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Explaining the relationship between attachment anxiety, eating behaviour and BMI

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overeating and higher body mass index (BMI). The current study explored the nature of the mechanisms underpinning this relationship. Study 1 assessed the relative contribution of 'emotional eating', 'susceptibility to hunger' and 'uncontrolled eating'. Study 2 assessed whether misperception of emotion and poor emotion management would mediate the relationship between attachment anxiety and stress-induced eating (and then BMI). Two cross-sectional online questionnaire studies were conducted (Study 1 N = 665, & Study 2 N = 548), in UK and US-based samples, which assessed attachment orientation and BMI alongside the potential mediators. The relative contribution of emotional eating, susceptibility to hunger and uncontrolled eating (Study 1) and difficulties in emotion regulation and stress-induced eating (Study 2) as mediators of this relationship were examined. In Study 1, parallel multiple mediation analysis (PROCESS) showed that emotional eating and susceptibility to hunger (but not uncontrolled eating) were significant mediators of the relationship between attachment anxiety and BMI. In Study 2, serial mediation analysis showed that difficulties in 'engaging with goal directed behaviours when upset' and stress-induced eating operated in series to significantly mediate the relationship between attachment anxiety and BMI. These findings suggest that attachment anxious individuals feel less capable in disengaging from negative emotions and go on to try to soothe themselves through eating which has a negative impact on their BMI. There was less support for an explanation of the relationship between attachment anxiety and BMI based around the misperception of emotion. Taken together, the findings highlight attachment anxiety and emotion regulation strategies as key targets for interventions that aim to reduce overeating and excess body weight.

Key words: attachment anxiety; affect regulation; emotional eating; body weight

and internal models of personal relationships (expectations of self and others in personal relationships). These models are usually abstracted from early interactions with caregivers (Bowlby, 1969). Attachment orientation is often assessed in terms of two orthogonal dimensions; attachment *anxiety* is characterised by a fear of abandonment whereas, attachment *avoidance* reflects a fear of intimacy. If an individual is low in attachment anxiety and avoidance, they are 'attachment secure'. If an individual is high in attachment anxiety or avoidance or both then they are 'attachment insecure' (Brennan, Clark, & Shaver, 1998). Attachment orientation can be assessed to reflect a general approach to relationships (dispositional attachment orientation) or to reflect the approach to a specific relationship (relationship-specific attachment orientation). Here, dispositional attachment orientation will be our focus. A recent meta-analysis indicated that attachment anxiety is more strongly associated with unhealthy eating behaviours than attachment avoidance (Faber, Dubé, & Knauper, 2018). Therefore, our paper focuses on attachment anxiety.

Previous research has shown that, in a UK university student population, greater attachment anxiety is predictive of a heavier body mass index (BMI) and that this relationship is significantly mediated by disinhibited eating, which reflects a general propensity to overeat (Wilkinson, Rowe, Bishop, & Brunstrom, 2010). In weight-loss surgery candidates, higher attachment anxiety is associated with greater incidence of binge eating (Shakory et al., 2015). Research has also shown that attachment anxiety is generally higher in bariatric surgery patients than lean controls (Nancarrow, Hollywood, Ogden, & Hashemi, 2017; Pratt et al., 2016) and Wilkinson, Rowe, Sheldon, Johnson and Brunstrom (2017) showed that disinhibited eating mediated the difference in attachment insecurity between bariatric surgery candidates/ recipients and lean, age and gender matched control participants.

population, Faber et al. (2018) found that attachment insecurity was positively associated with unhealthy eating behaviours (including binge eating, emotional eating and unhealthy food intake) whereas attachment security was negatively associated with these behaviours.

The prevailing view is that the relationship between attachment anxiety, overeating and body mass index can be explained in terms of affect regulation (Maunder, Hunter, & Le, 2017). Attachment anxious individuals are relatively poor at managing their emotions (compared to attachment secure individuals); the attachment system is hyper-activated leading to a hyper-vigilance to potentially upsetting/ stressful negative social cues (Mikulincer, 1998). Therefore, in order to 'soothe' themselves, attachment anxious individuals are more likely to rely on *externa*l sources of affect regulation such as food (amongst others, e.g., smoking, substance misuse, sexual promiscuity) (Maunder & Hunter, 2001). Indeed, in bariatric surgery candidates, attachment anxiety is associated specifically with *emotional* eating (Taube-Schiff et al., 2015) and overall difficulties in emotion regulation have been shown to mediate the relationship between attachment anxiety and binge eating (Shakory, et al., 2015).

However, other explanations also exist to potentially explain the relationship between attachment anxiety and eating behaviour/ BMI. First, Phillips, Gibson and Slade (2012) suggest that attachment anxiety is related to 'loss of control' over eating, after failing to find a relationship between attachment anxiety and a specific measure of 'emotional eating', rather finding a relationship only with a measure of 'uncontrolled eating' (measures were from the Revised Three Factor Eating Questionnaire (TFEQ); Karlsson, Persson, Sjöström, & Sullivan, 2000).

emotions as hunger by highly attachment anxious individuals. Specifically, Alexander and Siegel (2013) found that perception of one's own hunger (measured using the susceptibility to hunger subscale from the original version of the Three Factor Eating Questionnaire; Stunkard & Messick, 1985) mediated a relationship between attachment anxiety and eating in response to depression or anxiety. Stapleton and Mackay (2014) found that susceptibility to hunger mediated a relationship between attachment anxiety and emotional eating.

To date, the measures underpinning the three explanations described have not been compared within a single, well-powered model with appropriate control measures included. Therefore, the primary of objective of Study 1 was to assess the relative contribution of these potential mediators of the relationship between attachment anxiety and BMI.

As a secondary aim, we were concerned to include an alternative measure that more directly tests the affect regulation explanation. This is because the emotional eating measure from the revised TFEQ (Karlsson, et al., 2000) is relatively limited in terms of the emotions that it assesses (eating in response to 'feeling blue', 'loneliness' and 'anxious'). By contrast, the 'eating to cope' measure of the Palatable Eating Motives Scale (PEMS; Burgess, Turan, Lokken, Morse, & Boggiano, 2014) captures a broader range of emotions that are more targeted to the overall theoretical model of affect regulation (eating in response to 'forgetting worries', 'to help with depression and nervousness', 'cheer up in a bad mood' and 'forget about problems'). In so doing, we aimed to rule out the possibility that the failure to observe an effect of emotional eating, as reported by Philips et al. (2012), was due to the inadequacy of the scale used to measure the emotional experience of individuals high in attachment anxiety.

measure of food intake (frequency of healthy and unhealthy snack food intake; Brown & Ogden, 2004). Faber and Dubé (2015) showed that insecure parental attachment (reflecting both attachment anxiety and avoidance) was associated with greater consumption of high calorie foods in both adults and children. However, the role of mediators such as emotional eating, susceptibility to hunger and uncontrolled eating in this relationship remain unexplored. Therefore, the relationship between attachment anxiety and high calorie food consumption was modelled here with potential mediators included.

In summary, the overarching aim of this research was to explore the mechanisms underpinning the relationship between attachment anxiety and BMI. Study 1 assessed the relative contribution of 'emotional eating', 'susceptibility to hunger' and 'uncontrolled eating', hypothesising that one or more of these variables would mediate the relationship between attachment anxiety and BMI, and between attachment anxiety and high calorie food consumption. We then report the results of a second study which builds on Study 1 by examining the role of specific emotion regulation processes. In Study 2 we hypothesised that misperception of emotion and poor emotion management would mediate the relationship between attachment anxiety and stress-induced eating (and then BMI). We operationalised misperception of emotion as lack of emotional awareness and lack of emotional clarity. Poor emotion management was operationalised as difficulties in engaging in goal-directed behaviours when upset and having limited access to emotion regulation strategies.

Participants

A total of 665 participants (male= 144, female=521) completed the study (826 started the study but 161 failed to complete measures in full and were therefore excluded). They were recruited in a consortium-led approach (see Button, Lawrence, Chambers, & Munafò, 2016) by university students based at the University of Liverpool (*N* = 314), University of Bristol (*N* = 116) and Swansea University (*N* = 235) in the UK. To be eligible for the study participants needed to be aged 18 years or older and have no current or previous diagnosis of an eating disorder. The sample consisted mainly of university students and staff and had a mean age of 28.8 years (*SD* = 13.5) and mean BMI = 24.6 kg/m^2 (*SD* = 5.9). Participants provided informed consent prior to completion of the survey though the specific aims of the study were obscured with a cover story that stated that the study was concerned with the relationship between social factors and eating behaviour in general. Ethical approval was obtained from local human research ethics committees at each site.

Measures

Attachment orientation was assessed using the short form version of the Experiences in Close Relationships Questionnaire developed by Lafontaine and colleagues (Lafontaine et al., 2016). This comprised two 6-item subscales, one for attachment anxiety (Cronbach's alpha = .88)[1] and one for attachment avoidance (Cronbach's alpha = .84). Participants rated their level of agreement with statements about their experiences of interpersonal relationships (e.g., I worry about being abandoned) on a seven-point scale ranging from 'strongly disagree' to 'strongly agree'.

[1] All Cronbach's alpha values reported are from the current studies.

rated the extent to which statements about eating in response to emotional states applied to them (e.g., When I feel anxious, I find myself eating) using a four-point scale ranging from 'definitely true' to 'definitely false'.

Eating to cope was assessed using the 4-item subscale of the Palatable Eating Motives Scale (Burgess, et al., 2014; Cronbach's alpha = .88). Participants rated the extent to which they consumed palatable foods in response to emotions (e.g., To forget your worries) on a five-point scale ranging from 'almost never/ never' to almost always/ always'.

Susceptibility to hunger was assessed using the 14-item subscale of the Three Factor Eating Questionnaire (Stunkard & Messick, 1985; Cronbach's alpha = .77). Participants rated the extent to which they perceived themselves to experience hunger (not emotion-related) and how this affects their eating behaviour (e.g., 'I often feel so hungry that I just have to eat something'). They responded true/ false on the majority of measures or on a 4-point scale that depended on the wording of the question.

Uncontrolled eating was assessed using the nine-item subscale of the revised Three Factor Eating Questionnaire (Karlsson, et al., 2000; Cronbach's alpha = .86). Participants rated the extent to which statements about losing control over eating applied to them (e.g., Sometimes when I start eating, I just can't seem to stop) on a four-point scale ranging from 'definitely true' to 'definitely false' or a variant of this scale depending on the question.

Snack intake was assessed using a food frequency questionnaire focussed on food consumption between meals (Brown & Ogden, 2004). This comprised two subscales one for healthy snack intake (Cronbach's alpha = .68) and one for unhealthy snack intake (Cronbach's alpha = .82). Participants responded as to how often they consumed 22 common

BMI. Current height and weight were provided (self-report) in participants' preferred units. These were converted to metric measures in order to calculate BMI (kg/m^2).

Procedure

The study was hosted on Qualtrics survey software (Qualtrics, Provo, UT, USA) and participants had to click an anonymised link (advertised via social media, posters and student study-participation systems) in order to access the study. Participants were asked to read an information sheet and complete a tick box consent screen. Following this, they were asked to complete all of the measures as well as basic demographic questions. For each participant, the order that the questionnaires were delivered was randomised (using the randomisation function within Qualtrics). Upon completion, participants were asked to provide their beliefs about the aim of the study (demand awareness check) and were then presented with a debrief screen.

Data analysis

First, to assess the relative contribution of the potential mediators of the relationship between attachment anxiety and BMI (i.e., emotional eating, susceptibility to hunger, and uncontrolled eating,), we ran a parallel multiple mediation model using PROCESS v2.16 (Hayes, 2013). This approach was selected because it allows for the simultaneous entry of multiple mediators within a single model, such that the independent contribution of each mediator as part of an indirect pathway from the predictor to the outcome can be estimated. A significant indirect pathway is inferred if the lower and upper limit confidence intervals (LLCI & ULCI, respectively) do not cross zero. For an overview of mediation analysis and its application see Hayes (2012). Our model was conducted with attachment anxiety (predictor), BMI (outcome) and parallel multiple mediators (emotional eating, susceptibility

orthogonal dimensions of attachment orientation and it was therefore important to control for the potential influence of attachment avoidance within the model. Also, due to the consortium-based approach we also controlled for institution in which the data were collected. Second, to examine the influence of including a more targeted measure of affect regulation, an identical model was run again except with the 'eating to cope' measure in place of the 'emotional eating' measure.

Third, to examine the relationship between attachment anxiety and eating behaviour associated with specific food types, we ran a parallel multiple mediation model with attachment anxiety (predictor), unhealthy snacking (outcome) and parallel multiple mediators (emotional eating, susceptibility to hunger, and uncontrolled eating). In addition to the covariates outlined for the first two models, we also controlled for healthy snacking behaviour (to ensure that we did not just reflect an overall tendency to eat more). Finally, an identical model was run again except with the 'eating to cope' measure was included in place of 'emotional eating' measure.

In all models, the covariates were controlled for at the level of both the mediator and the outcome. All models ran 1000 bootstrap samples and 95% confidence intervals are reported.

Results

Cohort-level means and standard deviations for each measure and correlations between these measures can be found in the supplementary materials (Tables S1 and S2).

relationship between attachment anxiety and BMI when no mediators were included in the model. When mediators were included, the direct relationship between attachment anxiety and BMI was no longer significant and there were significant indirect relationships via both emotional eating and susceptibility to hunger. When the two simultaneous indirect effects were compared (contrasts) it showed there was no significant difference between them (i.e., one was not a significantly stronger/ weaker mediator than the other; LLCI = -.11 & ULCI = .2). However, there was no significant indirect relationship between attachment anxiety and BMI via uncontrolled eating.

Our second parallel multiple mediation model which included the 'eating to cope' scale in place of the 'emotional eating' scale showed an identical pattern of results. Further information on this model can be found in the supplementary material.

<<Figure 1>>

Mediators of the relationship between attachment anxiety and unhealthy snack intake

Our third parallel multiple mediation model (Figure 2) showed that there was a significant direct relationship between attachment anxiety and unhealthy snack intake when no mediators were included in the model. When mediators were included, the direct relationship between attachment anxiety and BMI remained significant and significant indirect relationships via emotional eating, susceptibility to hunger and uncontrolled eating were evident. When the indirect effects were compared (contrasts) it showed there was no significant difference between the effects via emotional eating and susceptibility to hunger (LLCI = -.13 & ULCI = .38). There was, however, a significant difference between the indirect effects via uncontrolled eating and emotional eating (this was due to uncontrolled eating having an unexpected negative relationship with unhealthy snacking whereas

relationships mediated by uncontrolled eating and susceptibility to hunger (LLCI = -.94 & ULCI = -.21).

Our fourth parallel multiple mediation model, which included the 'eating to cope' scale in place of the 'emotional eating' scale, showed an identical pattern of results. Further information on this model can be found in the supplementary material.

<<Figure 2>>

Interim discussion

Our findings suggest that emotional eating/ eating to cope mediates the relationship between attachment anxiety and BMI. In addition to this, we also found that attachment anxiety was positively associated with susceptibility to hunger and this, in turn, predicted BMI. However, inconsistent with Phillips et al. (2012), we failed to find an effect of attachment anxiety on BMI via uncontrolled eating.

We found that emotional eating/ eating to cope, susceptibility to hunger and uncontrolled eating all mediated the relationship between attachment anxiety and unhealthy snack intake. Faber and Dubé (2015) found that insecure parental attachment was associated with greater consumption of high calorie foods in both adults and children. Our study extends this finding by suggesting that unhealthy eating in attachment anxious individuals is underpinned by affect regulation and also enhanced hunger (but not loss of control over eating because the association between uncontrolled eating and unhealthy snack intake was unexpectedly in a negative direction).

Nevertheless, the findings of Study 1 are limited by factors that prevent us from drawing strong conclusions about the specific mechanisms (relating to emotional eating and

Eating Questionnaire in order to maintain consistency with previous studies which have found that this measure mediated the association between attachment anxiety and emotion-induced eating (Alexander & Siegel, 2013; Stapleton & Mackay, 2014). These researchers interpreted this finding as indicating that individuals high in attachment anxiety are inclined to misperceive emotions as hunger which in turn leads to overeating. However, it is important to clarify that the TFEQ simply assesses susceptibility to hunger alone and does not measure any dimension of misperception of emotion. Therefore, the emotion regulation processes that underpin the greater susceptibility to hunger in high-attachment anxiety individuals were not specifically tested here nor in the previous studies. In addition, the emotional eating measure used here (Study 1) does not specifically test whether attachment anxious individuals' poor emotion regulation skills underpin their emotional eating behaviour.

Therefore, in line with a study by Shakory et al. (2015), in Study 2 we explored mediators of the relationship between attachment anxiety and eating behaviour (and then BMI) with the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) which quantifies dimensions which relate to lack of emotional awareness, lack of emotional clarity, difficulties in engaging in goal-directed behaviours when upset, having limited access to emotion regulation strategies, non-acceptance of emotions and impulsive emotions. In a departure from Shakory et al. (2015), we chose to examine a general population rather than weight-loss surgery candidates and the individual subscales of the questionnaire (described in more detail below) rather than just the total score. The subscales assessing lack of emotional awareness and lack of emotional clarity were conceptualised in terms of 'misperception of emotion', as these subscales seem to reflect the concept as it was discussed in previous studies investigating the relationship between attachment anxiety and over-eating (Alexander

emotional responses" (p. 47) and define the lack of emotional clarity subscale as "reflecting the extent to which individuals know (and are clear about) the emotions they are experiencing" (p. 47). The subscales assessing difficulties in engaging in goal-directed behaviours when upset and having limited access to emotion regulation strategies were conceptualised in terms of 'poor emotion management', again, as these subscales seem to reflect the concept as discussed in the context of the relationship between attachment anxiety and over-eating (Maunder, et al., 2017). Gratz and Roemer (2004) define the difficulties in engaging in goal-directed behaviours when upset subscale as "reflecting difficulties concentrating and accomplishing tasks when experiencing negative emotions" (p. 47) and the subscale assessing limited access to emotion regulation strategies as "reflecting the belief that there is little that can be done to regulate emotions effectively, once an individual is upset" (p. 47). The subscale assessing impulse control difficulties was defined by Gratz and Roemer (2004) as "reflecting difficulties remaining in control of one's behaviour when experiencing negative emotions" (p. 47). The subscale assessing non-acceptance of emotion was defined by Gratz and Roemer (2004) as "reflecting a tendency to have negative secondary emotional responses to one's negative emotions, or non-accepting reactions to one's distress" (p. 47). To extend the results of Study 1, we hypothesised that subscales associated with misperception of emotion and poor emotion management would mediate the relationship between attachment anxiety and stress-induced eating (and then BMI) but that the subscales associated with impulsive emotions and non-acceptance of emotions would not.

In addition, in Study 2 we used other alternative measures to those used in Study 1; firstly, we used the revised 36-item measure of the Experiences in Close Relationships (ECR) Questionnaire to measure attachment orientation as this is more broadly used and therefore

to longer versions of the ECR. See Lafontaine et al., 2016). Secondly, we were concerned that the measures used in Study 1 were all derived from two different versions of the Three Factor Eating Questionnaire and therefore their use may create a vulnerability for spurious findings – for example, items from the Perceived Hunger Scale (Stunkard & Messick, 1985) are similar to items in the Uncontrolled Eating Scale (Karlsson, et al., 2000); indeed, indirect relationships involving uncontrolled eating and unhealthy snacking were in an unexpectedly negative direction. Therefore, in Study 2 we used a measure of eating behaviour (stress-induced eating scale) that does not originate from any version of the TFEQ (see Robinson, Hunger, & Daly, 2015). This measure also has the benefit of focusing on stress which is central to the theoretical understanding of attachment anxious individuals' experience (see Stapleton & Mackay, 2014 for further discussion) and it has been shown to be prospectively predictive of increased BMI (see Robinson, et al., 2015).

Study 2

Methods

Participants

Participants from the US were recruited online via Amazon Mechanical Turk and completed an internet based survey. A total of 698 participants provided initial consent and, of these, 620 participants completed the survey in full. Consistent with recommendations for internet-delivered research (Godinho, Kushnir, & Cunningham, 2016), during the survey there were several 'attention check' items to ensure that participants were completing the questionnaires diligently (e.g., embedded items for which participants were instructed to 'Select somewhat agree as the response option for this question'). If a participant failed one or more of the

female=311). The sample had a mean age of 36 years (*SD*= 11.9) and a mean BMI of 27.24 kg/m^2 (*SD* = 7.49). Participants provided full informed consent prior to completion of the survey and ethical approval was obtained from the University of Liverpool Ethics Committee.

Measures

Attachment orientation was measured using the 36-item Revised Experiences in Close Relationships Scale (Fraley, Waller, & Brennan, 2000) which consists of two subscales, attachment avoidance (Cronbach's alpha=0.91) and attachment anxiety (Cronbach's alpha=0.91). Participants are required to indicate their agreement with statements such as 'I am afraid that I will lose my partner's love' on a 7-point scale from strongly disagree (1) to strongly agree (7). Higher scores on both subscales indicate stronger levels of attachment anxiety/avoidance. In the current study, an error with the online survey meant that responses to one of the items on the attachment anxiety scale did not record, therefore the attachment anxiety scale is comprised of 17 items.

Stress-induced eating. Participants were asked to indicate the extent to which they engage in particular eating behaviours in times of stress, for example, 'Eating more than usual' and 'Eating more favourite foods to improve mood'. Responses were indicated on a 4-point scale from 'A lot' to 'Not at All' (Cronbach's alpha = .86).

BMI. Current height (in feet) and weight (in pounds) were provided (self-report). These were converted to metric measures in order to calculate BMI (kg/m^2).

Measure of Emotion Regulation. The 36-item Difficulties in Emotional Regulation Scale (Gratz & Roemer, 2004) was used to provide a measure of emotional dysregulation, with higher scores indicating increased issues in an individuals' ability to regulate their

'When I'm upset, I become irritated at myself for feeling this way' (Cronbach's alpha = .91). 2. A lack of emotional awareness ('awareness') with items such as 'I am attentive to my feelings' (reverse-coded) (Cronbach's alpha = .83). 3. A lack of emotional clarity ('clarity') with items such as 'I have difficulty making sense out of my feelings' (Cronbach's alpha = .83). 4. Difficulties engaging with goal directed behaviours ('goal directed') with items such as 'When I'm upset, I have difficulty concentrating' (Cronbach's alpha = 91). 5. Limited access to emotion regulation strategies ('strategies') with items such as 'When I'm upset, my emotions feel overwhelming' (Cronbach's alpha = .92). 6. Impulse control difficulties ('impulse') with items such as 'When I'm upset, I lose control over my behaviours' (Cronbach's alpha = .88). Participants were required to rate how frequently the statements apply, from Almost Never (0-10% of the time) = 1 to Almost Always (91-100% of the time) = 5.

Procedure

Prior to completing the online survey, participants accessed an information sheet and full informed consent was gained. All participants were initially asked to provide demographic information (age, gender, height and weight) before completing the battery of standardised and validated questionnaires as described in the *Measures* section. The order of the questionnaires was randomised to reduce possible bias and all participants were fully debriefed. The full questionnaire battery took approximately 20 minutes to complete and participants were provided with a small financial reward.

Data Analysis

First, we sought to replicate the significant mediated relationship between attachment anxiety, overeating and BMI in Study 1. Therefore, we conducted a mediation analysis using

for age, gender and attachment avoidance by entering them as covariates into all of the models presented here.

Second, we sought to explore the relative contribution of the different subscales of the Difficulties in Emotion Regulation Scale as mediators of the relationship between attachment anxiety and stress-induced eating. We used parallel multiple mediation analysis in PROCESS (Preacher & Hayes, 2004) with attachment anxiety (predictor), the six subscales of the Difficulties in Emotion Regulation Scale (parallel multiple mediators) and stress-induced eating (outcome). All six subscales were entered as mediators into the model in order to test the hypothesis that subscales associated with misperception of emotion (i.e. awareness, clarity) and poor emotion management (i.e. goal-directed, strategies) would mediate the relationship between attachment anxiety and stress-induced eating but that the subscales associated with impulsive emotions (i.e. impulse) and non-acceptance of emotions (i.e. non-acceptance) would not.

Finally, we tested a serial mediation model that brought together significant mediators identified in the first and second models presented. Specifically, we tested for a significant indirect relationship between attachment anxiety (predictor), difficulty in emotion regulation relating to goal directed behaviour (mediator 1), stress-induced eating (mediator 2) and BMI (outcome).

In all models, the covariates were controlled for at the level of both the mediator and the outcome, there were 1000 bootstrap samples and 95% confidence intervals are reported.

measures can be found in the supplementary materials (Tables S3 and S4).

Mediation model: Attachment anxiety, stress-induced eating and BMI

The mediation model (Figure 3) showed that attachment orientation significantly predicted stress-induced eating, and stress-induced eating significantly predicted BMI. The direct relationship between attachment anxiety and BMI missed significance (p = .09) when stress-induced eating was not included in the model and was not significant when stress-induced eating was included in the model. Importantly and consistent with our hypothesis, a significant indirect relationship from attachment anxiety to BMI through stress-induced eating was found.

<<Figure 3>>

Parallel multiple mediation model: Do difficulties in emotion regulation mediate the relationship between attachment anxiety and stress-induced eating?

The parallel multiple mediation model showed that there was a significant direct relationship between attachment anxiety and stress-induced eating when the mediators were included in the model and that this was significantly mediated by the subscale of the Difficulties in Emotion Regulation Scale quantifying 'difficulties in engaging in goal directed behaviours when upset'. None of the other subscales of the Difficulties in Emotion Regulation Scale were significant mediators of the relationship between attachment anxiety and stress-induced eating. Other details of the model can be found in Figure 4 and the associated figure legend.

<<Figure 4>>

Serial multiple mediation model: Attachment anxiety, difficulties in emotion regulation (goal directed behaviour), stress-induced eating and BMI.

goal directed behaviour when upset and stress-induced eating operating in series (i.e., attachment anxiety predicted difficulties in engaging in goal directed behaviour when upset which, in turn, predicted stress-induced eating). There was also a significant indirect relationship between attachment anxiety and BMI via stress-induced eating. No other indirect relationship was significant. There was no significant direct effect between attachment anxiety and BMI when mediators were included in the model.

<<Figure 5>>

General discussion

The overarching aim of this research was to explore the mechanisms underpinning the relationship between attachment anxiety and BMI. Study 1 found that emotional eating and susceptibility to hunger (but not uncontrolled eating) significantly mediated the association between attachment anxiety and BMI. Study 2 used the Difficulties in Emotion Regulation Scale to quantify the specific emotional processes that may underpin the relationship between attachment anxiety and eating. It found that the relationship between attachment anxiety and BMI was mediated by a failure to engage in goal directed behaviours when upset (i.e. indicative of poor emotion management) which, in turn, predicted stress- induced eating. This finding extends the results of Study 1 and is consistent with the broader attachment theory which suggests that attachment anxious individuals experience enhanced activation of the attachment system in response to distress that leads to hyper-vigilance to negative social cues (Kobak, Cole, Ferenz-Gillies, Fleming, & Gamble, 1993) and an inability to disengage from these cues and associated negative feelings (Mikulincer & Florian, 1998). Notably, this response pattern (representing poor emotion regulation) exacerbates the distress that is

for this explanation of the relationship between attachment anxiety, over-eating and BMI. Importantly, these findings were consistent across our two studies which sampled both UK (Study 1) and US (Study 2) adults. Future research would benefit from examining whether the significant mediators identified in the present studies also mediate relationships between attachment anxiety and the use of other types of external affect regulator (e.g., smoking, substance misuse, sexual promiscuity).

In Study 2, it was also predicted that misperception of emotion would mediate the relationship between attachment anxiety and stress-induced eating (and then BMI). However there were no significant indirect relationships via the subscales of the Difficulties in Emotion Regulation Scale that involved misinterpretation of emotion (lack of awareness of emotions or lack of clarity of emotions). Study 2 therefore failed to support the alternative explanation that the relationship between attachment anxiety and BMI is underpinned by a basic misinterpretation of emotions. To clarify, we found that attachment anxiety was significantly associated with these traits but that they did not, in turn, relate to eating behaviour. One possibility is that the role of susceptibility to hunger (demonstrated in Study 1 and by Alexander & Siegel, 2013 and Stapleton & Mackay, 2014) in the relationship between attachment anxiety and overeating/ emotional eating and BMI has been misunderstood. For example, attachment anxious individuals might engage in emotional eating and conclude/ report that they must be hungry (i.e., the emotional eating causes the misattribution of hunger rather than the emotion itself being misperceived as hunger). In this case, the order of variables in previously reported serial mediator models may have been specified incorrectly. Furthermore, the Difficulties in Emotion Regulation Scale used in Study 2 does not explicitly measure whether emotions are misperceived as hunger. To address this, future research

An important limitation of the present work is that the data from both studies are cross-sectional and it is therefore not possible to make causal inferences about the relationships reported. Our rationale for including attachment anxiety as the independent variable (predictor) in the statistical models is that attachment orientation is thought to be abstracted from early interactions with caregivers (Bolwby, 1969) and there is longitudinal evidence that it can remain stable into and throughout adulthood (with some exceptions) (Waters, Merrick, Treboux, Crowell, & Albersheim, 2000). However, we are not able to confirm this from the current data. With regard to the relationships between eating behaviours and weight, it is plausible that greater stress-induced eating may cause higher BMI and weight gain, however an individual may engage in stress-induced eating as a consequence of being overweight or perceiving oneself as overweight (e.g. see Robinson, et al., 2015). In relation to this point, we have recently shown that maternal attachment anxiety was associated with greater use of emotional feeding strategies (offering food when the child is anxious or upset) which, in turn, predicted child emotional over-eating (Hardman, Christiansen, & Wilkinson, 2016). However, there was stronger evidence for an alternative pathway whereby anxiously-attached mothers used emotional feeding strategies *in response* to their child's emotional over-eating (as opposed to the feeding strategies causing child emotional over-eating). This finding is consistent with broader evidence for bi-directional associations between parental feeding practices and child eating behaviours (Rodgers et al., 2013; Webber, Cooke, Hill, & Wardle, 2010).

Another possibility is that a far more complex non-recursive relationship exists in which attachment anxiety leads to emotional eating and an increased BMI, having an increased BMI becomes a source of social distress and increases attachment anxiety, which in

of obesity (Hemmingsson, 2014). Future studies within this field must now use longitudinal data to determine the temporal sequence of the variables and explore the possibility of complex multivariate and bi-directional relationships.

Importantly, there is a body of research that suggests that attachment anxiety can be manipulated through 'security priming' (acute activation of a representation relating to an attachment secure relationship in an individual's interpersonal network), such that individuals can be moved towards attachment security and benefit from its associated effects (Mikulincer & Shaver, 2007). Wilkinson, Rowe and Heath (2013) showed that in the laboratory individuals primed with attachment anxiety ate significantly more when presented with cookies than individuals primed with attachment security. Future research should specifically explore whether security priming affects the ability to engage in goal directed behaviour when upset and, in turn, eating behaviour (and the use of other sources of external affect regulation).

More generally, it should be noted that only a relatively small percentage of the variance associated with BMI is explained by attachment anxiety and its effects via mediators (all models in Studies 1 and 2 explained less than 17% of the variance associated with BMI). We note that this is in line with other studies that have investigated relationships between psychological traits and BMI (e.g., Hays & Roberts, 2008). Moreover, in two of our models (Figures 2 and 4) the inclusion of mediators did not render the direct relationship non-significant suggesting only partial mediation. Therefore, other unmeasured factors are likely to explain the relationships between attachment anxiety, eating behaviour and BMI. In addition, there were strengths and limitations of our studies. We used relatively large sample sizes and replicated our findings across two studies in different cultural contexts (a UK

weight. Previous research indicates that females and overweight/obese individuals significantly under-report their weight, however despite this self-reported and objectively measured weight data are strongly correlated (Ng et al., 2011; Pursey, Burrows, Stanwell, & Collins, 2014). This suggests that the self-reported weight data collected in our study may be a reasonable estimate of participants' actual weight, however further studies using objective measures of weight are needed to confirm this. A further limitation is that we did not include protocols to prevent participants from completing the surveys multiple times and Study 1 did not include any formal attention checks to identify careless responding (though this was addressed in Study 2). Finally, as discussed previously, the cross-sectional nature of this research is a limitation and experimental and longitudinal study designs are now needed in order to draw conclusions about the causal relations between the variables.

In summary, our findings provide evidence that attachment anxious individuals feel less capable in disengaging from negative emotions to maintain goal directed behaviours and go on to try to soothe themselves through eating which has a negative impact on their BMI. We found limited support for an explanation of the relationship between attachment anxiety and BMI based around the misperception of emotion.

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Figure Legends

Figure 1. Regression coefficients are shown with standard error in bracket, B(SE). Values in brackets are direct effects when controlling for indirect effects. Significant indirect relationships between attachment anxiety and BMI are denoted by an asterisk and were found via susceptibility to hunger (*B* = .13, (*SE* = .05), *LLCI* = .05, *ULCI* = .25) and emotional eating (*B* = .17, (SE = .05), LLCI = .08, ULCI = .29) but not via uncontrolled eating (B = .01, (SE = .05), LLCI = -.08, ULCI = .11). The overall R^2 for the model was .17.

Figure 2. Regression coefficients are shown with standard error in bracket *B*(*SE*). Values in brackets are direct effects when controlling for indirect effects. Significant indirect relationships between attachment anxiety and unhealthy snack intake are denoted by an asterisk and were found via susceptibility to hunger (*B* = .31, (*SE* = .1), *LLCI* = .15, *ULCI* = .56), emotional eating (*B* = .19, (SE = .08), LLCI = .06, ULCI = .39) and uncontrolled eating (*B* = -.19, (*SE* = .09), LLCI = -.42 , ULCI = -.04). The overall R^2 for the model was .21.

Figure 3. Regression coefficients are shown with standard error in bracket *B*(*SE*). Values in brackets are direct effects when controlling for indirect effects. The overall R^2 for the model was .11.

relationships between attachment anxiety and stress-induced eating were found via emotion regulation goal directed behaviour (*B* = .14, (*SE* = .04), *LLCI* = .07, *ULCI* = .23) but no other significant indirect relationships were found. The overall R^2 for the model was .12.

Figure 5. Regression coefficients are shown with standard error in bracket *B*(*SE*). Values in brackets are direct effects when controlling for indirect effects. Significant indirect relationships between attachment anxiety and BMI were found via emotion regulation goal directed behaviour and stress-induced eating operating in series (*B* = .14, (*SE* = .04), *LLCI* = .07, *ULCI* = .23) and stress-induced eating alone (*B* = .26, (SE = .1), LLCI = .09, ULCI = .46) but not via emotion regulation goal directed behaviour alone (*B* = .21, (*SE* = .12), LLCI = -.01, ULCI = .45). The overall R^2 for the model was .12.

Figure 1.

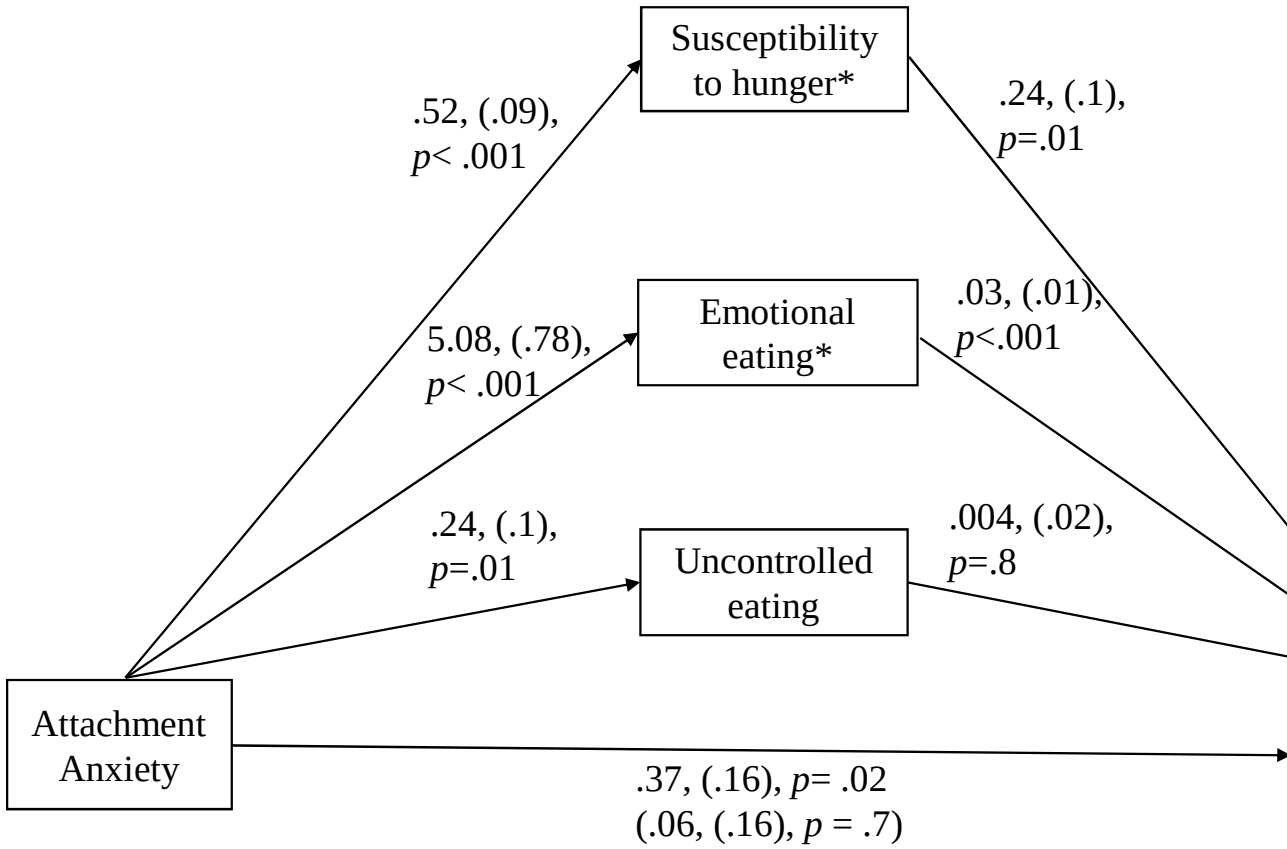

Figure 2.

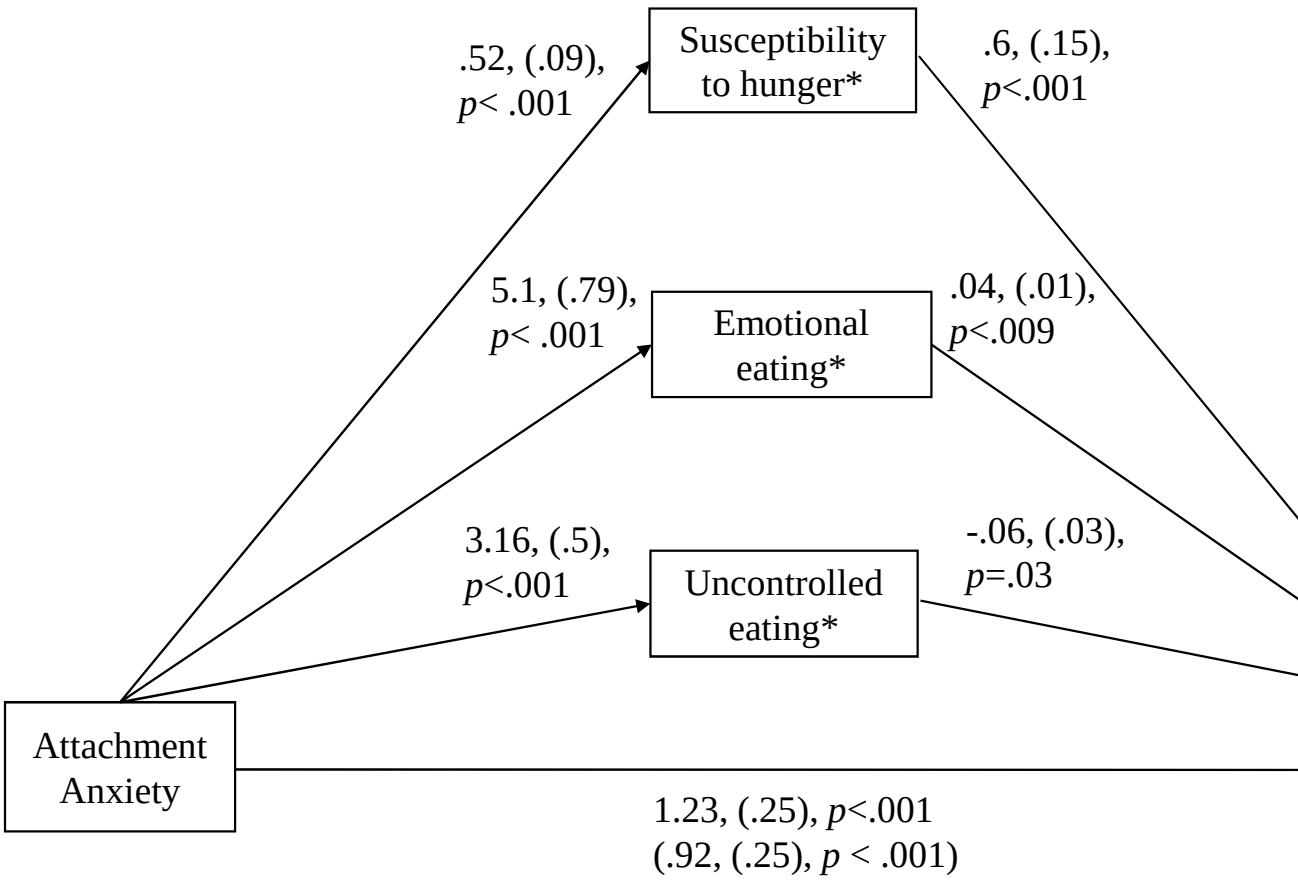

Figure 3.

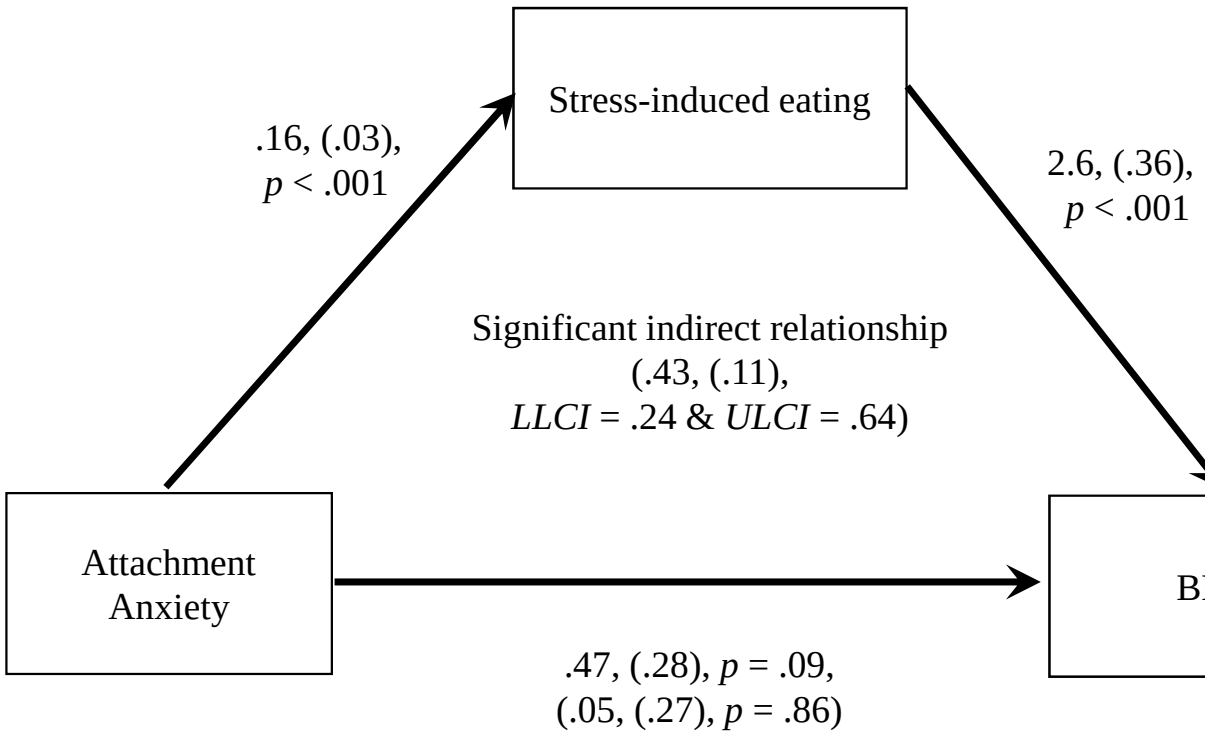

Figure 4.

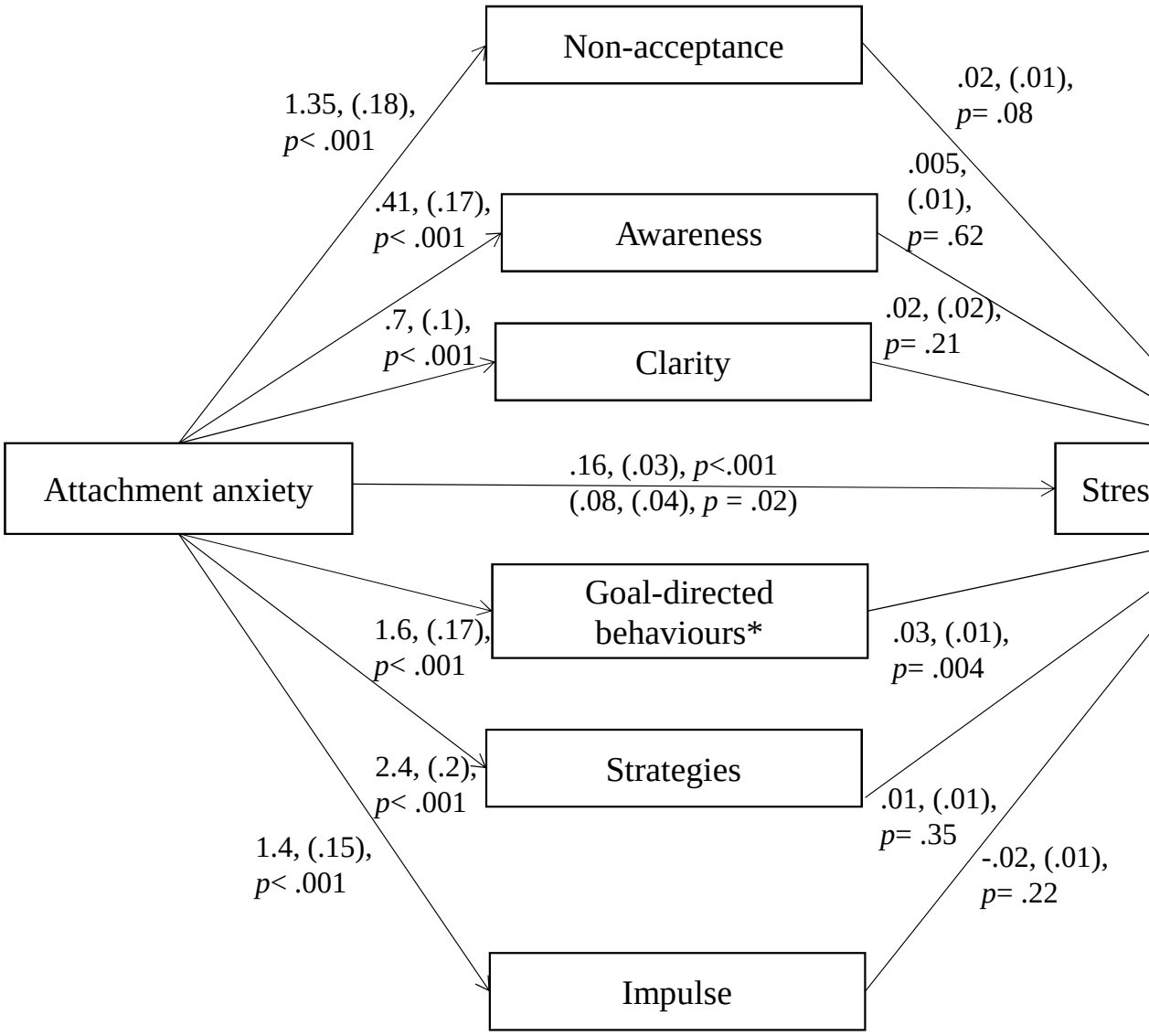

Figure 5.