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Improving laboratory studies of human eating behaviour: energy balance and real-world considerations.

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There is a need to standardise and improve the methodological quality and reporting practices involved in studies of human eating behaviour and the article by Robison and colleagues (2018) makes a valuable contribution in that direction. The paper highlights aspects of sample size, reporting quality (particularly weight status, eligibility criteria, allocation to experimental conditions and effect size information), sample size determination (many seem underpowered) and methodological practices (especially prior standardisation of appetite, blinding of participants and trial registration) (Robinson, Bevelander, Field, & Jones, 2018). We might include further limitations to many eating behaviour studies not mentioned by the authors, including the use of select samples, for example, undergraduate psychology students as participants (or indeed as research assistants); the short time periods covered by many experimental manipulations (usually <1d and sometimes <1 h); and the reliance on experimental contrivance that severely limit the interpretation or extrapolation of study outcomes (Caudwell et al. 2011). Although such studies may generate interesting pilot data or add to mechanistic understanding in specific experimental situations, they probably contribute less to the understanding of natural eating patterns of people.

The recommendations by by Robison and colleagues (2018) are reasonable but we wonder to what extent we might be able to use pre-existing, standardised practices from the fields that intersect with the laboratory study of ingestive behaviour to further improve methodological and reporting quality in laboratory studies of human eating behaviour? The CONSORT statement provides an evidence-based set of recommendations for reporting randomised trials and provides a 25 item checklist for conduct of such studies, which covers many of the issues discussed in the current paper including adequate description of study (or trial) design, participants, interventions, outcomes, sample size, randomisation (sequence, allocation and implementation), blinding, statistical methods, a priori specification of primary and secondary outcomes and analyses, limitations, generalisability,

interpretation of outcomes, trial registration, protocol and funding (Schulz, Altman, Moher, & Group, 2010) . In many cases adaptation of the CONSORT guidelines would provide a first step in addressing the issues raised and help standardise methodological and reporting quality in laboratory studies of human eating behaviour. In addition to this there are perhaps a few additional aspects worth considering.

Reporting the degree of experimental control.

In 1998 we wrote ‘‘in the laboratory, control of inputs and environment may constrain subject responses, and it is not always clear whether control of the experimental situation is as comprehensive as is supposed by the investigator (Stubbs, Johnstone, O'Reilly, & Poppitt, 1998)’. This is not a trivial issue. Some protocols are conducted entirely within an experimental facility, while others only bring subjects into that facility for specific meals. Others are a hybrid of controlled feeding studies and semi-free-living studies, allowing subjects to return home for the remainder of the day with a supply of foods. At present, we have few quality or reporting checks to assess the impact of these different experimental practices on outcomes. Similarly, while it is often stated that control of energy balance status or appetite is important prior to a laboratory study (e.g. (Livinstone, et al., 2000)) there is considerable variability in the extent to which that control is implemented ranging from no control, to asking subjects to consume the same foods the day before to providing subjects with a maintenance diet estimated to meet energy requirements for 1-2 days prior to the experiment. It would be methodologically advantageous to agree standard approaches to control of the antecedent diet and beneficial for reporting to specify the degree of control of the antecedent diet.

Controlling or measuring potential contaminants and confounders.

In other aspects of research into the impact of behaviour change techniques and approaches on behavioural outcomes, considerable care is taken to avoid contamination of behavioural outcomes by minimising or standardising subject-subject and subject-investigator interactions. It may be useful to review, consider and think about standardising these practices across protocols concerned with human eating behaviour to improve methodological and reporting quality. Generally speaking, the shorter the duration of an experiment the more likely it is to be affected by a number of potential confounders

including the psychometric eating traits of the subjects themselves. There are now a number of validated scales characterising appetite traits including (but not limited to) the Three Factor Eating Questionnaire (Stunkard & Messick, 1985), the Dutch Eating Behaviour Questionnaire (van Strein, Frijters, Bergers, & Defares, 1986), the Adult Eating Behaviour Questionnaire (Hunot, et al., 2016) and the Control of Eating Questionnaire (Dalton, Finlayson, Hill, & Blundell, 2015). It would be extremely valuable to agree a package of such questionnaires that are commonly used to profile the eating behaviour traits of study populations, and that can also be used to evaluate moderators of study outcomes.

The value of energy balance methodology in laboratory studies of human eating behaviour

It is now widely accepted that (with the exception of laboratory measured food intake), dietary intakes are subject to misreporting (Livingstone & Black, 2003). A recent consensus statement of the Energy Balance Assessment Working Group highlights the flawed nature of self-report dietary intake methods and that the potential inaccuracies of self-report data make findings in many studies questionable, incorrect or misleading (Dhurandhar, et al., 2015). While laboratory measured food intake is often a true measure of what foods and beverages are consumed under the conditions of a particular experiment, for the reasons stated above and elsewhere, potential contaminants and artefacts can influence estimates of energy and nutrient intakes, especially in short-term protocols characteristic of eating behaviour studies (Blundell, et al., 2009; Stubbs, et al., 1998). However, protocols increasingly involve combinations of laboratory and self-report food intake data. It would be useful to consider these measures with their various constraints and limitations, where possible in the context of energy balance or estimates of likely energy balance status. For studies that operate over a number of days, body weight change at a group level is a reasonable indicator of overall change in energy balance (e.g. see (Whybrow, Mayer, Kirk, Mazlan, & Stubbs, 2007)). Estimates of over- or undereating can be made more plausible by reference to likely energy requirements, particularly given that many studies ultimately aim to address eating behaviour issues concerned with obesity (a state of chronic positive energy balance). Increasingly, technologies are available to help facilitate this endeavor, particularly for the estimation of physical activity. However, it is worth remembering and specifying in scientific reports the limitations and constraints of those technologies. For

example, numerous tracking devices are now available that estimate (not measure) total daily energy expenditure (Evenson, Goto, & Furberg, 2015; Shcherbina, et al., 2017). Many of these devices are often precise and some facilitate collection of large amount of minute-by-minute data. They tend to be more precise than accurate (better for within than between subject tracking) and many use proprietary algorithms. By increasing our understanding of the methodological limitations of such approaches and evaluating the quality of such data in our scientific reports we can better approach a situation in the future where we can more accurately measure human feeding behavior in the context of energy balance.

Bridging experimental environments from laboratory mechanisms to real-world solutions. As mentioned above an increasing number of studies use laboratory measures of eating behaviour as a component of community based interventions e.g. (Buckland, et al., 2018) or large intervention studies (e.g. (Andriessen C., et al., 2018)). In considering a consensus statement it would be worth aligning the approaches of laboratory-based studies of ingestive behaviour with the reporting standards of randomised trials and energy balance methods, so that we can better examine mechanisms in the laboratory and how they may relate to real-world impact. Finally, a significant proportion of studies of human eating behaviour receive industrial funding and it is extremely difficult to conduct protocols that are completely divorced from the funding agendas of commercial agencies. Standardising and implementing methodological and reporting rigour would benefit the science we do and improve the integrity of results for both us as scientists and those who sponsor our research. This is particularly important in an area that has not been without controversy (Booth & Nouwen, 2010; de Graaf, 2011; Mea, 2011; Smeets & van der Laan, 2011).

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