The Relationship Between Dietary Restraint and Deficits in Reasoning about Causes of Obesity

Margaret Husted [1,2], Ellen Seiss [1,3] & Adrian P. Banks [1].

[1] University of Surrey, School of Psychology, Guildford, Surrey. GU2 7XH: [2] Winchester University, Department of Psychology, Winchester, Hampshire. SO22 4NR:[3] Bournemouth University, Department of Psychology, Poole, Dorset. BH12 5BB.

United Kingdom

Corresponding Author **Margaret Husted**

Email: Margaret.husted@winchester.ac.uk

Telephone: +44 (0) 1962 287478

Additional authors emails: a.banks@surrey.ac.uk

eseiss@bournemouth.ac.uk

Abstract

Objective: Increased levels of dietary restraint are associated with deficits on many cognitive tasks. Less is known about how individual differences in restraint influences complex cognition such as reasoning which is the focus of this research.

Design: Two experimental studies are reported. In study 1, participants (n = 158) completed a causal conditional reasoning task with statements about weight-related and general causal relationships. Study 2 replicated and extended Study 1. Participants (n = 108) completed a causal conditional reasoning task focusing on behavioural causes of weight change or general statements.

Main outcome measure: Causal conditional reasoning task performance.

Results: In study 1, levels of dietary restraint were negatively associated with reasoning abilities for weight-related statements only. Study 2 replicated the negative association between dietary restraint and reasoning finding the effect in both weight-related, and general, causal judgements.

Conclusion: The novel findings show that individual differences in dietary restraint have a wider relationship with cognition than previously demonstrated. Results tentatively support theoretical explanations of a reduction in cognitive capacity, rather than differences in belief, explaining reasoning deficits. These findings open an interesting avenue for research and might have implications for effective decision making about personal health behaviours, such as food choice.

Key Words: reasoning, food choice, eating behaviour, restraint, obesity education.

Introduction

Adopting healthy restrained eating and physical activity behaviours are preventative measures against weight gain and protective measures for longer healthy living standards (Abraham, Kelly, West, & Michie, 2009; NICE (NG7)). Dietary restraint is the restriction of food consumption which can be either a result of a perceived over-consumption of food, or a more habitual attempt to restrict both the amount, and type, of food consumed in order to lose, or maintain, weight (Van Strien, Frijters, Bergers, & Defares, 1986). Therefore, an individual can show high levels of dietary restraint and not be actively dieting, for example, weight maintenance may be the underlying motivation driving behaviour. But, it is still a conscious, cognitive choice, as demonstrated by the individual's self-awareness of their behaviour. In contrast, dieting is the deliberate restriction in calorie intake for achieving weight loss (Rogers & Green, 1993).

Restricting consumption to manage weight involves making deliberate food choices based on predictions about the consequences of eating different foods. For example, a goal to prevent weight gain involves predicting the causal effect of eating different foods on weight gain or loss and selecting food that is predicted to meet this goal. Many of these causal inferences are conditional, e.g. *if* I eat too much of this food *then* I will be full/happy/gain weight/lose weight etc. But causal inferences are influenced by many factors and are not always accurate. For example, research indicates that the causal conditional inferences individuals draw from authorised health claims about food are influenced by consumers' prior causal models of health, rather than their familiarity with the claim itself, and this leads to consumers drawing inferences that go beyond what is stated in the authorised health claim (Banks, Egan, Hodgkins, Peacock, & Raats, 2018).

This study proposes that individuals higher in dietary restraint may be especially prone to inaccurate causal reasoning. Two experiments investigate the association between dietary restraint and the accuracy of causal conditional inference about weight-gain and inferences unrelated to weight gain. Two possible mechanisms for this association are investigated: the reasoning process might be hindered by the reduced cognitive capacity found in restrained eaters (Rogers & Green, 1993, Green, Elliman & Rogers, 1997; Whitelock, Nouwen, van den Akker, & Higgs, 2018); or the inferences specifically about diet and weight gain may be influenced by prior knowledge used by restrained eaters such as biased nutrition knowledge or compensatory beliefs about diet (Carels, Harper, & Konrad, 2006; Hartmann, Keller, & Siegrist, 2016). Inaccurate causal reasoning by restrained eaters may have further implications for effectively managing diet, health, and well-being.

1.1 Restrained Eating and Reduced Cognitive Capacity

Dietary restraint has been shown to be positively associated with both attempts at, and failures in, self- control of food consumption (Hofman, Adriaanse, Vohs, Baumeister., 2014) and self-regulatory failure (Herman & Polivy, 1980; Papies & Hamstra, 2010; Rogers & Hill, 1989) which can lead to periods of over-consumption of food. The capacity to apply effective self-control suggested as an explanation for whether individuals are successful, or unsuccessful, in applying dietary restraint over time (Hofman et al., 2014; Ouwehand & Papies, 2010; Papies, Stroebe & Aarts, 2008). It has been shown that maintaining dietary restraint requires cognitive effort (Lattimore & Maxwell, 2004; Ward & Mann, 2000), which might leave limited resources to perform other cognitive tasks.

In accordance with this assumption, past research has provided evidence for a degree of cognitive impairment being evident in restrained eaters in comparison to unrestrained eaters (with effects seen in both adults and children) (Brunstrom, Davison, & Mitchell, 2005;

Rogers & Green, 1993; Westenhoefer et al., 2013). For example, restraint is associated with slower processing response times, as well as a reduction in working memory capacity (Brunstrom et al., 2005; Higgs, 2007; Jones & Rogers, 2003; Kemps & Tiggemann, 2005; Rogers & Green, 1993; Westenhoefer et al., 2013). There are indications that the performance deficits identified are due to an increased cognitive load/division in cognitive resources (Green, Elliman, & Rogers, 1997; Jones & Rogers, 2003). However, there is also evidence that the working memory deficit in restrained eaters increases during active dieting (Green, Elliman, & Rogers, 1997; Green, Rogers, Elliman, & Gatenby, 1994). Specifically, it has been suggested that the articulatory control process within working memory, is negatively affected by preoccupying cognitions concerning food and weight when applying dietary restraint (Shaw & Tiggemann, 2004).

1.2 Restrained Eating and Knowledge about the Causes of Weight Gain

Restrained eaters might be expected to have accurate knowledge of nutrition and the causes of weight gain to regulate weight more effectively. However, there is evidence suggesting that restraint is associated with a range of inaccurate beliefs. For example, restrained eaters have been shown to inaccurately estimate the caloric content of food (Tanaka, 2015). People on a restricted diet systematically underestimated the caloric content of foods perceived as ‘healthy/ contributing to weight loss’ and overestimated the caloric content of foods perceived as ‘unhealthy/ contributing to weight gain’, with greater inaccuracy associated with higher BMI (Carels, Harper, & Conrad, 2006). Restrained eating was also associated with using meal replacement products as a compensatory strategy for calorie overconsumption in other meals (Hartman, Keller, & Siegrist, 2016). Further, individuals have been shown to underestimate calories when something healthy is presented alongside an unhealthy option, in other words, the calorie count estimate was significantly lower for the unhealthy food when a healthy food was present than when the unhealthy food

was presented alone (Chernev, 2011) with this effect significantly greater for those expressing the greatest weight concern compared to individuals with less concern about their weight. Together, these studies suggest that restrained eaters may differ from unrestrained eaters in their nutritional knowledge, beliefs about the causes of weight gain and factors that prevent weight gain. When thinking about weight gain this biased knowledge may influence reasoning, making different causal inferences more, or less, likely.

1.3 Causal conditional reasoning and Restrained Eating

Working memory, and processing speed, deficits could affect higher level cognitive processes, such as executive functions which include reasoning, decision making, and problem solving (Green & Rogers, 1998; Logie & Gilhooly, 1998). But interestingly, to our knowledge, the relationship between dietary restraint and reasoning abilities has not been studied previously, although it has a high relevance in everyday life whereby much knowledge we have is conditional (Johnson-Laird & Byrne, 2002). Conditionals of the form "if p then q" are commonplace (Oberauer, 2006) and apparent within current behaviour interventions such as "Change4Life", for example, if you make the Change4Life snack swaps then your children will be healthier. The use of conditionals relies on individuals making the causal connection between their eating and physical activity behaviour and subsequent health outcomes and yet the above research may indicate that individuals who are higher in dietary restraint may have cognitive deficits that effect their ability to engage in accurate reasoning. For example, preoccupying cognitions about their own body shape or eating behaviour could affect their capacity to make effective reasoning decisions about subsequent health behaviours or alternatively past experiences whereby the proposed outcome has not actually occurred may act as disablers to engaging with the proposed conditional relationship. This is particularly apparent when you consider that in general, individuals try and reduce cognitive dissonance by finding alternatives, or exceptions, that allow inconsistencies in their own

behaviour to be over-looked (Totman, 1979). Indeed, interventions that purposefully focus on inducing cognitive dissonance have been shown to be an effective means to encourage health behaviours (Freijy & Kothe, 2013; Husted & Ogden, 2014). This would indicate that for some individuals an active reasoning process can occur to rationalise healthy or unhealthy behaviour choices. Therefore, examining dietary restraint and reasoning about weight change is needed to extend our understanding of how dietary restraint maybe impacting on subsequent decisions or behaviours.

Both studies presented here used a causal conditional reasoning task to examine whether variation in levels of dietary restraint influences an individuals' ability to reason accurately. In a standard causal conditional reasoning task people are given a conditional rule of the form "*if* **p** *then* **q**" that they are required to follow. They are then given an additional fact about the information in the rule and asked to evaluate if the conclusion offered follows logically from it. There are four possible conditional argument formats presented in Table 1.

- Suggest insert table 1 here -

Of these four, the modus ponens (MP) and modus tollens (MT) formats are logically valid arguments; the conclusion follows necessarily from the conditional rule and fact. Here accurate causal reasoning would result in an individual accepting that the conclusion did necessarily follow from the premise. The denial of the antecedent (DA) and affirmation of the consequent (AC) formats are not logically valid; the conclusion does not follow necessarily from the conditional rule and fact. Here accurate causal reasoning should result in an individual rejecting the conclusion as necessarily following on from the premise. The accuracy of a participant's performance on a causal conditional reasoning task therefore is reflective of their ability to reason logically based on the conditional rule that is presented.

As not all individuals are accurate in their responses past research has examined the possible explanations for individual differences in causal conditional reasoning capacity. Several models of causal reasoning have been proposed including probabilistic theories (Over, Hadjichristidis, Evans, Handley, & Sloman, 2007); theories explaining the role of semantic memory (Cummins, Lubart, Alkansis, & Rist, 1991; Cummins, 1995) and dual process theories proposing a role for both strategies (Verschuerne, Schaeken, & d'Ydewalle, 2005; Klaczynski & Daniel, 2005). In particular, past research (Cummins, Lubart, Alkansis, & Rist, 1991; Cummins, 1995) has established that individuals' prior semantic knowledge about alternative causes and disabling conditions influences their interpretation of the causal conditionals and hence their willingness to accept or reject a conclusion based on them. Within all these theories there are two mechanisms identified that influence the accuracy of causal conditional reasoning that could be affected by restraint eating: reduced cognitive capacity, and biased causal knowledge about alternative causes and disabling conditions.

Reduced Cognitive Capacity. Prior research has found a relationship between working memory capacity and causal conditional reasoning because accurate reasoning involves the construction and manipulation of representations of the information in the form of mental models in working memory in order to draw conclusions (Markovits, Doyon, & Simoneau, 2002). It has also been shown that people with high working memory capacity are more accurate because those with high working memory capacity can inhibit the activation of alternative causes and disabling conditions when they conflict with the logical validity of the problem (De Neys, Schaeken, & d'Ydewalle, 2005). As restrained eating is associated with general limits in cognitive capacity in a range of working memory and executive function tasks, reviewed above, we hypothesise that restrained eating would be associated with less accurate causal reasoning. Furthermore, as this is a general limitation on the reasoning

process we hypothesise that this effect would be found across all content of causal conditional reasoning – both related to weight gain and unrelated to it.

Biased Causal Knowledge. Restrained eating is associated with a range of beliefs about nutrition and the causes of weight gain. These are often inaccurate, as shown in the review above. Prior research has found a relationship between the activation of causal knowledge of alternative causes and disablers (Cummins et al., 1991, Cummins, 1995; De Neys, Schaeken, & d'Ydewalle, 2003; Quinn & Markovits, 2002). Alternative causes are other factors that could bring about the outcome under consideration and disablers are other factors that could prevent it. For example, for the Modus Ponens inference:

If you eat doughnuts, then you will get fatter

You eat doughnuts

You are fatter

An alternative cause might be 'eating an excess amount of chocolate'. This would bring about the outcome of 'being fatter' irrespective of whether the doughnuts are eaten. Whereas a disabler might be 'maintaining an otherwise healthy diet and exercise programme'. This would prevent the outcome of 'being fatter' as the doughnut is one item within an otherwise balanced diet. As this example illustrates, retrieval of alternative causes and disablers are counterexamples that reduce the likelihood of accepting conclusions (Cummins, 1995). If semantic memory for alternative causes and disablers concerning weight gain is more readily activated or biased for restrained eaters, then they would be less likely to endorse conclusions for weight-related conditionals than general conditionals. Therefore, we hypothesise that the association between restraint eating and causal conditional reasoning accuracy would be different for weight-related and general causal conditional reasoning. Furthermore, we hypothesise that the accuracy would differ across logical formats. Accuracy for the valid MP

and MT inferences would be reduced relative to general causal conditionals as these arguments would not be endorsed. But accuracy for DA and AC inferences would be increased relative to general causal conditionals because for these invalid arguments not endorsing the conclusion is the logically correct response.

1.4 Present Research

Two studies are presented within this paper to test the association between restrained eating and causal reasoning. To examine this association, we will present participants with a causal conditional reasoning task which will be comprised of causal conditionals relating a cause to an effect. Participants will be required to judge the logical validity of each of the possible logical outcomes. In Study 1 participants' reason about a range of weight-related causes whereas in Study 2 the task focuses specifically on behavioural causes of weight-change. Participants' logical accuracy on this task will be associated with restrained eating, measured using the DEBQ-RS (Van Strien, Frijters, Bergers, & Defares, 1986). They will be given two sets of causal conditionals, one describing weight-related causal relationships and the other describing general causal relations that are unrelated to weight. In summary, we hypothesise that restrained eating will be associated with a deficit in causal reasoning accuracy. Further, two possible mechanisms to explain this will be tested. If restrained eating is associated with less accurate causal reasoning because of an overall deficit in cognitive capacity, then we would expect to see a negative association across tasks regardless of topic. Alternatively, if the association is because of biased causal knowledge about diet and weight gain, we would expect to see a different strength of association with restrained eating for weight-related and general causal reasoning – an interaction with topic, indicating a difference in accuracy for weight-related and general causal reasoning.

Method – Study 1

2.1 Participants

Participants were recruited from both a university research site and multiple social networking forums to widen the participant demographic. Out of the 180 recruited participants, 22 participants did not fully complete the task. This reduced the participant number used for the final data analysis to 158. The age range of the final included participants was 17 to 68 years (mean ± SD: 24.5 ± 10.6 years) with 83% of participants being female and 17% male. Most participants had either completed college (42%) or undergraduate (50%) education programmes with the remainder (8%) reporting school-based education only. The participants mean BMI was within the normal category weight range (mean ± SD: 23.3 kg/m^2 ± 5.2 kg/m^2). There was no significant difference in BMI based on median split of restraint scores, low restraint mean BMI 22.8 kg/m^2 ± 5.5 kg/m^2, high restraint mean BMI 23.8 kg/m^2± 4.8 kg/m^2, $t(156) = -1.22$, $p = .225$. Over half (55%) of the participants reported regularly exercising each week (mean ± SD: 5 hours ± 3.7). Participants reported an average alcohol consumption of 6 units of alcohol per week (range 0-37 units). A subset of the participants (25 %) reported a current or previous participation in a diet within six months preceding the study. No reimbursement was offered for participation in this study.

2.2 Measures

Individual differences in restraint was measured using the restraint subscale of *The Dutch Eating Behaviour Questionnaire* (DEBQ-RS) (Van Strien, Frijters, Bergers, & Defares, 1986). This measure has been extensively validated and demonstrated both reliability and consistency within general and clinical populations (Caccialanza et al., 2004; Wardle, 1987). Further, it has previously been used in research examining restraint and cognitive performance (Husted, Banks & Seiss, 2016; Shaw & Tiggemann, 2004). Participants' responses for items range from 1 "not at all" to 5 "very often". Where

participants had no direct experience of the behaviour they were instructed to enter a 1 (not at all) response. Example items from the restraint scale include "Do you try to eat less at mealtimes than you would like to eat?" and "Do you deliberately eat less in order not to become heavier?". Items are summed to produce an overall restraint score with a high score indicating an increased tendency towards that eating behaviour. The Cronbach's alpha for the scale when applied to the study population was excellent $\alpha = .94$.

The *Causal Conditional Reasoning Task* is based on the standard causal conditional reasoning task design that has been long established and previously validated (Cummins, Lubart, Alksnis, & Rist, 1991; Cummins, 1995). Eight causal conditionals were developed; four general causal conditionals and four causal conditionals related to causes of weight-gain. The weight-related conditionals were based on an obesity causal model that has been established in both health professionals and general populations (Ogden et al., 2001; Ogden & Flanagan, 2008) whereby four potential causes; biological, behavioural, psychological and environmental, are proposed. Examples of the conditionals used in this task are shown in Table 2. Each of the four logical argument formats were presented for each conditional, i.e. Modus Ponens (MP), Modus Tollens (MT), Affirming the Consequent (AC) and Denying the Antecedent (DA).

- Suggest insert table 2 here -

As per standard procedure for causal conditional reasoning tasks (Cummins, Lubart, Alksnis, & Rist, 1991; Cummins, 1995) all participants were instructed that they must assume that the rule was true. They were then instructed to only consider whether the conclusion subsequently presented necessarily followed on from the conditional rule and fact. Participants responded on a 7-point scale from 1 "Definitely cannot reach that conclusion" through to 7 "Definitely can reach that conclusion". Mean scores are reported for each reasoning topic (obesity-related vs. general) and format (MP, MT, DA, AC). Accurate

reasoning, purely based on logic, should lead participants to choose 7 "Definitely can reach that conclusion" for the logically valid statements in the MP and MT conditions and choose 1 "Definitely cannot reach that conclusion" for the logically invalid statements in the DA and AC conditions. To be able to compare the accuracy levels for both the logically valid and logically invalid statements directly, the responses to logically invalid statements (AC and DA) are reverse scored, so that regardless of the format presented, a high score for the reasoning task indicates more accurate reasoning.

2.3 Design

A within subjects 2 x 4 experimental design was used with two topic content conditions (weight-related and general causal relations) and four logical argument formats (MP, AC, DA, MT). Individual differences in levels of dietary restraint was included in the ANOVA analysis as a covariate.

2.4 Procedure

The study was completed online via a secure hosting site. After providing informed consent, participants completed the reasoning task (where item order was randomised) and the DEBQ-RS before receiving a debrief. All procedures were subject to ethical approval that was obtained from the University Ethics Committee and carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Results

The accuracy of response data were analysed with the repeated measures 2 x 4 ANCOVA with the factors of Topic (General v Weight-related) and Format (MP v MT v DA v AC). Dietary restraint was entered as a covariate.

Results indicated a significant main effect of Topic, $F(1,156) = 15.05$, $p < .001$, $\eta_p^2 = .088$, was found. When responses to reasoning formats were combined, all participants were

significantly more accurate in their reasoning when using weight-related arguments (mean: 4.4 ± 0.05) compared to general arguments (mean: 4.2 ± 0.04); although this difference is numerically very small. Importantly, there was a significant interaction between topic and the covariate of dietary restraint $F(1,156) = 6.16$, $p = .014$, $\eta_p^2 = .038$. Results showed a significant negative association between dietary restraint and the weight-related causal reasoning accuracy, $r = -.199$, $p = .012$, but not with the general causal reasoning accuracy, $r = -.074$, $p = .354$. In other words, whereas the main effect is indicating that overall all participants were more accurate for weight-related responses, the interaction with dietary restraint shows this increase in accuracy is not apparent in individuals with increasing levels of dietary restraint. Here increased levels of restraint isare associated with reduced accuracy in reasoning for weight-related, but not general, reasoning items.

There was a significant main effect of Format, $F(3,468) = 14.94$, $p < .001$, $\eta_p^2 = .087$. As expected, participants were more accurate in their conclusion for logically valid items (mean MP score: 5.3 ± 1.16; mean MT score: 4.7 ± 1.20) than for invalid items (mean DA score: 3.7 ± 1.19; mean AC score: 3.5 ± 1.18). Accuracy scores were significantly different when comparing the reasoning formats, mean difference scores range .129 - 1.82, all p's < .001 apart from between DA and AC scores where $p = .034$. This confirms that the reasoning task worked as expected.

The interaction between the two factors of Topic and Format was also significant, $F(3,468) = 19.41$, $p < .001$, $\eta_p^2 = .111$. This interaction can be explained as follows and is illustrated in Figure 1: There is as a significant difference between general and weight-related topic for all formats (all t's $(157) \leq 14.01$, all p's <.001). However, this difference was significantly larger and reversed for the DA and AC formats (mean DA difference score: -1.10 ± 1.03; mean AC difference score: -1.08 ± 0.97) compared to the MP and MT formats

(mean MP difference score: 0.78 ± 0.97; mean MT difference score: 0.76 ± 1.11), $t(157) = 15.04$, $p < .001$. No other interactions were significant.

- suggest insert figure 1 here-

In summary, all participants were more accurate overall in their reasoning for weight-related conditionals than general conditionals. However, the interaction between topic and restrained eating demonstrated a negative association between restrained eating and causal conditional reasoning for weight-related but not general causal conditionals which meant that the increase in accuracy was not present for those higher in dietary restraint. This finding gives some initial support for the biased causal knowledge mechanism hypothesis which predicted that weight-related conditionals specifically would be influenced by restrained eaters. These findings fit less well with the limited cognitive capacity mechanism hypothesis which would predict that causal reasoning would be impaired on all problem types. The interaction of logical format and topic across all participants could be explained by the biased causal knowledge mechanism model which proposes that greater knowledge of disablers and alternative causes results in MP and MT responses being less accurate, but DA and AC being more accurate (Cummins, Lubart, Alkansis, & Rist, 1991; Cummins, 1995). The effect specifically being present on weight-related conditionals in comparison to general causal conditionals suggests that there is an effect of prior knowledge rather than a more general effect on all causal conditional reasoning (as would be predicted by a limited cognitive capacity mechanism).

Study 2

As the above study approach and findings are novel, it was important to attempt to replicate the pattern of association seen. Further, the aim of Study 2 was to focus on causal reasoning processes where participants have more direct behavioural control over possible outcomes, e.g. eating and physical activity behaviours, as opposed to other aspects of the

causal model, i.e. environmental, genetic factors etc. whereby individuals have minimal influence. This is of relevance as behavioural factors such as making healthy food choices and engaging in physical activity, are a central focus to interventions aimed at healthy weight maintenance. Hence, the causal reasoning task was adapted to concentrate on statements about behavioural causes of weight-gain, related to food choice, eating behaviour and physical activity.

In addition, the pattern of results of the first study suggested an increased number of alternative causes or disablers accessible to individuals who were higher in dietary restraint lead to a reduction in accuracy for the weight-related conditionals only. However, there are two possible reasons for this difference. One possibility is that restrained eaters activated more knowledge about alternative causes and disablers about weight-related conditionals. Alternatively, the general and weight-related conditionals may have simply differed in the number of alternative causes and disablers that exist for those causal relations. To control for this possibility, general and weight-related conditions were created that were matched in their believability and the number of available alternative causes and disablers to ensure that possible confounds in the experimental materials did not arise across topics.

It was predicted that the negative relationship seen in Study 1 between restrained eating and accuracy in reasoning performance, would be replicated and confirmed in Study 2.

Method

4.1 Participants

Participants were again recruited using a university research site and external social networking forums. Originally 120 participants took part however, twelve participants were excluded from the analysis as they did not complete the experimental reasoning task. No other participants were excluded therefore; 108 participants were included in the final

analysis. Of these participants, 88% were female and 12% male. Their age ranged from 17 to 43 years (mean 21 ± 4.7 years). In relation to their highest education level, 10% of participants stated school-based, 44% college, 43% undergraduate and 3% postgraduate level programmes. Due to a technical fault BMI data was not recorded for 33 participants, of the remaining 75 participants mean BMI fell within the normal category weight range (23.3 kg/m^2 ± 3.9). There was no significant difference in BMI based on median split of restraint scores, low restraint mean BMI 22.8 kg/m^2 ± 3.5 kg/m^2, high restraint mean BMI 23.7 kg/m^2± 4.2 kg/m^2, $t(73) = -1.08$, $p = .282$. Participants reported an average alcohol consumption of 5 units of alcohol per week (range 0-60 units) with 9.1% of participants reporting a current or recent participation in a diet in the 6 months preceding the study. Participants had the option to be included in a £25 voucher prize draw on completion of their participation.

4.2 Measures

Restraint was again measured using the subscale of the *Dutch Eating Behaviour Questionnaire (DEBQ-RS)*. The Cronbach's alpha for measure within this population remained excellent $\alpha = .94$.

- suggest insert table 3 here –

The *Causal Conditional Reasoning Task* was a modified version of the task presented in Study 1 with eight general causal conditionals and eight weight-related causal conditionals each presented across the four reasoning forms (See examples in Table 3). This resulted in 64 causal conditional reasoning items which were subject to computerised random order presentation. Prior validation of the stimulus ensured the conditionals used for each topic were matched for belief, disabling conditions and alternative causes.

Validation of stimulus: Twenty-four general and twenty-four obesity causal conditional statements were put to 38 pilot participants. Participants rated, as a percentage, how

believable they felt the rule was. The mean endorsement percentage for each conditional was then calculated. For the final 8 items used in study 2, the mean scores for general and weight-related items was 63%. As literature also indicates that differences in belief of causal connections will influence the levels of disabling conditions or alternative causes, pilot participants were also asked to generate as many disabling conditions (reasons why *p* might not lead to *q*) and alternative causes (reasons why *q* might occur without *p*) for each of the conditionals. This was matched across conditions based on the validation data with an average 1.3 disabling conditions offered by participants per item, and 1.4 alternative causes offered by pilot participants items for both general and weight-related items.

4.3 Design & Procedure

The design and procedure of Study 2 were the same as in Study 1.

Results

The main analysis of the data used a 2 x 4 repeated measures ANCOVA with the factors Topic (General v Weight-related) and conditional reasoning Format (MP vs. MT vs. DA vs. AC). Dietary restraint was included as a covariate. Results indicated a significant main effect of Reasoning Format, $F(3, 318) = 2.63$, $p = .050$, $\eta_p^2 = .024$, as illustrated in figure 2 which displays the findings for the reasoning accuracy separately for each topic and reasoning format.

- Suggest insert Figure 2 here. -

As expected, participants were more accurate in their conclusion for logically valid items (mean MP score: 5.2 ± 0.09; mean MT score: 4.4 ± 0.09) than for invalid items (mean DA score: 3.4 ± 0.09; mean AC score: 3.3 ± 0.09). Accuracy scores were significantly different for most reasoning formats, significant mean difference scores range.766 - 1.89, all p's < .001, expect for the non-significant difference between DA and AC scores (difference =.058) p = .39.

There was a significant interaction between Format and the covariate of dietary restraint $F(3, 318) = 7.26$, $p = .002$, $\eta_p^2 = .064$. This would indicate that the relationship between accuracy and dietary restraint differs between the different causal reasoning formats. Results showed a significant negative association between dietary restraint and overall accuracy for both the weight-related causal reasoning, $r = -.192$, $p = .046$ and general causal reasoning, $r = -.205$, $p = .034$. To explore the interaction in detail between format and dietary restraint, correlation analysis was undertaken and shown in Table 4.

- Suggest insert Table 4 here -

Analysis indicates an effect of dietary restraint on all causal reasoning formats except the simplest, MP. The pattern of correlations could possibly be indicative of heuristic bias, whereby participants higher in dietary restraint are "more accepting" of the causal connections regardless of format. This increased tendency to acceptance then seemingly increasing accuracy for valid items e.g. MT and in turn decreasing accuracy for invalid items i.e. DA or AC. These findings, in contrast to study 1, indicate an effect of dietary restraint on causal reasoning regardless of topic, the association evident in the results for study 2 more supportive of the hypothesis of a deficit in cognitive capacity, rather than additional prior knowledge and experience, explaining results.

There were no significant main effects of Topic, (General topic: 4.1± 0.03; Weight-related topic: 4.1 ± 0.03) or any other significant interactions indicated.

In summary, there was again a negative association between restrained eating and causal reasoning accuracy so that restrained eaters were less accurate overall, replicating the main empirical finding from Study 1 with a different set of causal conditionals. Specifically, in Study 2 the complex interaction between dietary restraint and format providing initial indications of an increased acceptance of causal reasoning items regardless of logical validity. However, unlike Study 1, the association between restrained eating and causal

reasoning was found for both weight-related and general causal conditionals. Furthermore, there was no interaction between logical format and topic, suggesting that all participants performance across both weight-related and general causal conditionals were equally accurate. These findings in Study 2 are more supportive of the limited cognitive capacity mechanism hypothesis which predicts that causal reasoning for restrained eaters would be impaired regardless of topic. This difference in finding to Study 1 is important because it suggests that when general and weight-related causal conditionals are matched for causal beliefs i.e. number of alternative causes and disablers, no topic difference in reasoning accuracy arises.

Discussion

This research aimed to investigate the association between restraint and the accuracy of causal reasoning about weight-related and general causal relations. The main empirical finding that was found in both studies was a negative association between restrained eating and overall causal reasoning accuracy. People with higher levels of restraint were generally less accurate in the causal conditional reasoning task but there was a difference between the studies in terms of how this deficit in performance was seen. In Study 1, there was a main effect of topic indicating that, in general, all participants were more accurate in their reasoning for the weight-related conditionals than for the general conditionals but, an interaction with dietary restraint indicated this increased accuracy did not occur for those higher in dietary restraint: the negative association between restrained eating and causal reasoning accuracy was found only for weight-related conditionals and not for general causal relations. An interaction was found between logical format and topic for all participants, such that for weight-related conditionals MP and MT responses were less accurate but DA and AC responses were more accurate in comparison to general causal conditionals. This pattern of responses is typical of past research indicating participants were drawing on semantic

knowledge (Cummins et al., 1991, Cummins, 1995; De Neys, Schaeken, & d'Ydewalle, 2003; Quinn & Markovits, 2002). However, in Study 2, where weight-related and general causal conditionals were matched for the number of alternative causes and disablers, the differences between weight-related and general causal conditionals disappeared and there was no format x topic interaction. In contrast to study 1, in study 2 the negative association between dietary restraint and causal reasoning was found for both weight-related and general causal conditionals. Specifically, in Study 2 correlation analysis between dietary restraint and task responses by format indicated an increased acceptance of causal reasoning items regardless of logical validity for individuals higher in dietary restraint. Where individuals are more accepting of causal connections, regardless of reasoning, this can present in results as an increased accuracy in valid MT format and decreased accuracy for the invalid DA and AC formats – as seen in the correlations in study 2. No significant association with the MP format was found, perhaps reflective of its simplicity as a mirror of the conditional rule presented. If the findings are indicative of a heuristic bias for individuals higher in dietary restraint, this provides some preliminary support for the reduced cognitive capacity hypothesis as an indication of reduced application of reasoning processes being applied to the task.

The negative association between restrained eating and causal conditional reasoning accuracy was found in both studies using different materials and therefore this is a consistent finding across studies. Study 1 drew on a broad model of the causes of weight gain, Study 2 focused only on behavioural causes of weight gain that are most relevant to health interventions. Both studies also used a diverse set of general causal conditionals. Replicating this effect across different participants and reasoning about different causal relations provides preliminary evidence suggesting that the negative association is a reliable effect. This novel finding adds to understanding about the relationship between restrained eating and cognition in both theoretical and practical terms. Previous research on restrained eating and cognition

has identified the impact of preoccupying thoughts loading working memory and reducing capacity, including the articulatory control process (Shaw & Tiggeman, 2004) and central executive (Vreugdenburg, Bryan, & Kemps, 2003). Unpacking executive function in more detail suggests that, in contrast, restrained eaters are associated with better inhibitory control (Leitch, Morgan, & Yeomans, 2013) and use inhibitory control more in daily life (Hofman et al., 2014) painting a complex picture of executive function and self-regulation of eating behaviour (Dohle, Diel, & Hofman, 2018). However, extant research does not examine the implications of restrained eating on effective thinking. This study does provide indications however that the relationship between restrained eating and high-level cognition, specifically causal reasoning, that draws upon these underlying cognitive functions to accurately apply a reasoning process may be hindered. This has direct consequences for predicting the causal outcome of behaviours related to weight gain. More generally, we propose that this finding might suggest that a wide range of deliberate thinking including decision making, planning, and problem solving may similarly be negatively associated with restrained eating as they too draw on the same underlying cognitive functions (Logie & Gilhooly, 1998).

There are two possible hypotheses that have been offered that might explain the relation between restrained eating and causal reasoning. One possibility is that causal reasoning is hindered by the reduced cognitive capacity of restrained eaters, the other possibility is that it is hindered by biased or inaccurate knowledge about the causes of weight gain in restrained eaters. In Study 1, the negative association between restrained eating and causal reasoning accuracy was found only for weight-related conditionals and not for general causal relations. An interaction was found between logical format and topic for all participants, such that for weight-related conditionals MP and MT responses were less accurate but DA and AC responses were more accurate in comparison to general causal conditionals. This is consistent with greater activation of semantic knowledge when

reasoning about weight-related than general causal conditionals. This initially suggests that weight-related conditionals might trigger more use of prior knowledge about weight gain than the general causal relations. The performance of all participants in general, combined with the specific reduction in accuracy for weight-related conditionals and not general causal conditionals for individuals higher in dietary restraint, is most consistent with the explanation that restrained eaters' reason less well because of their biased or inaccurate knowledge about the causes of weight gain.

An alternative explanation though is simply that the conditionals chosen were not matched for the number of alternative causes and disablers that exist for the weight-related and general causal relations. Study 2 removed this confound by matching weight-related and general conditionals. If restrained eaters did draw on semantic knowledge about weight gain differently to unrestrained eaters, there would still be a difference on the matched conditionals because restrained eaters would retrieve causal information differently. But in fact, the differences between weight-related and general causal conditionals disappeared. In study 2 a negative association between restraint and causal reasoning was found for both weight-related and general causal conditionals. There were no differences between the topics of weight-related and general causal reasoning, demonstrating that restraint has a more general negative effect on causal reasoning. This finding suggests that the difference between weight-related and general causal conditionals in study 1 was due to differences in the conditionals. It also most consistent with the explanation that the negative association between restrained eating and causal reasoning accuracy is caused by reduced cognitive capacity that hinders the reasoning process. It should be acknowledged however that although two explanations for a reduction in causal reasoning ability have been hypothesised (reduced cognitive capacity or biased weight-related knowledge) and that initial findings indicate the

reduced cognitive capacity explanation is more likely, it could also be the case that these two aspects could occur simultaneously, and future research should try and test this possibility.

Importantly, the study findings are a significant and novel demonstration of a wider detrimental relationship between restraint on cognition. Poor reasoning about the causes of obesity may undermine the efficacy of education-based interventions adopted for weight loss and maintenance as inaccurate reasoning about the causes of obesity may lead to ineffective changes in behaviour to address it. Whilst causal reasoning is not the only factor behind the efficacy of educational interventions, the results do add to existing research evidence on possible real world implications for the cognitive deficiencies associated with restraint (Higgs, 2015; Higgs, Dolmans, Humphreys, & Rutters, 2015; Rutters, Kumar, Higgs, & Humphreys, 2015). Understanding how deficiencies in executive function relate to causal reasoning and behavioural choices will help our understanding of the intention-behaviour gap and relapses in behaviour change attempts. However, it must be noted that any cognitive deficit may increase an individual's propensity to gain weight due to their inability to connect their eating/exercising behaviours with weight as an outcome and that this may precede any attempts at restrained eating/development of restraint – in other words that they are engaging in dietary restrictions because they are already overweight and that this weight gain is partially explained by the failure in causal reasoning. Although this is a clear possibility, and directionality in the relationship is not established by this research, interestingly no relationship between BMI and causal reasoning was apparent across either study.

Study Limitations

Although the study has adopted a well-established causal reasoning task to explore the possible implications of past research indicating cognitive deficits associated with restraint, the study itself is cross-sectional and therefore as mentioned previously, a causal link between restraint and reasoning cannot be established. This limits the conclusions that can be

drawn on the nature of the relationship between restraint and causal reasoning and future research should endeavour to determine more specifically the direction in effects. Another limitation is that although much theoretical speculation in the discussion is around the possibility that an underlying deficit in working memory may explain the findings, a measure of working memory was not included in the research – due to the novel nature of the research the authors acknowledge that not all possible explanations were anticipated. Future research should endeavour to examine more specifically the areas of executive function to determine where, if a cognitive deficit occurs, it is to be found.

Conclusion

In conclusion, the two studies offer an interesting and novel examination of the relationship between individual differences in restraint and the cognitive process of causal conditional reasoning. The findings indicate that as an individuals' level of restraint increases, their ability to undertake accurate causal reasoning judgements decreases. The findings are most consistent with the explanation that this is the result of reduced cognitive capacity in restrained eaters. It is proposed that the results provide a possible additional explanation for an element of the behaviour-intention gap as well as a reason why having good levels of nutritional knowledge does not necessitate transferal to health eating behaviour choices. Further, the results may provide a partial explanation for why individuals do not easily accept logically valid health claims found in public health or other educational literature.

Declaration of Interest: None

References

Abraham, C., Kelly, M., West, R., & Michie, S. (2009). The UK national institute for health and clinical excellence public health guidance on behaviour change: A brief introduction. Retrieved from http://discovery.ucl.ac.uk/110884/

Banks, A. P., Egan, B., Hodgkins, C. E., Peacock, M., & Raats, M. M. (2018) The role of causal models and beliefs in interpreting health claims *British Journal of Health Psychology, 23(4),* 933-948. doi: 10.1111/bjhp.12330.

Barton, K., Fugelsang, J., & Smilek, D. (2009). Inhibiting beliefs demands attention. *Thinking & Reasoning*, *15*(3), 250–267. doi.org/10.1080/13546780902930917

Brunstrom, J. M., Davison, C. J., & Mitchell, G. L. (2005). Dietary restraint and cognitive performance in children. *Appetite*, *45*(3), 235–41. doi.org/10.1016/j.appet.2005.07.008

Caccialanza, R., Nicholls, D., Cena, H., Maccarini, L., Rezzani, C., Antonioli, L., … Roggi, C. (2004). Validation of the Dutch Eating Behaviour Questionnaire parent version (DEBQ-P) in the Italian population: a screening tool to detect differences in eating behaviour among obese, overweight and normal-weight preadolescents. *European Journal of Clinical Nutrition*, *58*(9), 1217–22. doi.org/10.1038/sj.ejcn.1601949

Carels, R. A, Harper, J., & Konrad, L. (2006). Qualitative perceptions and caloric estimations of health and unhealthy food by behavioural weight loss participants. *Appetite 46(2),* 199-206. doi.org/10.1016/j.appet.2005.12.002

Chernev, A., (2011). The dieter's paradox. *Journal of consumer psychology 21(2).*178-83. doi.org/10.1016/j.jcps.2010.08.002

Cummins, D. D. (1995). Naive theories and causal deduction. *Memory & Cognition*, *23*(5), 646–658.

Cummins, D. D., Lubart, T., Alksnis, O., & Rist, R. (1991). Conditional reasoning and causation. *Memory & Cognition 19(3).* 274-82.

De Neys, W., Schaeken, W., & d'Ydewalle, G. (2003). Inference suppression and semantic memory retrieval: every counterexample counts. *Memory & Cognition 31*(4), 581–95. doi.org/ 10.3758/BF03196099

De Neys, W., Schaeken, W., & d'Ydewalle, G. (2005). Working memory and counterexample retrieval for causal conditionals. *Thinking & Reasoning, 11*(2), 123–150. doi.org/10.1080/13546780442000105

Dohle, S., Diel, K., & Hofman, W. (2018). Executive functions and the self-regulation of eating behaviour: A review. *Appetite 124.* 4-9. doi.org/10.1016/j.appet.2017.05.041

Freijy, T., & Kothe, E. J. (2013). Dissonance-based interventions for health behaviour change: a systematic review. *British Journal of Health Psychology 18(2).* 310-37. doi: 10.1111/bjhp.12035

Green, M. W., Elliman, N. A., & Rogers, P. J. (1997). Impaired cognitive processing in dieters: Failure of attention focus or resource capacity limitation? *British Journal of Health Psychology, 2*(3), 259–267. doi.org/10.1111/j.2044-8287.1997.tb00540.x

Green, M. W., Jones, A. D., Smith, I. D., Cobain, M. R., Williams, J. M. G., Healy, H., … Durlach, P. J. (2003). Impairments in working memory associated with naturalistic dieting in women: no relationship between task performance and urinary 5-HIAA levels. *Appetite, 40*(2), 145–153. doi.org/10.1016/S0195-6663(02)00137-X

Green, M. W., Rogers, P. J., Elliman, N. A., & Gatenby, S. J. (1994). Impairment of cognitive performance associated with dieting and high levels of dietary restraint. *Physiology & Behavior, 55*(3), 447–452. doi.org/10.1016/0031-9384(94)90099-X

Hartmann, C., Keller, C., & Siegrist, M. (2016). Compensatory beliefs, nutrition knowledge, and eating styles of users and non-users of meal replacement products. *Appetite 105,* 775-781. doi.org/10.1016/j.appet.2016.07.013

Herman, C. P., & Polivy, J. (1980). Restrained Eating. In A. Stunkard (Ed), *Obesity.* 208-225.

Philadelphia, USA.

Higgs, S. (2007). Impairment of cognitive performance in dietary restrained women when imagining eating is not affected by anticipated consumption. *Eating Behaviors*, *8*(2), 157–61. doi.org/10.1016/j.eatbeh.2006.03.004

Higgs, S. (2015). Manipulations of attention during eating and their effects on later snack intake. *Appetite*, *92*, 287–294. doi.org/10.1016/j.appet.2015.05.033

Higgs, S., Dolmans, D., Humphreys, G. W., & Rutters, F. (2015). Dietary self-control influences top-down guidance of attention to food cues. *Frontiers in Psychology*, *6*, 427. doi.org/10.3389/fpsyg.2015.00427

Hofmann, W., Adriaanse, M., Vohs, K. D., & Baumeister, R. F. (2014). Dieting and the self-control of eating in everyday environments: An experience sampling study. *British Journal Of Health Psychology*, *19*(3), 523-539.

Husted, M., Banks, A., & Seiss, E. (2016). Eating behaviour associated with differences in conflict adaptation for food pictures. *Appetite 105*, 630-637. doi:10.1016/j.appet.2016.07.003

Husted, M., & Ogden, J. (2014). Emphasising personal investment effects weight loss and hedonic thoughts about food after obesity surgery. *Journal of Obesity.* Article ID 810374, 8 pages. doi.org/10.1155/2014/810374

Jones, N., & Rogers, P. J. (2003). Preoccupation, food, and failure: an investigation of cognitive performance deficits in dieters. *The International Journal of Eating Disorders*, *33*(2), 185–92. doi.org/10.1002/eat.10124

Kemps, E., & Tiggemann, M. (2005). Working memory performance and preoccupying thoughts in female dieters: evidence for a selective central executive impairment. *The British Journal of Clinical Psychology / the British Psychological Society*, *44*(Pt 3), 357–66. doi.org/10.1348/014466505X35272

Klaczynski, P, A., & Daniel, D. B. (2005). Individual differences in conditional reasoning: a dual-process account. *Thinking & Reasoning 11(4).* 305-25. doi.org/10.1080/13546780442000196

Lattimore, P., & Maxwell, L. (2004). Cognitive load, stress, and disinhibited eating. *Eating Behaviors*, *5*(4), 315–24. doi.org/10.1016/j.eatbeh.2004.04.009

Leitch, M. A., Morgan, M. J. & Yeomans, M. R. (2013). Different subtypes of impulsivity differentiate uncontrolled eating and dietary restaint. *Appetite 69.* 54-63. doi.org/10.1016/appet.2013.05.007.

Markovits, H., Doyon, C., & Simoneau, M. (2002). Individual differences in working memory and conditional reasoning with concrete and abstract content. *Thinking & Reasoning 8(2).* 97-107. doi.org/10.1080/13546780143000143

Ogden, J., Bandara, I., Cohen, H., Farmer, D., Hardie, J., Minas, H., … Whitehead, M. A. (2001). General practitioners' and patients' models of obesity: whose problem is it? *Patient Education and Counseling*, *44*(3), 227–33. doi.org/10.1016/S0738-3991(00)00192-0

Ogden, J., & Flanagan, Z. (2008). Beliefs about the causes and solutions to obesity: a comparison of GPs and lay people. *Patient Education and Counseling*, *71*(1), 72–78. doi.org/10.1016/j.pec.2007.11.022

Over, D. E., Hadjichristidis, C., Evans, J. S., Handley, S. J., & Sloman, S. A. (2007). The probability of causal conditionals. *Cognitive Psychology 54(1).* 62-97. doi.org/10.1016/j.cogpsych.2006.05.002

Papies, E. K., & Hamstra, P. (2010). Goal priming and eating behaviour: enhancing self-regulation by environmental cues. *Health Psychology 29(4).* 384-8 doi.org/10.1037/a0019877

Papies, E. K., Stroebe, W., & Aarts, H. (2008). The allure of forbidden food: On the role of

attention in self-regulation. *Journal of Experimental Social Psychology 44(5).* 1283-92. doi.org/10.1016/j.jesp.2008.04.008

Ouwehand, C., & Papies, E. K. (2010). Eat it or beat it. The differential effects of food temptations on overweight and normal-weight restrained eaters. *Appetite 55(1).* 56-60. doi.org/10.1016/j.appet.2010.04.009

Quinn, S., & Markovits, H. (2002). Conditional reasoning with causal premises: Evidence for a retrieval model. *Thinking & Reasoning 8.* 179-191. doi.org/10.1080/13546780244000015

Rogers, P. J., & Green, M. W. (1993). Dieting, dietary restraint and cognitive performance. *The British Journal of Clinical Psychology, 32 (1).* 113–6. doi.org/10.1111/j.2044-8260.1993.tb01034.x

Rogers, P. J., & Hill, A. J. (1989). Breakdown of dietary restraint following mere exposure to food stimuli: interrelationships between restraint, hunger, salivation and food intake. *Addict Behaviour 14(4). 387-97*

Rutters, F., Kumar, S., Higgs, S., & Humphreys, G. W. (2015). Electrophysiological evidence for enhanced representation of food stimuli in working memory. *Experimental Brain Research*, *233*(2), 519–28. doi.org/10.1007/s00221-014-4132-5

Shaw, J. and Tiggemann, M. (2004). Dieting and working memory: Preoccupying cognitions and the role of the articulatory control process. *British Journal of Health Psychology, 9,* 175-185. doi:10.1348/135910704773891032

Tanaka, K. (2015). Relationship between test anxiety and restrained eating using estimates of the calorie content of food. *Japanese Journal of Health Psychology*, *28*(1), 15–21. doi-org.winchester.idm.oclc.org/10.11560/jahp.28.1pass:[_]15

Totman, R. (1979). *Social Causes of Illness.* Souvenir Press, London. ISBN 0285648624.

Vanstrien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating

Behavior Questionnaire (Debq) for Assessment of Restrained, Emotional, and External Eating Behavior. *International Journal of Eating Disorders*, *5*(2), 295–315.

Verschueren, N., Schaeken, W., & d'Ydewalle, G. (2005). Everyday conditional reasoning: A working memory–dependent tradeoff between counterexample and likelihood use. *Memory & Cognition 33*, 107-19. doi:10.3758/BF03195301

Vreugdenburg, L., Bryan, J., & Kemps, E. (2003). The effect of self-initiated weight-loss dieting on working memory: the role of preoccupying cognitions. *Appetite 41(3).* 291-300.

Ward, A., & Mann, T. (2000). Don't mind if I do: Disinhibited eating under cognitive load. *Journal of Personality and Social Psychology*, *78*(4), 753–763. doi.org/10.1037/0022-3514.78.4.753

Wardle, J. (1987). Eating Style - a Validation-Study of the Dutch Eating Behavior Questionnaire in Normal Subjects and Women with Eating Disorders. *Journal of Psychosomatic Research*, *31*(2), 161–169. doi.org/10.1016/0022-3999(87)90072-9

Westenhoefer, J., Engel, D., Holst, C., Lorenz, J., Peacock, M., Stubbs, J., … Raats, M. (2013). Cognitive and weight-related correlates of flexible and rigid restrained eating behaviour. *Eating Behaviors*, *14*(1), 69–72. doi.org/10.1016/j.eatbeh.2012.10.015

Whitelock, V., Nouwen, A., van der Akker, O., & Higgs, S. (2018). The role of working memory sub-components in food choice and dieting success. *Appetite 124.* 24-32. doi: 10.1016/j.appet.2017.05.043

Tables

Table 1.

Standard conditional argument formats

Argument form	Rule	Fact	Conclusion
Modus ponens If *p* then *q*; *p*, therefore *q*	If you eat doughnuts, then you will get fatter	You eat doughnuts	You are fatter
Denial of the antecedent If *p* then *q*; not-*p*, therefore not-*q*	If you eat doughnuts, then you will get fatter	You do not eat doughnuts	You are not fatter
Affirmation of the consequent If *p* then *q*; *q*, therefore *p*	If you eat doughnuts, then you will get fatter	You are fatter	You ate doughnuts
Modus Tollens If *p* then *q*; not-*q*, therefore not-*p*	If you eat doughnuts, then you will get fatter	You are not fatter	You did not eat doughnuts

Table 2.

Examples of the Causal Conditional Reasoning (CCR) Statements used in the tasks

General CCR Statements	**Weight-related CCR Statements**
If a person uses a breath mint, then the person will have fresh breath.	If a person has certain genes, then the person will be more over-weight.
If a person cuts their finger, then the finger will bleed.	If a person goes on a diet, then the person will lose weight.
If a person drinks lots of alcohol, then the person will get drunk.	If a person has high self-esteem, then the person will control their weight.
If a person studies hard, then they will do well on the test.	If a person lives near lots of fast-food outlets, then they will be more overweight.

Table 3.

Examples of the Causal Conditional Reasoning (CCR) Statements used in Study 2.

General CCR Statements	**Weight-related CCR Statements**
If you sleep, then you will feel refreshed.	If you diet, then you will get thinner.
If you revise, then you will remember.	If you exercise, then you will be healthier.
If you drink caffeine, then you will feel alert.	If you eat doughnuts, then you will get fatter.
If you win the lottery, then you will be happy.	If you go running, then you will be healthier.

Table 4.

Correlations between Dietary Restraint and Accuracy of Causal Reasoning Task by Format

	GR_MP	**OR_MP**	**GR_MT**	**OR_MT**	**GR_DA**	**OR_DA**	**GR_AC**	**OR_AC**
Dietary Restraint	.106	.110	.283**	.190*	-.314**	-.242*	-.319**	-.270**

*** = p value < .01 * = p value < .05*

Figures

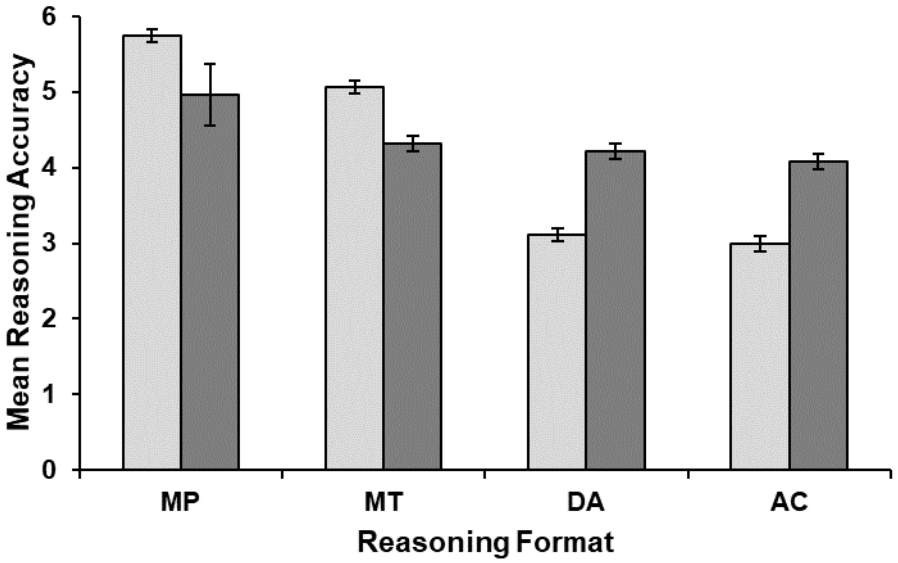

Figure 1. Reasoning accuracy for Study 1 separately presented for each causal reasoning topics (general vs. weight-related topic statements) and conditional reasoning format (MP, MT, DA, AC). Light grey bars: general statements. Dark grey bars: weight-related statements. Mean and SE values.

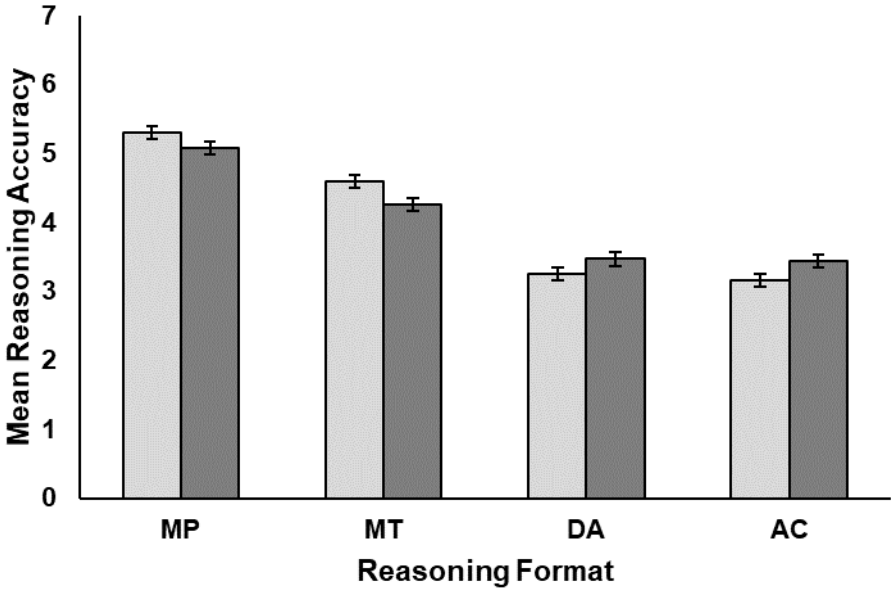

Figure 2. Reasoning accuracy for Study 2 separately presented for each causal reasoning topics (general vs. weight-related statements) and conditional reasoning format (MP, MT, DA, AC). Light grey bars: general statements. Dark grey bars: weight-related statements. Mean and SE values.