Doing the counter-regulation shuffle: The importance of flexibility and hunger for predicting food consumption following a preload.

**Suggested running head:** Determinants of food consumption following a preload.

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Abstract

This study utilised the preload paradigm to evaluate whether stable, trait-like dieting attitudes and behaviours (dietary restraint and flexibility in dieting rules) and more proximal, context-specific factors (negative mood and current hunger levels) predict heightened food consumption among male and female participants. Following a high calorie preload, 79 participants aged 18 to 40 completed a deceptive taste test in which they were encouraged to eat as much of the taste test foods as desired, and this *ad libitum* intake was measured. Although each of the predictors (except negative mood) predicted food consumption when tested individually, individuals scoring higher on restraint consumed less than individuals scoring low on restrained, which is contrary to counter-regulation theory and earlier findings using the preload paradigm. Moreover, regression analyses revealed that flexibility in dieting rules and current hunger levels were the strongest unique predictors of quantity consumed, suggesting that emphasis on dietary restraint in preload studies may be misplaced.

*Keywords:* Preload, Restraint, Food consumption, Hunger Level, Counter-regulation

Highlights

*Influence of dieting rules and context on food intake were tested in a preload study

*Restraint, flexibility in dieting rules and hunger predicted food consumption post-preload

*Negative mood was not reliably associated with food intake

*Hunger level was the strongest unique contributor to prediction of food consumption
Rates of overweight and obesity are high in western countries (ABS, 2012; Flegal, Carroll, Kit, & Ogden, 2012) and are linked to excessive intake of calorie-dense and/or sugary foods (Rosenheck, 2008). Consequently, researchers have attempted to identify determinants of overconsumption eating practices. In addition to genetic predisposition, modifiable individual difference factors have been implicated.

In the preload paradigm, participants consume a preload meal (energy-dense food or liquid), and then are asked to consume additional foods under the pretence of a taste test exercise. Participants are encouraged to eat as much as they wish of this taste test food, and amount consumed is monitored (Herman & Polivy, 2005; van Strien & Ouwens, 2003). Early studies showed amount consumed is higher among restrained eaters (i.e., those who intend to restrict calories) than non-restrained eaters, both without (Herman & Polivy, 1975) and with a preload (Herman & Mack, 1975), although subsequent studies provide mixed support for the effect of restraint on food consumption (Adams & Leary, 2007; Jansen, 1996; Stice, Fisher, & Lowe, 2004).

This inconsistency may be attributable to several limitations in these past studies. First, restrained eaters are unlikely to be a homogenous group. Some individuals hold a rigid view of their diet (such that, they must adhere at all times to their diet), whereas others are more accepting that they will occasionally eat forbidden foods. Those dieters who have a more flexible view of dieting may be better equipped to moderate food consumption after
eating a personally prohibited food, and thus, may be less likely to overeat post-preload (Westenhoefer, Broeckmann, Münch, and Pudel, 1994).

Second, restraint is typically operationalized as an enduring, stable set of attitudes and behaviours, neglecting more proximal, context-specific influences that may either potentiate or over-ride dieting efforts. Past research has shown that both negative mood states and hunger levels are key antecedents for food over-consumption among dieters (Lowe & Maycock, 1988; Yeomans & Coughlan, 2009). Therefore, the present study re-evaluates the influence of restraint on ad libitum food consumption post-preload, by also considering the influence of context-specific predictors (negative mood and hunger level) and flexibility in dieting beliefs. Based on prior findings, it is predicted that:

1. Each of the predictors will be significantly related to food consumption when tested individually, but
2. Flexibility in dieting beliefs will be a stronger predictor than restraint when considered jointly, and
3. Contextual factors will be stronger predictors than trait measures (flexibility, restraint) for food consumption.

2. Method

2.1 Participants

The sample comprised 79 normal weight participants aged 18 to 40 (M=24.65, SD=6.08), 53 female (Age: $M=25.62$ years, $SD=6.72$) and 27 male (Age: $M=22.65$ years, $SD=3.91$). Females were significantly older than males ($t(74.65)=-2.47, p<.05$). None of the study variables differed significantly by gender ($p$s ranged from .09 -.44). Level of educational attainment varied across the sample: 34 participants (43%) completed high school, 11
completed a technical or vocational degree (13.9%), 30 (38%) completed an undergraduate degree at university, and 4 (5.1%) have completed a postgraduate degree. The majority of participants were in a relationship or married (62%).

2.2 Materials

Preload. A 250ml glass of chocolate milk (200 kcal, 19% protein, 58% carbohydrate, and 23% fat). Previous studies have shown that this preload amount is sufficient to elicit the counter-regulation of eating behaviour (Herman & Mack, 1975; Herman, & Polivy, 2005).

Deceptive Taste Test. 50g bowls of both ‘Arnott’s Barbeque Shapes’ (260 kcal), and ‘ALDI Barbeque Snackos’ (256kcal; both a type of savoury biscuit), and 100g bowls of both ‘M&M’s’ (486kcal) and ALDI’s equivalent ‘Munchers’ (476kcal; both a type of chocolate candy in a crisp shell).

2.3 Measures

Dietary restraint. The 10-item restraint scale from the Dutch Eating Behaviour Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986) was used to assess attitudes and behaviours related to dietary restraint. Items are ranked on a 5-point Likert scale and scores range from 10 to 50, with higher scores indicative of greater levels of restraint. The DEBQ has good psychometric properties (van Strien et al., 1986). Cronbach’s alpha was .86 in the present study.

Flexibility in dieting. The 12-item flexible control subscale of the Three-Factor Eating Questionnaire (Stunkard & Messick, 1985; Westenhoefer, Stunkard, & Pudel, 1999) measured cognitive and behavioural (in)flexibility in dieting. Items were summed together, with higher and lower scores reflecting greater and limited flexibility in dieting behaviour, respectively. This subscale has demonstrated convergent and discriminant validity, and good
internal consistency (Westenhoefer et al., 1999). In the present study, Cronbach’s alpha was .73.

*Negative Mood.* Colautti et al.’s (2011) 2-item negative mood scale was used to assess participants’ mood state immediately prior to commencing the taste test. Items ask how unhappy (Q1) and discontent (Q2) the participant feels *right now*, with rating options ranging from 0 (Not at all) to 4 (Extremely). As per prior studies (e.g., Colautti et al., 2011), this brief scale exhibited acceptable internal consistency in the present study (alpha = .86).

*Current hunger level.* A single item (How hungry are you right now?) was asked prior to the preload. Participants responded on a 10-point Likert scale (1 = Not at all, to 10 = extremely).

2.4 Procedure

Following approval from the university ethics board, participants were recruited through university notice boards and social media. Participants were tested individually in an office at a time of mutual convenience. Participation involved (in the following order): (1) A standardised statement was read to participants explaining the taste test experiment and the aim of the taste test study (2) consuming a preload (milkshake), (3) participating in a taste test wherein they were asked to taste and rate the desirability of four foods (snakos, shapes, munchers, and M&Ms), and (4) filling out a questionnaire with measures of restraint, flexibility, mood, and hunger items. Prior to excusing him/herself from the room under the pretense of needing to complete another work task, the experimenter told participants they could eat the remaining food in the taste test as it would be thrown out. The experimenter returned 15 minutes later, and the participant was asked if they knew the purpose of the study, was debriefed and her/his bowls were weighed in order to ascertain how much s/he ate *ad libitum.*
3. Results

3.1 Data Cleaning and Manipulation Check

Less than 5% of data were missing, and were replaced using expectation maximisation (Nelwamondo, Mohamed, & Marwala, 2007). No outliers were identified and assumptions of normality were met. Preliminary analyses demonstrated that the chosen taste test foods were viewed as desirable: M&Ms ($M = 7.24$, $SD = 2.22$), Munchers ($M = 5.69$, $SD = 2.23$), shapes ($M = 6.95$, $SD = 1.94$), and snakos ($M = 6.18$, $SD = 2.09$). Furthermore, only 4% ($n = 3$) correctly identified the purpose of the study. The majority of participants believed the study was a taste test, as advertised ($n = 61$, 77%), and the remainder indicated that they were unsure about the real aim of the study ($n = 15$, 19%).

3.2 Main Analyses

Pearson’s correlations were conducted to test the association between post-preload food consumption and proposed predictors (see Table 1). Amount consumed was negatively associated with dietary restraint tendencies and flexibility in dieting rules, and positively related with current hunger level. Consumption was not reliably associated with negative mood. Among the predictor variables, flexible dieting rules and dietary restraint were strongly, positively related. None of the other relationships among predictors were significant.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Food</th>
<th>Flexible</th>
<th>Rest</th>
<th>Mood</th>
<th>Hunger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food in grams</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A standard regression analysis demonstrated that, in combination, the predictors accounted for 20% variance in amount of food consumed; $R^2 = .20$, $F(4, 75) = 4.53$, $p = .003$. As shown in Table 2, current hunger level made the strongest unique contribution, followed by flexible dieting rules. Neither restraint nor negative mood uniquely contributed to prediction of food consumption post-preload.

Table 2. Regression of food consumption onto trait-based and contextual predictors

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$</th>
<th>t</th>
<th>p</th>
<th>sr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraint</td>
<td>.16</td>
<td>0.87</td>
<td>.386</td>
<td>.09</td>
</tr>
<tr>
<td>Flexible</td>
<td>-.44</td>
<td>-2.37</td>
<td>.020</td>
<td>-.25</td>
</tr>
<tr>
<td>Mood</td>
<td>-.09</td>
<td>-0.83</td>
<td>.410</td>
<td>-.09</td>
</tr>
<tr>
<td>Hunger</td>
<td>.34</td>
<td>3.13</td>
<td>.003</td>
<td>.33</td>
</tr>
</tbody>
</table>

Notes: $\beta$ = standardized coefficient, sr = unique correlation between IV and DV. Flexible = flexibility in dieting rules; rest = dietary restraint; mood = negative mood state; hunger = current hunger level.
4. Discussion

Since Herman and Mack’s (1975) finding that restrained eaters consume more food than non-restrained eaters in a food preload study, subsequent findings have provided inconsistent support for this counter-regulation effect (Adams & Leary, 2007; Jansen, 1996; Stice, Fisher, & Lowe, 2004). The present study tests the possibility that food consumption is better predicted by: (1) flexibility in food restriction rules rather than general tendency towards dietary restraint, and (2) immediate, contextual influences (negative mood and hunger levels) than these more stable, trait-like predictors of flexibility and dietary restraint.

When tested individually, each of the variables reliably predicted ad libitum food intake, with the exception of negative mood. Contrary to the counter-regulation effect (Herman & Mack, 1975), restraint was negatively correlated with post-preload food consumption. Although hunger level was a significant predictor of food consumption, the null relationship between hunger level and restraint rules out the possibility that the influence of restraint on food consumption in the present sample is driven by level of hunger at time of testing. Instead, present findings suggest that the influence of dietary restraint on food consumption may depend on the extent to which participants are flexible or rigid in their dieting beliefs. In the present sample, there was a strong positive association between restraint and flexibility in dieting rules, consistent with prior findings (e.g., Westenhoefer et al., 1994). This overlap reduced the unique contribution of restraint, but flexibility still contributed to prediction of food overconsumption. This pattern of findings therefore supports the hypothesis that food consumption is more strongly predicted by flexibility in dieting beliefs than dieting per se.

The present findings also suggest that contextual factors are relevant for predicting food consumption. Hunger level was the strongest predictor of food consumption both
individual and when considered in the multivariate context. However, the bivariate correlations involving restraint and flexibility were only marginally smaller than the correlation for hunger level. Moreover, negative mood – the other proposed contextual determinant of food consumption – was not reliably associated with food intake. Despite the limited overlap between restraint and hunger level in the present study, the clear contribution of hunger level for predicting food consumption suggests that researchers should take precautionary steps to control for individual differences in hunger in order to accurately model the influence of other predictors on food over-consumption. We surmise that the inconsistency in prior findings may be, at least partially, attributable to group differences (between restrained and non-restrained eaters) in level of hunger preceding the experiment.

Present findings should be interpreted within the context of study limitations. First, although the mean scores suggested that the average participant reported moderate level dieting attitudes and behaviours, it is possible that the current pattern of findings differ from what may be observed in clinical populations characterised by overeating, such as individuals with eating disorders involving a binge component. Likewise, other aspects of dieting, such as dieting success, disinhibition of eating, and emotional eating, may also factor into how much food a participant consumes post-preload. Second, although participants rated hunger level and mood, other potential covariates of food consumption were not controlled for, such as recency of exercise. Related to this, present comparisons of ad libitum food intake post-preload did not adjust for individual differences in typical eating habits that may provide context to interpret the quantity of food participants consume. For an individual who regularly engages in binge-eating, her/his food consumption may be larger than others in the sample, yet smaller than her/his typical meal. Thus, for the purposes of the experiment, the intake amount would fail to classify as restraint, when in view of typical consumption
patterns, it should. Future research should seek to incorporate this information into analyses to evaluate the extent to which results are unduly influenced by individual differences in average intake. Finally, although the present study assessed effects of preload on food consumption as a function of dietary restraint and other individual difference factors, the absence of a no-preload control condition limits ability to contextualise whether amount consumed post-preload is abnormal. Our design is therefore consistent with some past preload studies without this control condition (e.g., Appleton, Martin & Morgan, 2011; Sin & Vartanian, 2012; Timko, Juarascio, & Chowansky, 2012), but inconsistent with others that did include a control (e.g., Herman & Mack, 1975; Lowe, Witlow & Bellwoar, 1991; Westenhoefer, 1994).

4.1 Conclusion

Despite these limitations, the present findings suggest that restraint may not be the most appropriate measure for predicting food over-consumption. The greater role played by flexibility in dieting beliefs suggests that food consumption patterns are likely to meaningfully differ for different subgroups of dieter, whereas the predictive value of current hunger level suggests the need to also consider proximal, context-dependent determinants of food consumption.
5. References


