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1 **Commentary: Methodological and reporting practices for laboratory studies assessing food intake**  
2 **using fixed and ad libitum test meals.**

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UNCORRECTED PROOFS

10 A number of expert reports have provided methodological recommendations on how to conduct  
11 rigorous and scientifically sound laboratory studies to investigate appetite control (most recently:  
12 Blundell et al., 2010, Blundell et al., 2009, Gibbons et al., 2014). However, a recent examination of the  
13 methodologies used in laboratory food intake studies by Robinson, Bevelander, Field, and Jones  
14 (2018) showed that many failed to adopt basic methodological procedures and reporting practices.  
15 Based on their examination Robinson et al. proposed recommendations that should be adopted as  
16 best practice in appetite-related research. We wholly support Robinson et al.'s effort to highlight  
17 where scientific rigour needs to be improved in this research area. Indeed, in one of our recent meta-  
18 analyses on studies assessing food intake we also concluded that most studies were of low  
19 methodological quality (Buckland et al., *under review*).

20 While we support the recommendations of Robinson et al. (2018), we propose that in their current  
21 form the recommendations are limited and overlook other important '*basic*' methodological factors  
22 that should be considered when designing and reporting studies that assess food intake. Such factors  
23 include adopting additional pre-manipulation control procedures (e.g. controlling for alcohol intake  
24 and physical activity levels), designing (and reporting) an appropriate order for study procedures to  
25 ensure that any manipulations are not confounded by other study measures (e.g. weighing  
26 participants or administering psychometric questionnaires before assessing food intake), detailed  
27 reporting of sample type (e.g. student, community-based, dieting status), reporting whether measures  
28 taken were objective or subjective (e.g. self-reported versus researcher measured body weight and  
29 height) and appropriate design and reporting of standardised test meals. Reporting information on  
30 these additional methodological factors would facilitate the replication of studies. Further,  
31 recommendations may need to be tailored according to study aims. For example, when considering  
32 the issue of standardised test meals, recommendations will vary if the study is examining processes  
33 affecting satiation or satiety or if it is examining food hedonics and food choice.

34 A thorough review and examination of each of these additional factors are beyond the scope of this  
35 commentary, so we will focus on extending Robinson et al. (2018) recommendations with regards to  
36 developing criteria for appropriate standardised test meal design.

### 37 **Appropriate design and reporting of standardised test meals**

38 The focus of Robinson et al. (2018) examination was on laboratory studies of human food intake. The  
39 advantage of laboratory assessments of eating behaviour is that they allow for the precise assessment  
40 of food intake in a controlled environment that is free from potential confounding variables such as  
41 extraneous smells, sounds, competing activities and social stimuli (Blundell et al., 2009). Broadly  
42 speaking there are two forms of food intake assessment within the laboratory; the first is a measure  
43 of fixed intake (termed as “fixed energy meals”) where the type and amount of food consumed by the  
44 participant is pre-determined by the researcher and is less susceptible to confounding variables. The  
45 second is a measure of ad libitum intake where the amount (and in some cases type) of food consumed  
46 is determined by the participant (ideally in response to the experimental manipulation) within the  
47 limitations of the experimental design. This second measure is more vulnerable to confounding factors  
48 (Stubbs et al., 1997). For both fixed and ad libitum test meals the type and amount of food provided  
49 requires careful consideration as variation in these factors has been shown to influence the amount  
50 of food consumed (Beaulieu et al., 2017; Hetherington & Blundell-Birtill, 2018). Within their  
51 examination, Robinson et al. assessed whether the studies reported the types of foods provided but  
52 they did not provide recommendations on which variables are important to consider when designing  
53 and reporting fixed and ad libitum test meals used in laboratory studies of human food intake.

### 54 **Fixed energy meals**

55 Fixed energy test meals are those in which the researcher provides the participant with a compulsory  
56 “fixed” test meal that they are instructed to consume in its entirety. Fixed energy test meals allow for  
57 the composition of food to be manipulated and standardised across participants. Fixed energy test  
58 meals allow for increased experimental control in designs where food is being used as an independent

59 variable. However, fixed energy test meals are not suitable for studies examining satiation as they do  
60 not account for individual differences in energy requirements.

61 Fixed energy test meals are also useful to standardise participants' appetite before they are exposed  
62 to an experimental manipulation. When used to standardise appetite, ideally fixed meals should be  
63 tailored to individual daily energy needs (e.g. based on Schofield equations or measured resting  
64 metabolic rate). The proportion of daily energy requirements a fixed meal provides will be determined  
65 by study aims and time of day the test meal is served (Dalton et al., 2015). An alternative method  
66 when there are multiple conditions is to have participants self-determine their fixed meal by providing  
67 an ad libitum amount in the first condition and asking them to eat to comfortable fullness. The amount  
68 consumed can then be provided in the experimental conditions that follow (for an example see  
69 Beaulieu et al., 2017). It is important to consider individual energy requirements as providing the same  
70 portion to all participants does not account for energy needs differing depending on individual  
71 characteristics such as age, gender, body weight and body composition (Ravussin & Bogardus, 1989).  
72 This may lead to some participants receiving too little and still feeling hungry and others receiving too  
73 much and feeling too full which can interfere with any subsequent assessments of food intake.

#### 74 **Ad libitum test meals**

75 In ad libitum test meal designs participants are normally provided with a larger than can be consumed  
76 portion of food, which the researcher weighs before and after consumption. A range of foods are  
77 often provided for participants to choose from which allows for the assessment of quantitative aspects  
78 of eating behavior (i.e. how much) and qualitative aspects of eating behavior (i.e. nutrient and/or  
79 sensory food choice). When used correctly ad libitum test meals are useful to assess the process of  
80 satiation (i.e. meal size and termination) however there are several important considerations when  
81 designing ad libitum test meals. Research has shown that factors such as variety, texture, physical  
82 form (liquid or solid), palatability and energy density can induce over- and under-eating in laboratory  
83 conditions (Buckland et al., *in press*; de Graaf, 2012; Hetherington, Foster, Newman, Anderson &

84 Norton, 2006; Raynor & Epstein, 2001; Rolls, Van Duijvenvoorde, & Rolls, 1984). Additionally, care  
85 must be taken with regards to the portion size of the ad libitum test meal items as larger portion sizes  
86 have been shown to lead to greater intake (for a review see Hetherington & Blundell-Birtill, 2018;  
87 Zlatevska et al., 2014) whereas providing small portions may constrain participants' food intake and  
88 limit the opportunity to observe effects of the independent variable. It is recommended that the  
89 portion size of ad libitum test meals is clearly reported in each study and the range of food consumed  
90 is provided.

91 Furthermore, it is recommended that researchers assess participants' liking of study foods as an  
92 inclusion criterion; a factor that was not examined by Robinson et al. (2018). Liking for food has a  
93 positive effect on food intake (De Graaf et al., 1999) and therefore to accurately assess the effects of  
94 a manipulation, the foods provided must be liked by participants (Blundell et al., 2010). If study foods  
95 differ between study conditions, then food liking should be matched across conditions to ensure any  
96 differences in intake can be attributed to the study manipulation rather than the extent to which  
97 participants like the food. For example, one study compared whether intake differed if participants  
98 were provided with the same (fish and chips or beef stew) or different (lemon mousse) food to that  
99 previously eaten (Ferriday et al., 2016). Compared to when eating the same food, participants ate less  
100 of the different food and reported feeling less full. Crucially, the authors did not check pre-study  
101 whether participants liked the lemon mousse (any pre-screening attempts were not reported) and as  
102 such as the authors discussed, it was unclear whether participants ate less of the mousse because of  
103 the study manipulation (varied the test foods to be either the same or different to foods previously  
104 eaten) or due to a dislike for the lemon mousse. Such issues can easily be prevented by assessing liking  
105 for study foods in a pre-study screening questionnaire, with the aim of including low liking for the  
106 study foods (e.g. ratings of <4 on a 7-point Likert scale) as an exclusion criterion (Gibbons et al., 2014)  
107 In addition, study foods should adequate undergo pilot testing to ensure they are equally palatable.

108 Lastly, studies should also report the test meal environment, including the presence or absence of  
109 social others, participants' focus on the test meal and the time of day that test meals were  
110 administered. The presence of social others (social influences) has been shown to influence food  
111 intake (Herman et al., 2003). As such, if social cues are not part of the research question then  
112 participants should be tested in individual cubicles. Distractions such as watching television, listening  
113 to audiobooks and completing computer tasks increase food intake (Oldham-Cooper et al., 2011, Higgs  
114 and Woodward, 2009, Bellisle et al., 2004). Therefore, food intake should also be assessed in a  
115 distraction-free environment where participants do not have access to their mobile phone, computer  
116 or other distractions to ensure their attention is focussed on the test meal. The time of day that the  
117 test session takes place can also influence food intake. Certain foods will be more culturally  
118 appropriate at particular times of the day compared to others. As such, to avoid confounding the  
119 variable of interest, test foods should be appropriate for the time of day that the test session takes  
120 place (Blundell et al., 2010).

121 These methodological aspects related to study foods are not exhaustive of the "basic" methods that  
122 researchers should consider when assessing food intake within the laboratory using standardized test  
123 meals (see Blundell et al., 2010). We have raised these points to demonstrate that Robinson et al.  
124 (2018) did not discuss or provide recommendations for a large number of "basic" methodological and  
125 reporting practices. While we are aware that Robinson et al. acknowledged that "*it was not feasible*  
126 *(however), to evaluate all aspects of study design and reporting*" (p.490) we believe that providing  
127 restricted recommendations risks future studies overlooking important methods. Overlooking such  
128 methods can lead to the collection of low quality data and make it difficult to form justifiable  
129 conclusions (Brown et al., 2018). As such, in line with Robinson, we call for experts in the laboratory  
130 assessment of food intake to agree and establish a comprehensive set of recommendations that can  
131 be used by researchers and reviewers of manuscripts to encourage and promote scientifically sound  
132 research.

133 Conclusions

134 We support Robinson et al. (2018) recommendations to promote scientific rigour in laboratory studies  
135 investigating food. However, to avoid important aspects of research design being overlooked we  
136 strongly urge experts in eating behaviour to collaboratively establish more thorough  
137 recommendations.

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