of the study was masked from them. Study groups were well balanced and stratified by gender. The fake 'taste-test' is a validated measure of ad libitum food intake. The study tested a novel hypothesis which to date had not been investigated. The study completed sample size had sufficient power to detect effects of calorie intake at the test meal.

Cons: A 'distracted' group, similar to previous research, would have been useful to further test whether any effects are only observed when compared to a distracted condition, i.e., is it actually attention or *lack* of attention, that may explain any relationship with subsequent energy intake? The main limitation is that the memory tests used by the researchers have not been validated; this was acknowledged by the authors.

Key Characteristic

The choice of satisfaction as an outcome differs to the previous research in this area, and as noted in the ***Cons***, the measurement tools were devised by the researchers for the study and have not yet been validated. In this sense, the study was admittedly covering new ground, and this is always welcome in science. In the research on food satisfaction, however, it is noted that a number of variables may influence satisfaction [(8)]. For example, expectation for a meal, the occasion related to a meal, and sensory properties during a meal, are just a few factors which may relate to satisfaction [(8)]. But satisfaction itself may not influence subsequent energy intake. And it could be that the variables which influence satisfaction have little to do with memory itself. Given that the researchers were interested in the relationship between memory and satisfaction, the use of the lunch meal - an ASDA pasta ready-meal - sounds neither satisfying nor memorable. While ready-meals like this serve a purpose in being able to quantify and standardise the weight of food, the properties of the food, and the calorie and macronutrient content of the meal, it could have influenced the sense of satisfaction remembered from the lunch.

Interesting Finding

The finding that memory related to dissatisfaction with the satiety from lunch, but satisfaction memory had no effect. It is important to keep in mind that this was not a test of satiety per se, but a test of remembering satiety as it related to meal satisfaction. The hunger ratings did not differ significantly between groups, and ultimately there was no difference in calorie intake from the biscuits in response to the test meal. This suggests that whatever memory of dissatisfaction from the lunch meal that this group has, it did not influence any significant compensatory calorie intake later in the day. This is consistent with another previous experimental study published by the same group, in which meal satisfaction with lunch had no effect on subsequent energy intake [(9)].

Relevance

Taken together, the limited number of studies that this group have produced on satisfaction are not, to date, suggestive that satisfaction with a meal has any significant bearing on subsequent energy intake. However, it is also important to realise that these results are preliminary, and future research will be required to validate the measurement instruments used and conduct further tests. In this study, however, memory of satisfaction was not overall significantly associated with subsequent energy intake, although dissatisfaction was associated with lower remembered satiety.

Where does this study sit with the wider literature? The three most recent papers in this area have failed to replicate the earlier studies, which may have been due to the fact that the interventions did not affect memory of the meal [(9)]. This raises questions over whether it is specific memory domains that underpin the relationship between attention and satiety. For example, is it memory of amount eating, memory of the time of eating, or memory of subjective meal enjoyment? Further, the interventions do differ in important ways, particularly the fact that the earlier interventions were comparing distracted eating; the recent interventions have focused on increasing attention, and the present study did not specifically look to enhance attention at the lunch meal, but to recall memory of satisfaction/dissatisfaction.

A 2013 systematic review and meta-analysis of the literature examined the effect of attention, memory and other cognitive processes on food intake, both immediately and at subsequent meals [(10)]. The review consistently found that distracted eating resulted in both immediate and subsequent increases in food intake. While the increase in immediate intake was more moderate, interestingly the increase was *independent of dietary restraint*. In effect, it didn' t matter whether subjects were *trying* to control intake, eating while distracted caused them to overeat nonetheless. The review indicated that food intake at subsequent meals increased to a greater extent from distracted eating at an earlier meal. It also demonstrated that enhanced memory of food intake was the factor associated with reduced subsequent consumption.

Therefore, it may be that the more informative comparison is distraction vs. attention. Perhaps in this context, memory mediates the subsequent reduction in energy intake: but the evidence would suggest this may relate specifically to working and episodic memory [(3)]. The jury is out for now.

Application to Practice

The present study is preliminary, but for now suggests that memory of satisfaction has no effect on subsequent energy intake. However, it is important to factor in that there is a more substantial body of evidence showing that eating while distracted relates to passive over-consumption [(10)]. And that attentive eating may result in lower consumption of hyper-palatable foods, and enhance enjoyment of food [(11)]. These behavioural modifications may be useful tools for practitioners in our hyper-connected, busy lives.

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