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Favouring more rigour when investigating human eating behaviour is like supporting motherhood and apple pie: A Response to Robinson, Bevelander, Field, and Jones (2018)

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Abstract

In a 1987 paper, addressing questions about factors that influence the initiation, maintenance, and termination of food intake, we wrote, "development of systematic procedures to measure eating behaviour is essential if descriptive and inferential statistics are to be applied to answering such questions, giving them power and replicability" (Hetherington & Rolls, 1987 page 77). Therefore, as longstanding advocates of rigorous procedures in laboratory-based investigations of food intake, we welcome Robinson et al.'s (2018) clear recommendations for laboratory studies. However, this is akin to voting for "motherhood and apple pie", and few would argue against deployment of improved procedures for these studies. What then can we contribute to the debate in order to refine the recommendations made or add to them? Our most important message for researchers is that the central hypothesis or main research question will determine the most appropriate methods for any study. If a laboratory-based study is planned, then there are basic methodological questions that must be answered before proceeding to a final protocol. While such guidelines are needed to ensure basic methodological rigour, these should not be so prescriptive as to inhibit creativity. Here we provide several thoughts on how to advance studies of ingestive behaviour, including the need to apply appropriate controls, encouragement to move beyond convenience samples, and to remember the value of exploratory, observational, and naturalistic studies to complement laboratory-based studies.

Some background – the apparent "ease" of eating behaviour studies

Investigators from a variety of fields may be drawn to studies in ingestive behaviour believing them to be straightforward. It seems intuitively simple to conduct a study on why people eat what they do, what choices they make and how much is eaten. Yet designing and conducting laboratory-based food intake studies needs to be a systematic process in order to ensure quality, replicability and meaningful outcomes. There are a number of publications setting out good practice in this field (Blundell et al, 2009, 2010; Hetherington and Rolls, 1987; Hill et al., 1995; Rolls and Hetherington, 1990) and the recent recommendations from Robinson et al. (2018) represent a further step towards greater transparency and rigour. We build on these publications to suggest some initial questions that need to be answered in order to progress to a developed protocol. Before designing any study of ingestive behaviour investigators must decide on the main research question and specific hypothesis as well as whether a laboratory is the best place to address the question. The next issue to consider is whose eating is under scrutiny to test this hypothesis, and what foods are appropriate to the experiment. Next, ask how the protocol can be developed to limit or control for potential variables that can influence food intake. For instance establish whether participants eat alone or with others, whether the foods offered should be familiar and liked, and what portion sizes are appropriate to the question.

We advocate involving collaborators from a number of cognate disciplines so that the research design is informed by expert advice. Given that determinants of food intake are multifactorial, experimental design will benefit from the input of a multidisciplinary team, particularly by including those trained in nutrition, food science, psychology, and/or physiology. For example, an experienced nutritionist or dietitian can help to identify the foods to be used, while ensuring compatibility with the research question and the participant population. The advice of psychologists can be useful in choosing assessment instruments, designing experimental manipulations to change eating behaviour and developing theoretical models of ingestive behaviour.

In this commentary, the list of questions that should be considered at the start of any eating behaviour study was developed through our experience as well as that of graduate students and other faculty attending a class on ingestive behaviour at Penn State in March 2018. While they may not all agree with every point we make here, there was a general consensus that having guidelines for good practice would be useful to guide protocol development, not only informing experimental design, but also forming part of the pre-registration process. We add the caveat that any guidelines should not stifle novel, innovative and imaginative studies, rather we outline the basics of good practice without mandating or prescribing set protocols.

Basic principles of design in laboratory-based studies of food intake

It is good practice for scientists to provide a clear rationale for all aspects of the experimental design and to relate these to the specific hypotheses. For all experiments an essential starting point is that the study protocol must be submitted to and approved by the Institutional Review Board, or local research ethics committee. The Declaration of Helsinki provides for the ethical treatment of human participants with the proposal that research should have ethical

oversight by an independent review panel. In bringing participants to a laboratory for any observational study or experiment, it is imperative that participants provide informed consent.

Robinson et al (2018) flagged some omissions in study reporting such as participant eligibility criteria and justification of subject numbers. Here, in order to improve rigour and transparency, we highlight some key aspects of experimental design and questions that should be addressed in preparing protocols:

Setting – Is the laboratory the best place to investigate the main hypothesis? There is always a trade-off between the control afforded by a laboratory setting and the artificiality of attending a laboratory to eat a meal or snack. However, measurements of food intake in the laboratory have been shown to provide a "reasonable approximation" of intake under free-living conditions (Obarzanek & Levitsky, 1985). Laboratory settings permit isolation of specific features of the food, environment, or person as well as novel influences on ingestive behaviour. The laboratory provides an optimal setting to control for extraneous variables, but it is clear that the more controls applied the less ecologically valid the context.

Ideally and where feasible, naturalistic studies should accompany laboratory-based research (Rolls & Hetherington, 1990) in an effort to test the generalisability of findings and applicability beyond the laboratory. When developing a laboratory protocol, it is important to acknowledge the limitations of conducting this type of research and make explicit what controls were put in place to reduce the effects of extraneous influences on intake.

Participants – In considering recruitment of participants to a study, investigators must ask whose eating behaviour is under investigation and who should be invited to participate. Is it important to recruit a sample ranging in characteristics such as age, ethnicity, and body size to ensure broad application, or is it more important to select a specific, homogeneous population to decrease variability? It is tempting within a University setting to employ a convenience sample of students. However, involving highly educated and privileged psychology or nutrition students makes it difficult to blind them to the purpose of the study and the sample is not representative of the general population. A pilot study testing a protocol might be conducted on a student sample, but then for the main study a wider pool of participants from diverse backgrounds might be recruited. There are considerable benefits associated with enrolling participants varying in age, education and socioeconomic background. These benefits include improving generalisability and identifying individual characteristics that differentially influence food intake. When selecting participants based on age, sex, anthropometrics, behavioural traits, or demographics, provide a clear justification for these choices along with the inclusion/exclusion criteria and recruitment strategies, then describe the sample studied in detail as part of good reporting practice. Provide information on how participants were recruited and what they were told about the purpose of the study since this process will generate expectations of participant behaviour in the laboratory.

Instruments/questionnaires - Decide a priori which tools are needed to characterise the participants on a number of individual eating traits and eating habits. As part of the screening process include probes about food restrictions (whether for religious, ideological or medical reasons), dieting to manage weight, and whether the foods used in the study are liked and acceptable for consumption. If the study requires that foods are novel and there must be no prior experience of this food, then test for this. Either during screening or at the end of the study, ensure that traits known to influence individual responses to experimental

manipulations are measured, including the tendency to restrict food intake (cognitive restraint), or the tendency to overeat (disinhibition, emotional overeating, and loss of control of eating). Ensure that the tools used to screen, recruit and categorise participants are described and a rationale given for each.

Demand characteristics - The recommendation to blind participants to the study hypothesis is a well-known maxim in psychological research to minimise experimental bias and expectancy effects. Attempts are made to provide a cover story or to collect intake data incidental to a number of other measurements. This has limitations since most participants cannot be blinded to the fact that food is offered and the expectation is that they have agreed to attend a laboratory for an eating occasion. At the end of the study, participants should be asked what they thought the purpose of the experiment was. Statistical analyses can be applied to test whether these beliefs influenced outcomes. Clearly, it is important to know if any effects of the experiment can be attributed to social desirability effects or to the manipulation under investigation. Efforts to reduce demand characteristics should be described and any impact on outcomes of correctly guessing the true purpose of the study reported.

Protocol –Depending on the hypothesis, investigators may decide to use a within- or between-subjects design. A within-subjects design often affords the best comparison strategy as subjects serve as their own control. However, attending the laboratory on multiple occasions increases the risk that participants will work out the purpose of the experiment and behave in socially desirable ways. The credibility of the cover story for within-subjects designs is clearly important. The alternative, a between-subjects design, avoids problems associated with multiple tests but requires more participants and increases variability.

Other considerations include: whether manipulations of food characteristics are covert or overt, whether a short-term or longer-term exposure is needed; whether food is offered ad libitum or as a fixed amount or preload; whether hunger should be standardised before the test meal (Robinson et al., 2018; Meule, 2018); and whether dietary intake before the test meal should be standardised (see Gregersen et al. 2008).

Ideally, when participants arrive in the laboratory to participate in an experiment in which food intake is the primary outcome measure, readiness to eat should be similar across or within participants. This can be achieved in various ways including offering 3-4 hr before the test meal either a fixed amount of a standard meal, or an ad libitum standard meal with the request to consume a similar amount on subsequent visits. If these procedures are followed, then hunger, desire to eat, fullness and prospective consumption ratings should be relatively consistent within an individual. If a less standardized approach is adopted, then baseline ratings can be included as covariates in analyses. The decision regarding standardisation of prior diet, hunger, appetite and fullness will depend on the question. Could the outcomes depend on participants reporting a similar appetite state or is it more important that participants eat normally before starting the study? Whatever decisions are made regarding the design, these should be articulated clearly and justified, and if readiness to eat is standardised, then say how this was achieved.

Foods – Since some aspect of food intake is at the core of these experiments, it is essential to provide a detailed table of the foods used, their energy content, energy density, macronutrient profile, and specific brands. Are participants familiar with these foods, are ratings of these

foods positive on whatever scale you are using, are the foods appropriate to the time of day of testing, and are they relevant for meals or snacks? If the question relates to food composition such that foods are high in energy density or high in fat content, then be meticulous in determining this and in providing adequate control foods that systematically differ along the parameter being tested. Is it enough to have two levels of this variable or should a dose-response design be employed with a baseline condition? In experiments testing effects on satiety, it is essential to consider the nature of the test meal offered. Will participants be offered a single food or a variety? Characteristics of a test meal such as portions offered, energy density of the foods, variety, and palatability determine the effects of preloads on satiety (Williams, Roe and Rolls, 2013). Investigators should therefore be aware that the effects of any experimental preload manipulation might be influenced or even superseded by the foods offered in a test meal. Whatever decisions are made regarding the foods chosen for the study, provide a detailed description of the foods and a clear rationale including them.

Outcomes – With regard to the specific hypothesis you have posed, what is your primary outcome? Is the outcome related to food choice (foods selected) or intake (weight, macronutrients, energy), and is the study sufficiently powered to detect differences in these measures? Ideally, an a priori power calculation should be done to determine the sample size needed for the primary outcome. This can be challenging if a study is breaking new ground; nonetheless, similar paradigms can be used to inform decisions about adequate sample size. Researchers are encouraged to report the magnitude of their effects in terms of the outcome measures (weight of food consumed in grams and energy intake in kcal). This can be done either in place of a standardized effect size calculation (e.g. Cohen's d) or in addition to standardized calculations. Reporting effect sizes in terms of the units measured can be more useful in determining clinical relevance of effects. For example, it is more meaningful to state that "the manipulation resulted in a 50g increase in intake" than to state that "the effect was small based on Cohen's d criteria." In reporting outcomes we encourage investigators to present findings and effect sizes in a relevant and meaningful way.

Alongside the primary outcome, secondary analyses of individual differences, for example, can produce rich insights into broader aspects of the regulation of food intake. However, investigators often need to declare that the study was not powered to conduct these more exploratory statistical analyses. Nevertheless, exploratory analyses themselves can be helpful in defining questions that can be addressed in subsequent studies that are planned, appropriately designed, and powered to answer these new hypotheses.

The importance of observation

Our field has benefitted greatly from observational studies both inside and outside the laboratory. The scientific origins of ingestive behaviour research include the classic observational studies of the rat by Curt Richter (1922) showing the periodicity of meal intake, activity, and changes with ageing. Since then a strong tradition of observing eating behaviour in different contexts has emerged. For example, Rozin and colleagues (2003) conducted a simple study of the differences between American and French diners in the same fast food franchise. By recording the time spent seated during the meal, they demonstrated that French diners took significantly longer over their meals than American diners. Being able to observe

eating in everyday settings prompts questions about rate of eating and whether manipulating this can influence the development of satiation and the amount eaten.

Observation of eating behaviour remains crucially important to understand eating behaviour, and indeed some questions are best addressed through observational studies, particularly in naturalistic settings. For example in working with children, families and older adults, observing and measuring behaviours at home or in the care setting is less demanding, more feasible and ecologically valid than bringing these participants to the laboratory. Of course, conducting research in naturalistic environments presents different challenges than in the laboratory, but there are considerable benefits to this approach. We previously advocated that where feasible naturalistic studies should accompany laboratory-based research (Rolls & Hetherington, 1990) to test and expand the generalisability of findings for translation purposes. We would add that observational and exploratory studies have a place in our discipline as an important first step in the scientific method, especially if we want our research to both develop theory and to have impact beyond the laboratory.

Conclusions

While some standardisation of laboratory-based designs is important, the final protocol must be shaped by the specific question being asked. We have proposed some basic guidelines regarding setting, participants, tools, demand characteristics, protocol, foods, and outcomes that can inform experimental design. Such guidelines can help ensure basic methodological rigour in laboratory-based experiments to promote transparency, replication, and evidence synthesis. We advocate moving beyond convenience samples and appeal to researchers to maintain their interest in observational and naturalistic studies. These can complement and inform laboratory experiments on human eating behaviour, as part of the development of impactful, translational research. By advocating for agreement on methodological rigour and reporting guidelines, we share the hope that both new and experienced scientists will apply these guidelines to the design of creative studies while reaching out to collaborators across disciplines to develop the best protocols possible to answer questions about human food intake.

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