Perceived social support mediates the association between attachment and cardiovascular reactivity in young adults

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Abstract

To understand the influence of social relationships on cardiovascular responses to stress, the present study investigated perceived affectionate support as a mediating variable explaining the association between specific attachment bonds (i.e., mother, father, partner, best friend) and cardiovascular reactivity. Utilising a standardised stress testing protocol, 138 young adults completed measures of attachment and social support, with continuous cardiovascular measurements obtained using the Finometer Pro hemodynamic monitor. Results showed that the association between anxious and avoidant attachment and reactivity were mediated by perceived affectionate support; insecure attachment was linked to lower levels of perceived social support, which in turn, was associated with lower cardiovascular reactivity. For anxious attachment, this was only noted for mothers (SBP: *B* = -.94, 95% CI [-1.94,-0.20]; DBP: *B* = -.57, [-1.27,-0.10]), fathers (SBP: *B* = -.72, [-1.42,-0.17]; DBP: *B* = -.48, [-1.01,-0.13]) and best friends (SBP: *B* = -.64, [-1.23,-0.18]; DBP: *B* = -.40, [-0.81,-0.12]). For avoidant attachment, it was only evident for fathers (SBP: *B* = -.70, [-1.33,-0.17]; DBP: *B* = -.48, [-0.92,-0.15]) and partners (SBP: *B* = -.78, [-1.64,-0.09]; DBP: *B* = -.53, [-1.10,-0.11]). These findings suggest that insecure attachment is associated with lower levels of reactivity, which have been linked to negative health outcomes such as poor self-reported health, depression and obesity. Overall, this research expands on the support and relationship science literature, by incorporating under-researched aspects of social relationships (i.e., specific attachment styles) and focusing on the mechanisms by which they are associated with physiological stress responses.

1. INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death worldwide, claiming the lives of over 17 million people annually (World Health Organisation, 2017). In addition to traditional risk factors such as smoking, genetics, obesity, or high cholesterol (Critchley & Capewell, 2003; Kathiresan & Srivastava, 2012; Poirier, 2006; Yusuf et al., 2016), psychosocial factors such as acute psychological stress (Dimsdale, 2008) are also important determinants of CVD. For example, the cardiovascular reactivity (CVR) hypothesis postulates that exaggerated cardiovascular responses to psychological stress contributes to the manifestation of CVD (Obrist, 1981; Manuck, 1994) in both healthy and clinical populations (Treiber et al., 2003). Indeed, considerable empirical research has demonstrated that such exaggerated cardiovascular responses to stress leads to an increased risk of hypertension, cardiovascular disease, and poorer cardiovascular risk status (for a review see Chida & Steptoe, 2010). However, atypical responses in general has been the subject of much debate (Phillips, Ginty and Hughes, 2013). This debate comes in lieu of recent research demonstrating that a blunted or atypically lower response to stress can also lead to negative health outcomes (Carroll, Ginty, Whittaker, Lovallo, & de Rooij, 2017; Phillips, Ginty, & Hughes, 2013) such as poor self-reported health, depression and obesity (Carroll, Phillips, & Der, 2008; de Rooij, 2012; Phillips, 2011). Indeed, Phillips et al., (2013) refer to 'blunted reactivity' "as an empirically demonstrable cardiovascular response pattern which is comparatively lower than that seen during typical states of homeostatic function during stress" (pp. 1). While cardiovascular reactivity to stress is well established as a risk factor for CVD, the factors influencing this association, however, are still being investigated.

Social relationships, and in particular the social support that these relationships provide, are key factors for influencing health outcomes (Holt-Lunstad, Smith, & Layton, 2010). Extensive theoretical and empirical evidence has highlighted the benefits of social support for health (e.g., Cohen & Syme, 1985; Orth-Gomer et al., 1993; Pinquart & Duberstein, 2010; Uchino, 2009); in fact, social support is one of the most commonly documented psychosocial factors to influence cardiovascular health outcomes (Uchino, 2006). According to Cohen (2004) and Cobb (1976), perceiving that support is available from these relationships, particularly in times of stress, help us believe that we are cared for, loved, and valued. Specifically, the stress-buffering hypothesis suggests that social support can reduce or buffer the damaging effects of stress on health (Cohen & Wills, 1985). This theory suggests that when support is available to us as a coping resource during stressful periods, it can help us to reappraise the stressor in a more positive or manageable way, which in turn, can lower blood pressure responses to stress and reduce the risk of cardiovascular disease development (Lovallo, 2005; Uchino, Carlisle, Birmingham, & Vaughn, 2011).

Indeed, several empirical studies using both manipulated social support in laboratory-based studies (i.e., received support), and self-reported psychometric evaluations of support in real life (i.e., perceived support) demonstrate that support is associated with adaptive cardiovascular responses (Gallagher et al., 2014; Howard, Creaven, Hughes, O'Leary, & James, 2017; O'Donovan & Hughes, 2007). Moreover, various types of social support are often discussed within the literature, for example, informational (providing helpful information or advice), tangible (providing material or behavioural assistance) or emotional support (the expression of positive emotions and empathetic understanding), but affectionate support (the love, care and affection we perceive as available from others) in particular, has been shown to be important for stress responses and physiological health (Floyd et al. 2007; Jakubiak & Feeney, 2016). However, the underlying factors that drive such benefits of support on health and CVD are still being elucidated (Pietromonaco & Collins, 2017; Uchino, Bowen, Carlisle, & Birmingham, 2012). One such framework known to affect both the perception of social support (Stanton & Campbell, 2014) and health outcomes directly (Balint et al., 2016), is attachment. Indeed, a recent theoretical model proposed by Pieteromonaco and colleagues (2013), has suggested that the association between social relationships and health, including physiological outcomes, are influenced by attachment. In fact, they argue that attachment style is a key determinant of social relationships processes (e.g., social support). Specifically, this model focuses on anxious, avoidant and secure attachment styles, which are explained in more detail below, as individual differences in attachment style in adults are typically categorised by these dimensions. Therefore, in order to fully understand how, and for whom, the health benefits of social relationships occur, it is important to look at the factors that influence social support.

Attachment is defined as the secure emotional bond between people over time and space (Ainsworth, 1979; Bowlby, 1969). While attachment theory primarily focuses on childhood, the importance of attachment in adulthood has also been acknowledged (Hazan & Shaver, 1987). As children seek out their primary caregiver for comfort, security, or a 'safe haven' in times of fear, uncertainty or illness (Bowlby, 1982, Bretherton, 1985), similarly, adults turn to their attachment figures in times of stress (Robles & Kane, 2014). Although attachment and social support are often researched within separate domains (Antonucci, 1991), the association between these constructs is conceptually (Sarason, Pierce, & Sarason, 1990) and empirically (Davis, Morris, & Kraus, 1998) evident. In fact, research has shown that those who have secure attachment bonds (people who are confident that others will be there for them and are open to others depending on them) report an increased perceived availability of social support (Sarason, Pierce, & Sarason, 1990). In contrast, those with insecure attachment bonds, categorised in terms of anxious attachment (those who have a strong desire for intimacy and fear rejection from others) or avoidant attachment (individuals uncomfortable with closeness and intimacy because they often fear being hurt) (Ainsworth & Wittig, 1969) perceive lower levels of social support (Collins & Feeney, 2004).

Attachment, however, is also linked to perceived social support, and directly linked to health outcomes (Robles & Kane, 2014). Specifically, insecure attachment has been associated with adverse physiological health outcomes, such as hypertension (Balint et al., 2016) and cardiovascular disease (McWilliams & Bailey, 2010). Moreover, in explaining such association, the few studies that focus on CVR in particular, have highlighted that insecure attachment is linked to exaggerated responses to stress (Pietromonaco, Barrett, & Powers, 2006). For example, studies have shown that those who have anxious or avoidant attachment styles display heightened cardiovascular responses to acute psychological stress in the presence of their romantic partners (Carpenter & Kirkpatrick, 1996; Feeney & Kirkpatrick, 1996). Therefore, to provide further insight into the association between attachment and reactivity, we aim to examine if our attachment bonds influence how we perceive the availability of support, which then in turn, influences how people respond to stress. Indeed, the model proposed by Pieteromonaco and colleagues (2013) describes how attachment theory and relationship processes can lead to physiological responses and health outcomes through mediational pathways. Extending the stress-buffering hypothesis, this theoretical approach suggests that attachment style can influence relationship processes (e.g., increase or decrease perceived social support) which can lead either directly to health and disease outcomes, or to negative health outcomes through physiological responses (e.g., cardiovascular reactivity as an indicator of cardiovascular disease).

Thus, informed by Pietromonaco's (2013) theoretical framework, we expect the influence of attachment on CVR to be mediated by perceived support. Further, given the strength of the association between affectionate support, stress and physiological health, we focus on this aspect of social support. We anticipate that both anxious and avoidant attachment will negatively influence individual's perception of social support, and this in turn will lead to an exaggerated cardiovascular response to stress. Although we expect that anxious and avoidant attachment overall will negatively impact cardiovascular reactivity, research also suggests that global, or general measures of attachment are not ideal (La Guardia, Ryan, Couchman, & Deci, 2000), as attachment styles can vary across different relationship figures (Fraley, Heffernan, Vicary, & Brumbaugh, 2011). Therefore, we aim to examine avoidant and anxious attachment styles with four key attachment figures (mother, father, partner and best friend) individually, and expect that there may be differences across these relationships. Indeed, research has suggested that differences in relationship figures in terms of health are evident, particularly at different life stages; for example, some research has noted that during adolescence and early adulthood, peers and partners are most important (Furman & Buhrmester, 1992) while others have suggested that parental attachment is more important (Raja, McGee, & Stanton, 1992). Therefore, given such contradictory findings, specific hypotheses regarding differences across attachment relationships have not be determined a priori, and such analyses are exploratory.

2. METHOD

2.1 Design

The present study was an observational laboratory-based study. The attachment styles of young adults to specific relationship figures (mother, father, partner, best friend) were the independent variables, while the dependent variables were systolic (SBP) and diastolic (DBP) blood pressure, and heart rate (HR; pulse rate measured in beats per minute) responses to stress, with perceived affectionate support as a mediator. Consistent with prior research, these cardiovascular reactivity scores were computed based on the difference between the mean baseline and mean task values (Task – Baseline) (e.g., Gallagher, O'Riordan, McMahon, & Creaven, 2018).

2.2 Participants

A sample of young adults (*N* = 138) were recruited from our local university student population through an online module credit system. Based on power calculations, a minimum sample size of 129 participants were needed to detect a significant effect (p = .05, F^2 = 0.06) at 80% power. However, in order to account for attrition and potential outliers a higher number was recruited. In order to ensure a healthy sample and to minimize the issue of confounding variables, the following were excluded from participation: people with a diagnosis of cardiovascular disease, hypertension or an immune disorder, people taking medication that is known to influence cardiovascular measures (other than oral contraceptives; e.g., beta blockers), or women who were pregnant. Moreover, given that research has pointed to additional factors influencing blood pressure, participants were asked to refrain from vigorous exercise and consuming alcohol for 12 hours before the procedure, and from caffeine consumption and smoking 2 hours prior to the procedure (e.g. Savoca et al., 2005; James & Richardson, 1991). The sample consisted of 47 (34.1%) men and 91 (65.9%) women ($\text{Range}_{\text{age}}$ = 18 to 35; M_{age} = 20.32, *SD* = 2.62) (see Table 1 for descriptive characteristics). Ethical approval for the study was granted by the university's ethical review board.

2.3 Psychological Measures

2.3.1 Attachment Styles.

The 9-item Experience in Close Relationships – Relationships Structures Questionnaire (Fraley, Heffernan, Vicary, & Brumbaugh, 2011) was used to measure the attachment styles of young adults on a 7-point Likert scale (1 = *Strongly Disagree,* 7 = *Strongly Agree*). This scale assesses individual's attachment style to four key relationship figures: mother, father, partner and best friend individually, using the same 9 items for each relationship figure. Examples of items on the scale include "*I'm afraid that this person may abandon me, I don't feel comfortable opening up to this person*". Anxious attachment and avoidant attachment scores are based on average scores from each subscales (See Fraley, 2011 for more details) with higher scores representative of higher levels of anxious and avoidant attachment. As a recent and reliable measures of adult attachment (Moreira, Martins, Gouveia, & Canavarro, 2015) this scale adapts a continuous, dimensional approach to attachment incorporating advances in attachment measurement (Roisman, Fraley, & Belsky, 2007). Reliability analyses for the individual relationship subscales, and the overall scale, yielded high levels of internal consistency (Mother: Cronbach's α = .84, Father: Cronbach's α = .90, Partner: Cronbach's α = .88, Best Friend: Cronbach's α = .88, Overall Scale: Cronbach's α = .91).

2.3.2 Affectionate Social Support.

Perceived affectionate social support was measured using a 3-item scale of affectionate support adapted from the Medical Outcomes Survey- Social Support Survey (MOS-SSS; Sherbourne & Stewart, 1991) which asks participants if they have *"Someone who shows you love and affection, Someone to love and make you feel wanted, Someone who hugs you"*. From this 5-point Likert scale (1 = *None of the time,* 5 = *All of the time*), a total score was generated from the mean score of all items, with higher scores indicative of higher levels of perceived affectionate support. Cronbachs α of .82 was noted within the current sample.

2.3.3 Psychological Stress Reactivity.

Immediately before and after completing the stress tasks, participants were asked to indicate how stressful they expected to find the task, and how stressful they found it. These items were scored on a 7- point Likert scale (0 = *Not at all* to 6 = *Extremely*) and were used as a manipulation check to confirm that the task was psychologically stressful, an approach used in previous studies (e.g., Gallagher, Meaney & Muldoon, 2014).

2.4 Cardiovascular Assessment

Beat-to-beat measures of SBP, DBP and HR were recorded using a Finometer hemodynamic cardiovascular monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer is an effective apparatus for measuring cardiovascular function, and is often used in similar CVR research (e.g., Hughes, Howard, & James, 2011). The monitor comprises of a finger-cuff and an arm-cuff which are placed on the non dominant hand of the participant, secured to their wrist to reduce potential motion detection. The finger-cuff is attached to the participants' middle finger and contains an infrared photo-plethysmograph which detects changes in the diameter of the arterial wall. Employing the Finometer's Return-to-Flow technology, a once-off inflation of the arm-cuff is used to calibrate reconstructions of the intrabrachial pressure derived from the finger cuff. In order to correct for hand-to-heart distance, a hydrostatic height correction system is used. The Association for the Advancement of Medical Instrumentation and the British Hypertension Society (according to Schutte et al., 2003) supports the use of the Finometer as an accurate and validated method of measuring cardiovascular reactivity.

2.5 Stress Task

An adapted version of the Trier Social Stress Task (Kirschbaum et al., 1993) which incorporated a maths task (the paced auditory serial addition test (PASAT; Gronwall, 1977) and a speech task was used within the current study to elicit stress responses. Each task is pre recorded and presented on a laptop. First, the PASAT requires the participants to add together each pair of numbers and say the answer out loud, while remembering the previous number in order to add it to the next number presented. Numbers were presented at rates of

2.4, 2.0, 1.6, and 1.2 seconds apart during each minute, respectively, with a 5 second break at the end of each minute. For the speech task, another commonly used stress-invoking task (Bosch et al., 2009), participants were asked to describe three of their best and three of their worst characteristics during a 4-minute speech. Participants were prompted by the experimenter to 'Please continue until the end of the task' if their speech ended before the designated time. The order of which the tasks were presented to participants were selected at random, to eliminate order effects.

2.6 Procedure

Prior to arrival at the laboratory, participants were sent an information sheet highlighting the specific requirements for the study such as refraining from alcohol, exercise, etc. Those who were deemed eligible and agreed to take part were invited to attend a 1-hour testing session at our health and psychophysiology laboratory. On arrival, a checklist was completed to ensure they met the requirements, written consent was obtained, and their height and weight recorded. Participants were then invited to sit at a desk and were asked to place their feet in a box on the floor to restrict movement, as this has previously been shown to alter CVR measurements (Pickering et al., 2005). The Finometer apparatus was connected and a test-measure recorded. These events occurred within a 20-minute acclimatisation period to allow participants to habituate to the surroundings and to ensure a more accurate baseline reading, and was then followed by a vanilla baseline, stress task and recovery periods, detailed in Figure 1. During the 10-minute baseline period, participants sat quietly out of view from the researcher completing basic demographic questionnaires and were provided with neutral magazines to occupy time until the stress task. Through the procedure, the experimenter wore a white laboratory coat and the area was dimly lit with only a desk lamp focusing on the participant during completion of the task. This aimed to heighten the participant's feelings of stress, and to create a psychological divide between the participant and experimenter. Throughout the procedure, continuous beat-to-beat blood pressure measures were recorded using the Finometer Pro monitor. Following the recovery period, the apparatus was removed from the participants arm, the participants were thanked, debriefed and exited the laboratory. Of note, the current study only focuses on cardiovascular reactivity (Task – Baseline).

[INSERT FIGURE 1 ABOUT HERE]

2.7 Statistical Analyses

The data was screened prior to analyses to ensure a healthy sample of young adults. From the initial sample (*N* = 169), 18 outliers were removed for having a resting blood pressure of greater than 140/90 (Stage 2 hypertension according to the American Heart Association (2019) and 13 removed for being outside the young adult age range (18-35), similar to previous studies (e.g., Brown, Creaven, & Gallagher, 2019; Howard, Myers & Hughes, 2017). Repeated measures Analysis of Variance (ANOVAs) were first conducted to ensure that the task was both physiologically and psychologically stressful, with partial eta squared (ηp^2) reported as a measure of effect size. Further, correlational analyses and independent sample t-tests were conducted to determine the effect of potential confounding variables on measures of reactivity.

Hierarchical linear regression analyses first examined the association between each predictor variable (anxious and avoidant attachment with each relationship figure: mother, father, partner, best friend) and cardiovascular reactivity parameter: SBP, DBP and HR. For all regression analyses, both standardized (β) and unstandardized (*B*) values are presented. Finally, a series of mediation analyses were conducted to examine whether the relationship between anxious and avoidant attachment and reactivity measures were mediated by perceived affectionate support. Based on previous correlational and t-test analyses, regression and mediation analyses controlled for any confounding variable that were noted to statistically influence reactivity. All mediation analyses were conducted using Hayes (2013) PROCESS Model 4 for SPSS.

3. RESULTS

3.1 Descriptive Statistics

Participant characteristics, including baseline blood pressure measures, are noted in Table 1.

[INSERT TABLE 1 ABOUT HERE]

Descriptive statistics were conducted on anxious (Mother: M = 1.38, SD = 0.80; Father: M = 1.70, SD = 1.23; Partner: M = 3.32, SD = 1.74; Best Friend M = 2.83, SD = 1.57, Range = 1-7) and avoidant (Mother: M = 2.55, SD = 1.21; Father: M = 3.62, SD = 1.56; Partner: M = 2.37, SD = 1.13; Best Friend M = 2.61, SD = 1.18, Range = 1-7) attachment, as well as perceived affectionate support (M = 11.71, SD = 3.15). Scores on both attachment and support measures were similar to those found in previous research (Fraley, 2018; Gallagher et al., 2008). Finally, in terms of participants' cardiovascular responses to stress, descriptive statistics show a mean reactivity score of 18.25 mmHg for SBP, 11.95 mmHg for DBP and 6.65 bpm for HR.

3.2 Manipulation check

Results from a series of repeated measures ANOVAs demonstrate an increase in cardiovascular responses from baseline to task across each parameter; SBP: $F(1, 133) = 356.02$, $p < .001$, $\eta p^2 = 0.73$; DBP: $F(1, 133) = 389.55$, $p < .001$, $\eta p^2 = 0.75$ and HR: $F(1, 133) = 137.79$, $p < .001$, $\eta p^2 = 0.51$), confirming that the task was physiologically stressful.

Further, demonstrating that the task was also psychologically stressful, results revealed a significant increase of self-reported stress from pre to post task for both the maths task, $F(1, 136) = 42.60$, $p < .001$, $\eta p^2 = 0.24$ and speech task $F(1, 136) = 59.62$, $p < .001$, $\eta p^2 = 0.31$.

We also examined whether those in a relationship differed from those not in a relationship on any of our main variables. Results show that there was only a difference between those who are single, and those in a relationships in terms of their ratings of partner anxious ($t(129) = 4.60$, $p < .001$) and avoidant ($t(127.61) = 5.62$, $p < .001$) attachment . Specifically, those who were in a relationship reported lower levels of both anxious (M = 2.61, SD = 1.44) and avoidant (M = 1.18, SD = 0.79) attachment than those not in a relationship (M = 3.89, SD = 1.75; M = 2.79, SD = 1.18). Moreover, those who are in a relationship report more perceived affectionate support (M = 4.38, SD = 0.57) than those who are not (M = 3.58, SD = 0.94) ($t(117.77) = -5.80$, $p < .001$). Given these findings, relationship status was included as a covariate in all relevant analyses (i.e., where anxious and avoidant attachment with a partner is included as an IV).

In order to control for potential confounding by health and socio-demographic variables (e.g., age, BMI, smoking status) correlation analyses were first conducted (see Table 2). Results illustrate that age was the only covariate statistically correlated with reactivity. Specifically, analyses show a positive association between age and both DBP and HR reactivity, such that those who were older, had higher responses to stress. Moreover, an independent sample t-test highlighted a gender difference in terms of HR reactivity, $t(132) = -2.28$, $p = .024$, with women (M = 7.57, SD = 7.02) displaying higher HR responses to stress than men (M = 4.89, SD = 5.21). As a result, both age and gender were controlled for within all analyses.

[INSERT TABLE 2 ABOUT HERE]

3.3 Regression Analyses

3.3.1 Anxious Attachment.

Hierarchical linear regressions analyses examined the association between anxious attachment relationships and each cardiovascular parameter. The covariates were entered at Step 1, and each IV (anxious attachment with mother, father, best friend and partner) entered at Step 2. Analyses were ran separately for each relationship figure and each cardiovascular parameter. Results show that, maternal anxious attachment was negatively associated with SBP ($\beta = -.21$, $B = -2.92$, $p = .02$, 95% CI [-5.27, -0.57], $r^2 = .06$) and DBP ($\beta = -.19$, $B = -1.64$, $p = .03$, [-3.10, -0.18], $r^2 = .07$) reactivity. This suggests that higher levels of maternal anxious attachment was associated with lower blood pressure response to stress. For fathers, anxious attachment, while not associated with DBP ($\beta = -.14$, $p = .16$), was significantly negatively associated with SBP ($\beta = -.23$, $B = -2.05$, $p = .01$, [-3.61, -0.49], $r^2 = .06$). A similar pattern was observed for anxious attachment with both partners and best friends for SBP (Partner: $\beta = -.32$, $B = -2.03$ $p = .001$, [-3.18, -0.88], $r^2 = .11$; Best Friend: $\beta = -.19$, $B = -1.35$, $p = .03$, [-2.56, -0.14], $r^2 = .05$) and DBP (Partner: $\beta = -.29$, $B = -1.17$, $p = .002$, [-1.89, -0.45], $r^2 = .12$; Best Friend: $\beta = -.17$, $B = -.77$, $p = .045$, [-1.52, -0.02], $r^2 = .07$) reactivity. Again, this indicates lower cardiovascular reactivity. There were no statistically significant association between any anxious attachment relationships and HR ($p > .05$). Overall, this suggests that while controlling for age or gender, young adults who have higher levels of anxious attachment towards mothers, fathers, partners, or best friends, are more likely to display lower blood pressure response to stress.

3.3.2 Avoidant Attachment.

Similar hierarchical regressions examined the association between avoidant attachment relationships and reactivity. Covariates were entered as covariates at Step 1, and each IV (avoidant attachment with mother, father, best friend and partner) entered at Step 2. Analyses were again ran separately for SBP, DBP and HR. Results showed that partner attachment was the only attachment relationship associated with SBP (β = -.22, *B* = -2.16, *p* = .02, [-4.04, -0.28], r^2 = .07) reactivity, but not DBP (*p* = .07) with those reporting higher levels of avoidant partner attachment displaying lower cardiovascular stress responses. Avoidant attachment with either parent, or a best friend, was not significantly associated with any of the cardiovascular reactivity parameters.

3.3.3 Affectionate Support.

Further hierarchical regression analyses were conducted on affectionate support and each cardiovascular reactivity measure; covariates, age and gender, were again entered at Step 1, and the IV entered at Step 2. Results showed a positive association between affectionate support and SBP (β = .28, *B* = 3.54, *p* = .003, [1.23, 5.85], r^2 = .10) and DBP (β = .27, *B* = 2.14, *p* = .004, [0.71, 2.57], r^2 = .10) reactivity, but not HR reactivity (*p* = .37) which suggests that lower levels of affectionate support are linked to a lower response to stress.

3.4 Mediation Analyses

Separate mediation analyses were conducted to examine social support as a mediating variable explaining the association between each of the anxious and avoidant relationships noted above, again controlling for age and gender.

3.4.1 Anxious Attachment.

Analysis confirmed that the association between anxious attachment and SBP, was mediated by affectionate social support for mothers (β = -.94 (*SE* = .45) [-1.94, -0.20]), fathers (β = -.72 (*SE* = .32) [-1.42, -0.17]), and best friends (β = -.64 (*SE* = .27) [-1.23, -0.18]). Specifically, we can see that higher levels of anxious attachment with mothers (β = -

.30) father (β = -.23) and best friends (β = -.21) was associated with lower levels of affectionate support (See A paths in Figure 2) which in turn, was linked to lower levels of SBP reactivity (β = 3.18; β = 3.08; β = 2.95, respectively) (See B paths in Figure 2). In terms of anxious attachment with a partner, no significant indirect effect through perceived support was evident.

[INSERT FIGURE 2 ABOUT HERE]

Similar results were observed for DBP reactivity and anxious attachment for mothers (β = -.57 (*SE* = .30) [-1.27, -0.21]), fathers (β = -.48 (*SE* = .23) [-1.01, -0.13]), and best friends (β = -.40 (*SE* = .28) [-0.81, -0.12]). Again, we can see that higher levels of anxious attachment with these relationship figures was correlated with lower levels of support (See A paths in Figure 1.3.) which in turn, was related to lower DBP responses to stress (β = 1.93; *B* = 2.68; *B* = 1.86, respectively) (See B paths in Figure 3). In terms of anxious attachment with a partner, no significant indirect effect through support was evident. However, it is important to note higher levels of anxious attachment was associated with lower levels of affectionate social support (β = - .19, $p < .001$), although was not predictive of either SBP or DBP reactivity.

[INSERT FIGURE 3 ABOUT HERE]

3.4.2 Avoidant Attachment.

Further, mediation analyses also found a statistically significant indirect effect of both partner (β = -.53 (*SE* = .34) 95% CI [-1.31, -0.007]) and father (*B* = -.70 (*SE* = .30) [-1.33, -0.17]) avoidant attachment SBP reactivity, through affectionate social support (See Figure 4 for Path Diagram). Specifically, results show that avoidant attachment with a partner (β = -

.19) or father (*B* = -.22) is negatively associated with support; thus, higher levels of avoidant attachment was related to perceiving lower levels of affectionate support, and which in turn results in a pronounced blunted SBP reactivity (β = 2.75; β = 3.17, respectively). Importantly however, despite a significant indirect effect for partners Path B (support – SBP reactivity) is statistically insignificant when examined independently. No statistically significant indirect effect of attachment on SBP reactivity though social support was evident for mother and best friend.

[INSERT FIGURE 4 ABOUT HERE]

Similarly, in terms of DBP reactivity, a negative indirect effect of partner (β = -.37, (*SE* = .26), [-0.93, -0.02]) and father (β = -.48, *SE* = .20) [-0.92, -0.15]) through social support was found (See Figure 5 for Path Diagram). Specifically, the findings suggest that higher levels of avoidant attachment with a partner (β = -.19) or father (β = -.22) was linked to lower perceived affectionate social support, which in turn was associated with blunted SBP reactivity (β = 1.90; *B* = 2.18, respectively). Again, no statistically significant indirect effect of mother or best friend on SBP reactivity was seen.

[INSERT FIGURE 5 ABOUT HERE]

3.5 Sensitivity Analysis

Moreover, previous research has shown that reactivity can vary by stressor type (Bibbey, Carroll, Ginty, & Phillips, 2015). Given that two stress tasks were employed, we examined if any differences were noted between the maths and speech task in the current study. A paired samples t-test indicated a statistically significant difference in SBP ($t(132) = 3.04$, $p < .01$) and DBP ($t(132) = 3.26$, $p < .01$) reactivity between the maths and speech task. Specifically, lower reactivity was noted for the maths task (SBP: *M* = 138.64, *SD* = 13.80; DBP: *M* = 83.74, *SD* = 9.70) than speech task (SBP: *M* = 143.16, *SD* = 15.96; DBP: *M* =

86.80, *SD* = 10.18). There was no significant difference ($p = .24$) between task on HR reactivity. Moreover, there was also no significant difference on task order for SBP ($p = .86$), DBP ($p = .82$), or HR ($p = .94$).

Further analyses examined the relationship between attachment, support and CVR to each task independently (calculated by Maths Task - Baseline; Speech Task- Baseline). Mediation analyses showed no indirect effect of either anxious or avoidant attachment relationships on SBP or DBP reactivity to the speech task through affectionate support; a direct effect was only noted for anxious (SBP: $\beta = -3.18$, $p = .01$, [-5.62, -0.74], DBP: $\beta = -1.53$, $p = .047$, [-3.04, -0.02]) and avoidant (SBP: $\beta = -2.07$, $p = .04$, [-4.08, -0.06], DBP: $\beta = -1.27$, $p = .04$, [-2.50, -0.04]) attachment with fathers. Similar to the main analyses, indirect effects through affectionate support were noted for anxious attachments to all relationship figures on both SBP and DBP reactivity to the maths task, and for father and partner in terms of avoidant attachment (See Figures 6-9).

[INSERT FIGURES 6-9 ABOUT HERE]

All mediation analyses were repeated reversing the order of the predictor and mediator variables. Results showed the results showed that only anxious attachment with a partner was a significant mediator of the association between affectionate support and SBP and DBP reactivity; however, the effect was lower than the theoretically driven model. There were no significant indirect effects from affectionate support to reactivity through any of the other relationship figures.

4. DISCUSSION

This study examined social support as a mediator between specific attachment bonds and cardiovascular responses to acute stress, with a view to providing further insights into the mechanisms by which social relationships influence cardiovascular health outcomes. Our findings suggest that anxious attachment was associated with lower SBP and DBP stress responses, and as expected, this was mediated by perceived affectionate support. Interestingly however, this is noted only in terms of mother, father and best friend relationships, but not partners. In other words, individuals who are anxiously attached to their mother, father or best friend, perceived lower levels of affectionate support, which in turn is associated with lower blood pressure responses to stress. Moreover, similar findings were seen for avoidant attachment; the negative effect of attachment on reactivity was also mediated by perceived affectionate support, but this was only evident for father and partner relationships. These findings contribute to the wealth of literature demonstrating the benefits of social relationships for physiological health by highlighting that it is important to 1) look at other social relationship factors such as attachment styles, 2) focus on the mechanisms by which these factors are associated with cardiovascular reactivity and 3) consider that insecure attachment styles and lower levels of social support may be associated with negative health outcomes by means of *lower* reactivity.

As discussed earlier, social support is widely known to influence CVR and cardiovascular health outcomes (e.g., Uchino, 2006). Much of this previous research has highlighted the protective benefits of social support, such that perceiving support to be available in times of stress can buffer or attenuate cardiovascular responses to stress (e.g., Cohen & Wills, 1985; Uchino, Carlisle, Birmingham, Vaughn, 2011). In contrast, however, our findings suggest that lower levels of perceived affectionate support are linked to decreased reactivity. Given the limitations of a cross-sectional observation design, it could be argued however, that such effects may occur in the opposite direction: higher levels of affectionate support were linked to higher levels of reactivity. In fact, Teoh and colleagues (2016) suggest that social support is associated with increased CVR due to greater task engagement; when people are engaged in stressors, social support can act as a comfort and attenuate CVR, but when not engaged, it can be seen as social encouragement and elevate CVR (see Teoh & Hilmert, 2018, for a review). Importantly, however, such research examines experimentally manipulated social support conditions. In the current study, social support is measured using questionnaires. As a result, it is unlikely that support as operationalized in this study increased task engagement, and thus our findings are discussed as lower support associated with lower reactivity. Nonetheless, the distinction between perceived and actually received support merits further consideration in relation to attachment and CVR.

It has been suggested that the influence of social support on health might be more nuanced than initially expected (Stanton & Campbell, 2014); in fact, research has shown that support can, in some circumstances, be damaging for cardiovascular health (Christenfeld, Glynn, Kulik, & Gerin, 1999; Hilmert, Christenfeld, & Kulik, 2002; Hughes & Curtis, 2000), particularly for specific types of people (Westmaas & Jamner, 2006). For example, Stanton and Campbell (2014) suggest that negative perceptions of social support might undermine its beneficial effects for health among insecurely attached individuals. In other words, support may not function as a 'blanket protective factor' for health, especially for those who do not have high-quality attachment bonds with others (Rapoza et al., 2016, pp. 10). In line with this, our findings suggest that those who have insecure attachment bonds with others perceived lower levels of support, and as such, this lower perception of the availability of affectionate support was associated with lower cardiovascular stress responses. Overall, this corroborates the notion that our attachment styles play an important role in understanding the mechanisms by which social relationship influence cardiovascular health, as well as potentially resolving some of the issues within the social support literature regarding inconsistent findings.

Attachment, and insecure attachment in particular, has been widely shown to have an adverse impact on health outcomes (e.g., Kotler, Buzwell, Romeo, & Bowland, 1994; McWilliams & Bailey, 2010). However, the few studies focusing on CVR have shown that insecure attachment is associated with heightened stress response (e.g., Feeney & Kirkpartick, 1996). Contrary to this, we found that both anxious and avoidant attachment were associated with lower reactivity. Although unexpected, it could be argued that the overall understanding of insecure attachment and health within the literature somewhat remains the same: insecure attachment leads to poor cardiovascular health via atypical cardiovascular responses. Indeed, previous research has suggested that comparatively lower reactivity than typically seen, or blunted reactivity, is linked to a range of negative health outcomes. Despite this, limitations of such conclusions regarding 'blunted reactivity' should be acknowledged. Currently, there is no consensus on what constitutes a blunted response regarding unit changes in blood pressure. However, without a predefined way or threshold to determine a true 'blunted' response, both directions can be argued: lower levels of reactivity are beneficial for health by attenuating harmful stress response (Cohen, 1985) or lower levels are detrimental to health, due to the negative health outcomes associated with a blunted response (Phillips, Ginty & Hughes, 2013). As a result, the findings of this study, alongside others who note similar results, are limited to tentatively alluding to blunted CVR. It is therefore important that future research aim to determine a threshold or predefined way to measure blunted and normative cardiovascular reactions.

Additionally, there are also differences noted across the two stress tasks. Indeed, our sensitivity analyses suggested that participants had lower reactivity to the maths task, and higher reactivity to the speech task. One potential explanation for this lies in the nature of the tasks; the speech task and presenting on self-characteristics can be considered more socially relevant, and requires self-evaluation. However, our findings suggest that the maths task was more sensitive to mediation effect, and indicative of lower CVR. Thus, future psychophysiological research should consider potential variations in reactivity across stressor types.

In terms of differences across attachment relationships, we found that participants who were anxiously attached to their mother, father or best friend showed blunted cardiovascular responses. Put simply, those who seek intimacy and closeness, and fear rejection from their mother, father or best friend, showed adverse cardiovascular responses to stress. Moreover, in terms of avoidant attachment, those who are uncomfortable being close or intimate with their father or partner because they fear being hurt, also demonstrated adverse cardiovascular responses to stress. Importantly, such findings suggest that the effect of insecure attachment on reactivity varies depending on the type of insecure attachment, and the attachment figure.

Though previous research has suggested that throughout adolescence and early adulthood, friends and partners begin to replace parents as the primary attachment figure and provider of support (e.g., Freeman & Brown, 2001), among our sample of young adults, this does not seem to be the case. In fact, it indicates that, at least in terms of health outcomes, parental attachment remains important in early adulthood; in line with other research suggesting that attachment to parents continues throughout life, but in an adapted way (Bowlby, 1982; Cicirelli, 1991). Of course, adults can still depend on their parents during stressful times (Cicirelli, 1983). Further, Fraley and Davis (1997) suggest that the transfer of attachment from parents to peers occurs circa 22 years. Given that this sample consists predominantly of university students, perhaps they still rely on their parents for tangible, financial and emotional support, and thus, consider them as their primary attachment figure(s).

Indeed, the only overlapping relationship figure across anxious and avoidant attachment from these findings was the father. Although the importance of both parents are evident, often, research within the attachment literature focuses primarily on attachment with the mother, and not father (e.g., e.g., Emerson, Donenberg & Wilson, 2012; Gandhi et al., 2016; Frigerio et al., 2009). However, the importance of including paternal attachment when examining various health outcomes has been discussed (Breinholst, Tolstrup, & Esbjørn, 2019). As such, if paternal attachment can have implications for health outcomes, it is important that future research ensure that father relationships are incorporated into attachment research so we can better understand the effect of parental attachment for health. With that being said however, it is important to note that such analyses were exploratory and the sample limited to young adults within a university setting. Indeed, it should also be acknowledged that approximately 18% of the original sample was excluded from analyses due to their age and hypertension status. Indeed, findings may vary for older or less healthy groups. As such, further experimental research across other age groups and health status' is warranted, particularly given potential changes in attachment and stress reactivity throughout the lifespan. However, it is important to understand the effect of attachment and social support among healthy young adults; which was the focus of the current study.

Alongside its empirical importance, this study extends the theoretical literature focused on the stress-buffering hypothesis and understanding the social relationship – health link, by examining social support and stress reactivity within an attachment framework. Certainly, our findings align with the directional pathways put forward by Pieteromoncao's (2013) theoretical framework: attachment styles influence relationships process (such as the perception of social support) which in turn influence physiological parameters that can impact health and disease outcomes. Indeed, it expands on the recommendation to focus on individual factors, such as attachment, in adapting mediating pathways to understand the implications for health and disease (Pietromonaco & Collins, 2017)

The current laboratory-based study, though observational in nature, provides a useful insight into the mechanisms by which attachment can influence health, within a controlled environment. However, it is important to acknowledge that such findings may be limited by the self-reported nature of the social relationship measures, and cross-sectional design of the study. Indeed, the lack of temporal ordering make claiming mediation effects difficult because mediation consists of causal processes that unfold over time (Maxwell & Cole, 2007). Despite this, such findings highlight the importance of examining the role of attachment alongside social support in understanding the benefits of relationships for health, and can be used to inform future research. Perhaps future research should consider experimental laboratory-based studies; perhaps examining how support from an attachment figure, present during an acute stress, exposure may influence reactivity. Moreover, the measure of perceived support utilised within the study has both strengths and weaknesses. As mentioned previously, affectionate support has been shown to be of particular importance for health (Ibrahim et al., 2015). However, future research should consider other aspects of perceived social support measured within the MOSS (e.g., tangible, instrumental or emotional support), to examine if variances in the type of support plays a role in the impact of attachment on cardiovascular reactivity. In summary, this research indicates that those who have insecure attachment bonds with others perceive lower levels of affectionate support, and as such, this lower perception of the availability of support is linked to adverse cardiovascular stress responses; associated with a myriad of negative health outcomes. Overall, this study illustrates the importance of attachment styles in understanding the mechanisms by which social relationships influence health, and contributes to the underlying mechanisms by which the benefits of social support for cardiovascular health are understood.

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Figures

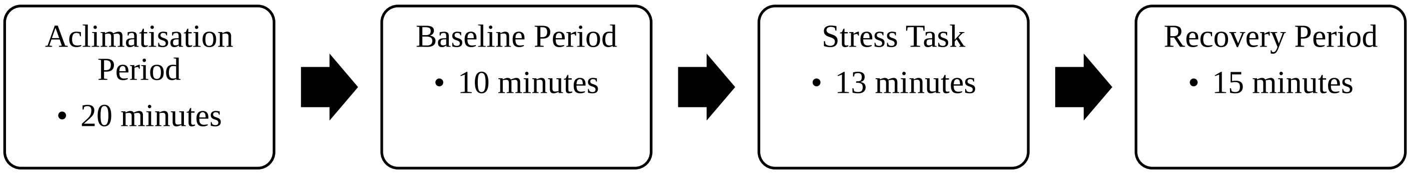

Figure 1. Standard Testing Protocol Timeline

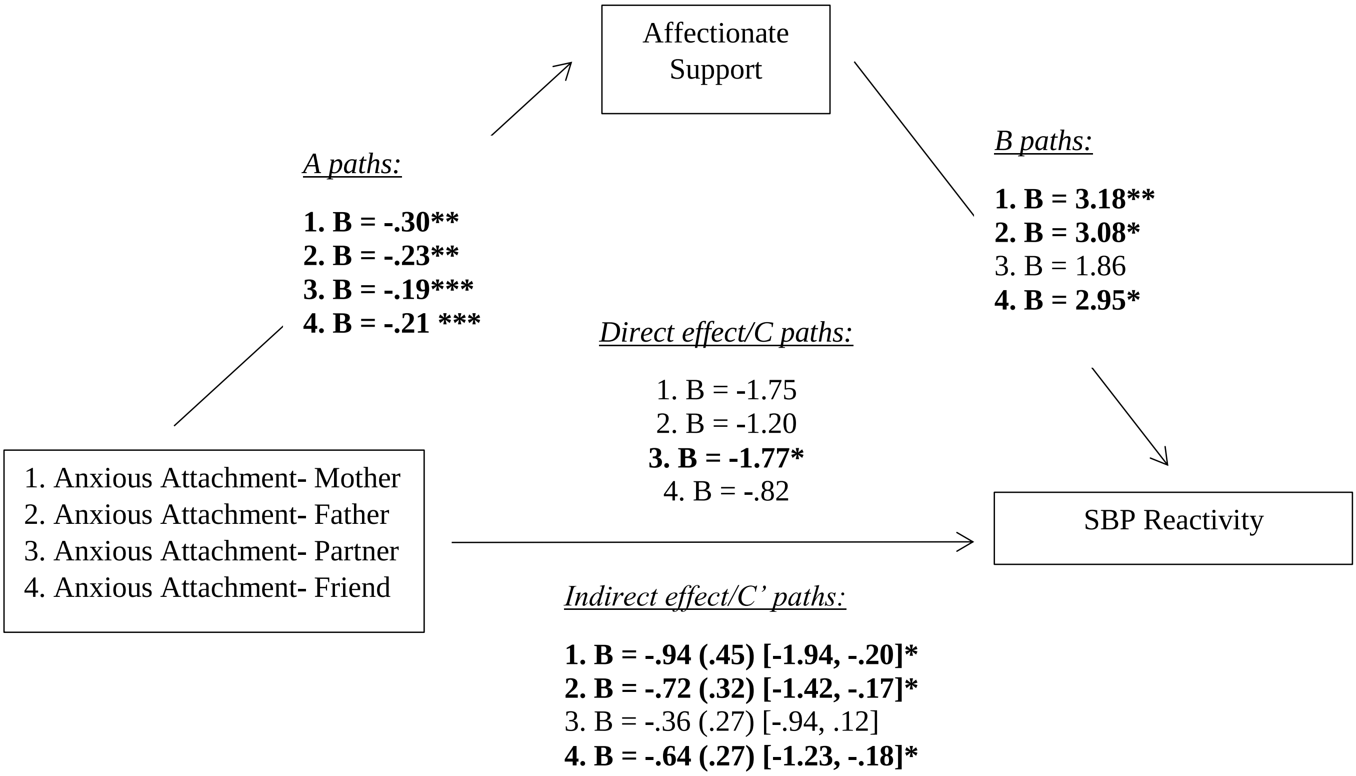

Figure 2. Mediation Path Diagram: Anxious Attachment and SBP Reactivity

Note: Each mediation analysis includes age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A path represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and SBP reactivity. Path C represents the direct effect between each independent variable and SBP reactivity (while holding the mediator and covariates constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through affectionate social support. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

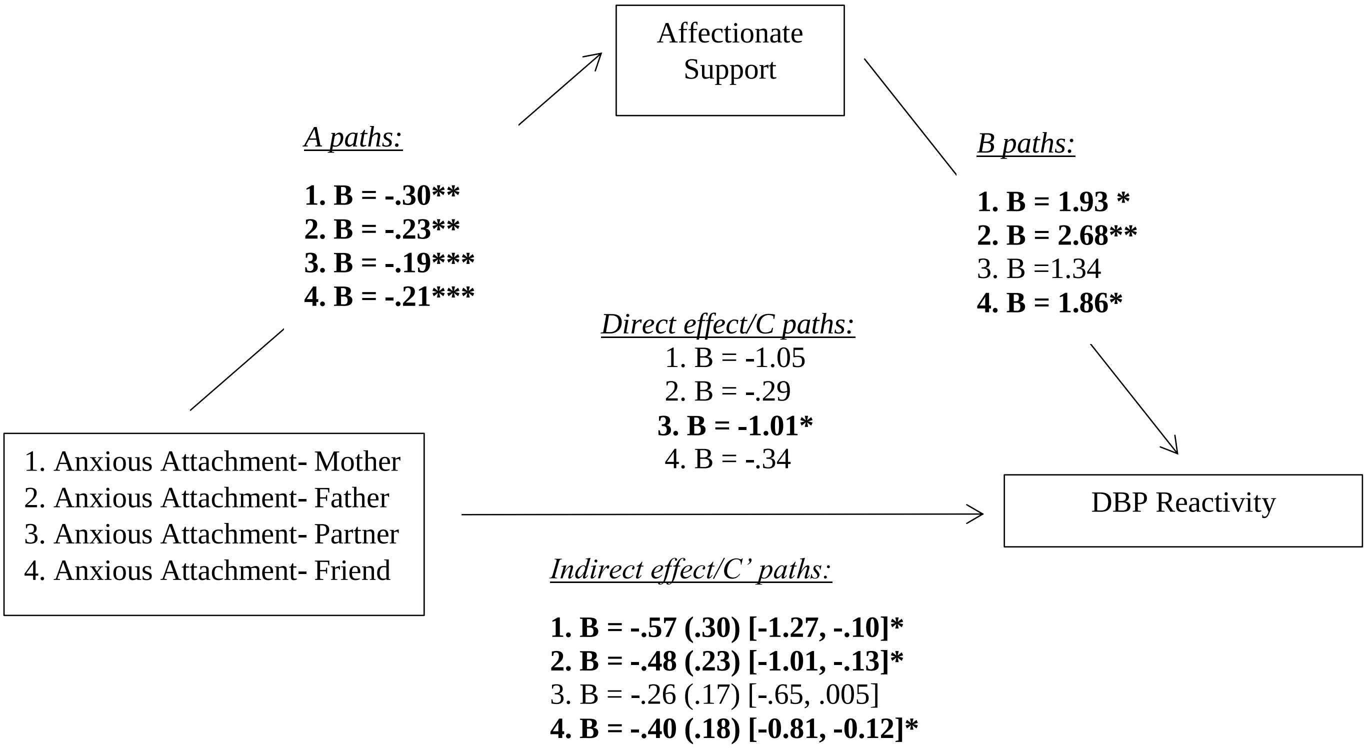

Figure 3. Mediation Path Diagram: Anxious Attachment and DBP Reactivity

Note: Each mediation analysis has included age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Note: Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A pathways represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and DBP reactivity. Path C represents the direct effect between each independent variable and DBP reactivity (while holding the mediator, and covariates, constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through affectionate social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

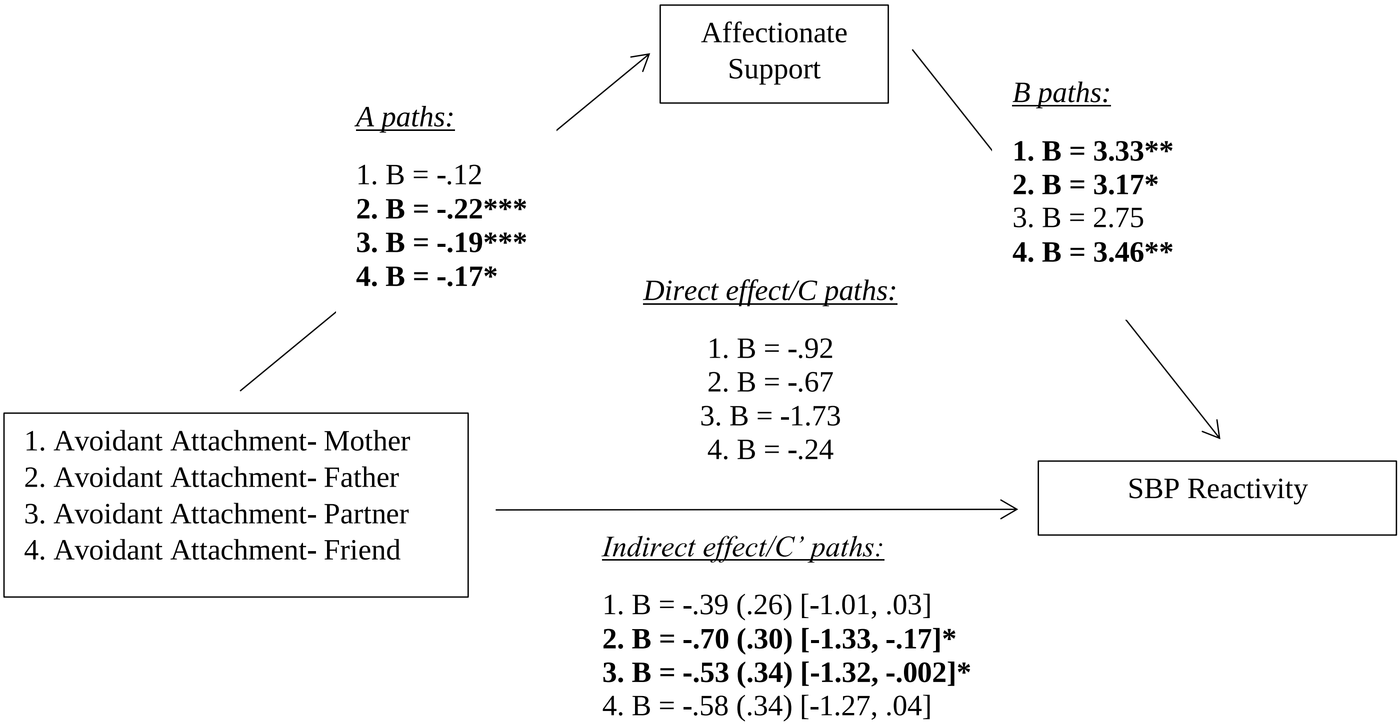

Figure 4. Mediation Path Diagram: Avoidant Attachment and SBP Reactivity

Note: Each mediation analysis includes age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A path represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and SBP reactivity. Path C represents the direct effect between each independent variable and SBP reactivity (while holding the mediator and covariates constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

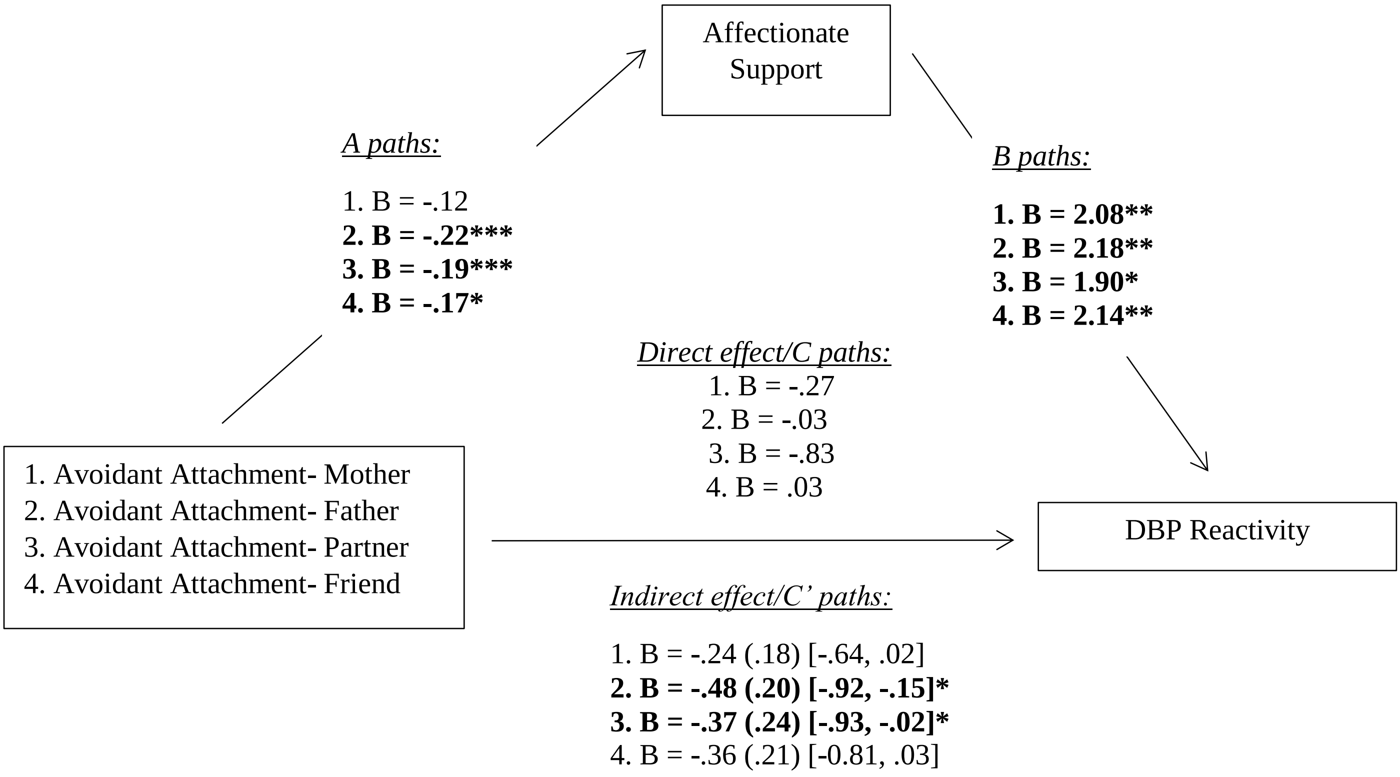

Figure 5. Mediation Path Diagram: Avoidant Attachment and DBP Reactivity

Note: Each mediation analysis has included age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Note: Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A pathways represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and DBP reactivity. Path C represents the direct effect between each independent variable and DBP reactivity (while holding the mediator, and covariates, constant). Finally, Path C' represents the indirect effect of each independent variable on DBP reactivity through social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

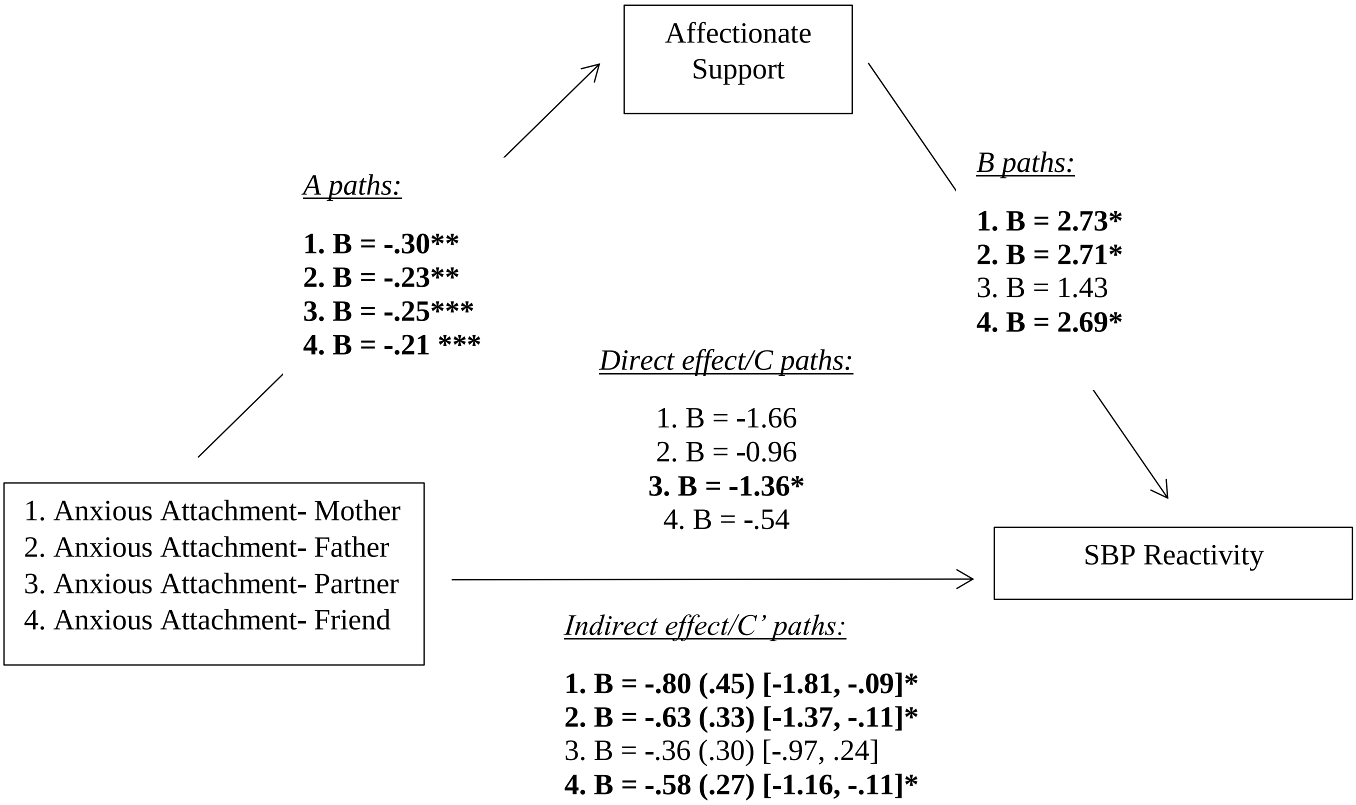

Figure 6. Mediation Path Diagram: Anxious Attachment and SBP Reactivity to Maths Task

Note: Each mediation analysis includes age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A path represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and SBP reactivity to the maths task. Path C represents the direct effect between each independent variable and SBP reactivity (while holding the mediator and covariates constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through affectionate social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

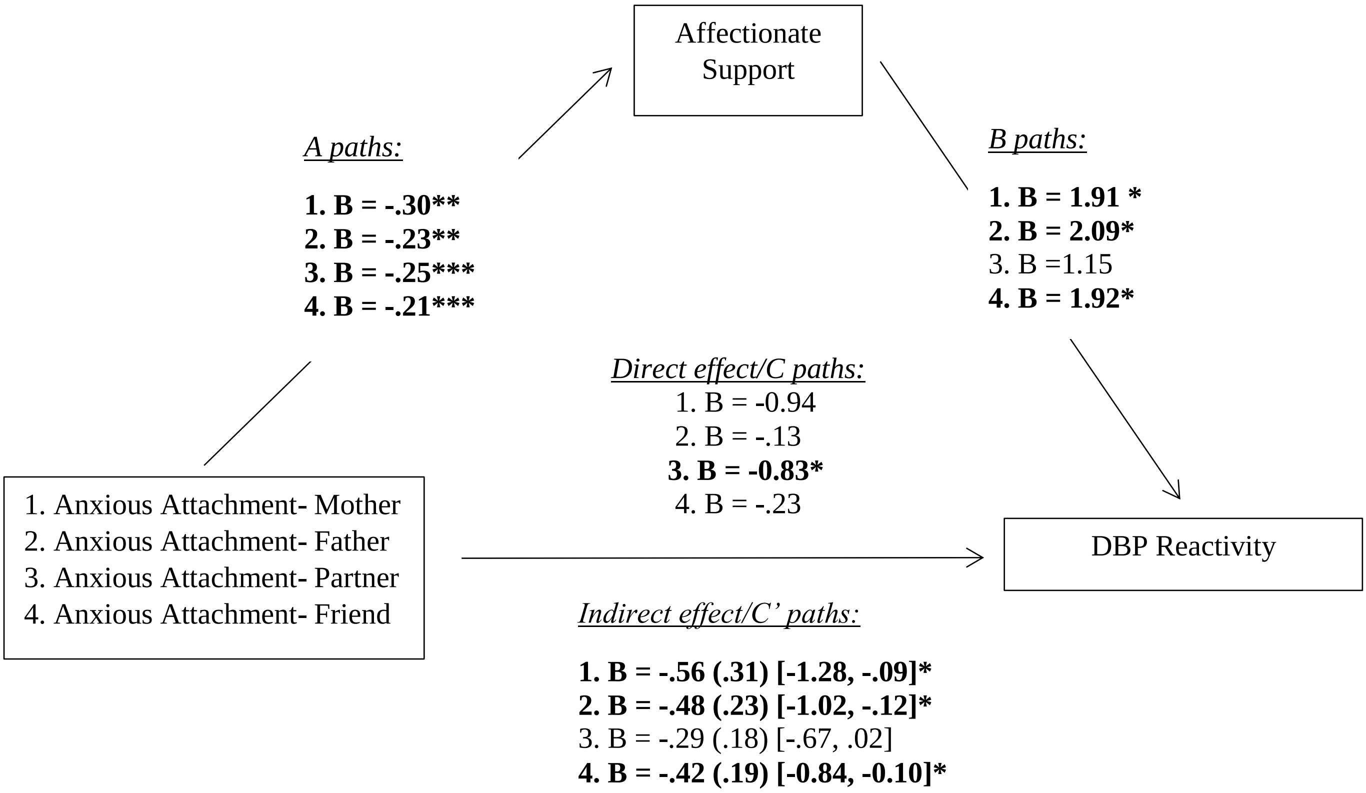

Figure 7. Mediation Path Diagram: Anxious Attachment and DBP Reactivity to Maths Task

Note: Each mediation analysis has included age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Note: Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A pathways represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and DBP reactivity to the maths task. Path C represents the direct effect between each independent variable and DBP reactivity (while holding the mediator, and covariates, constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through affectionate social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

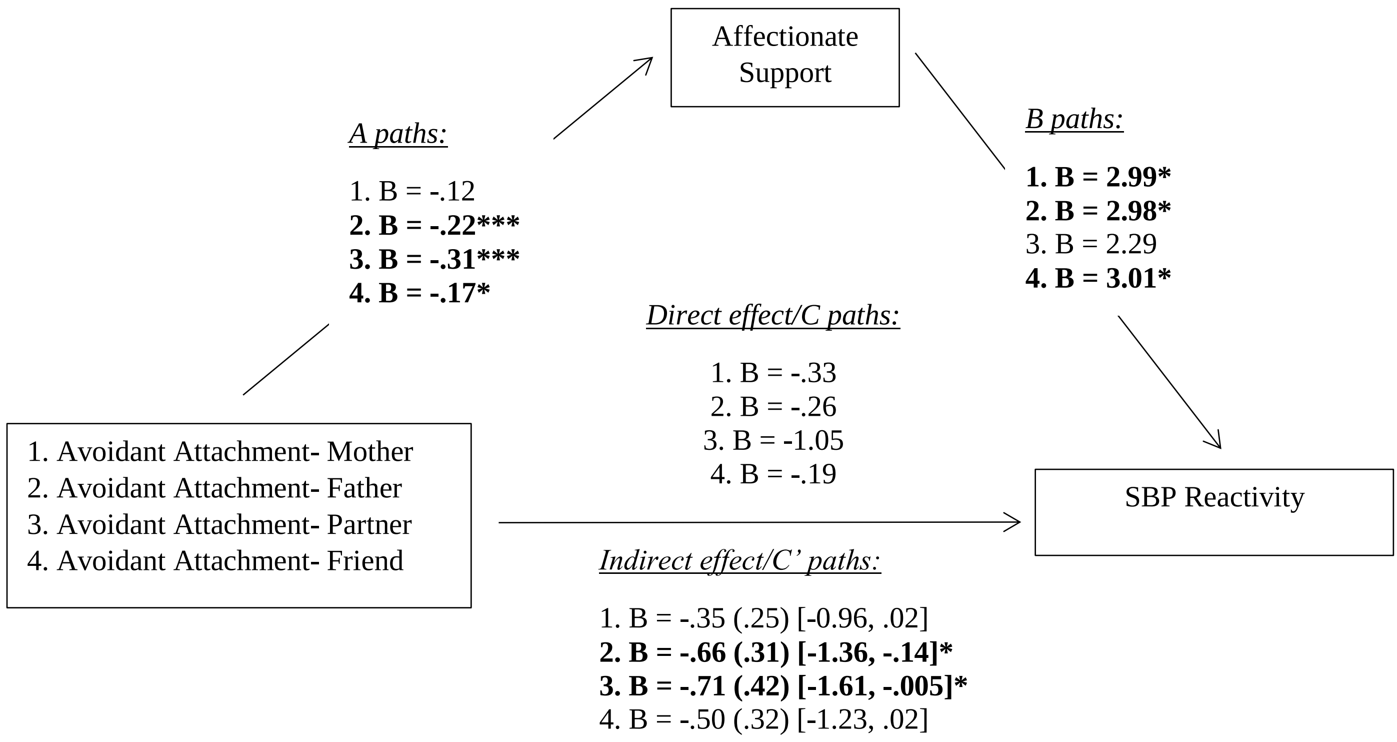

Figure 8. Mediation Path Diagram: Avoidant Attachment and SBP Reactivity to Maths Task

Note: Each mediation analysis includes age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A path represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and SBP reactivity to the maths task. Path C represents the direct effect between each independent variable and SBP reactivity (while holding the mediator and covariates constant). Finally, Path C' represents the indirect effect of each independent variable on SBP reactivity through social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

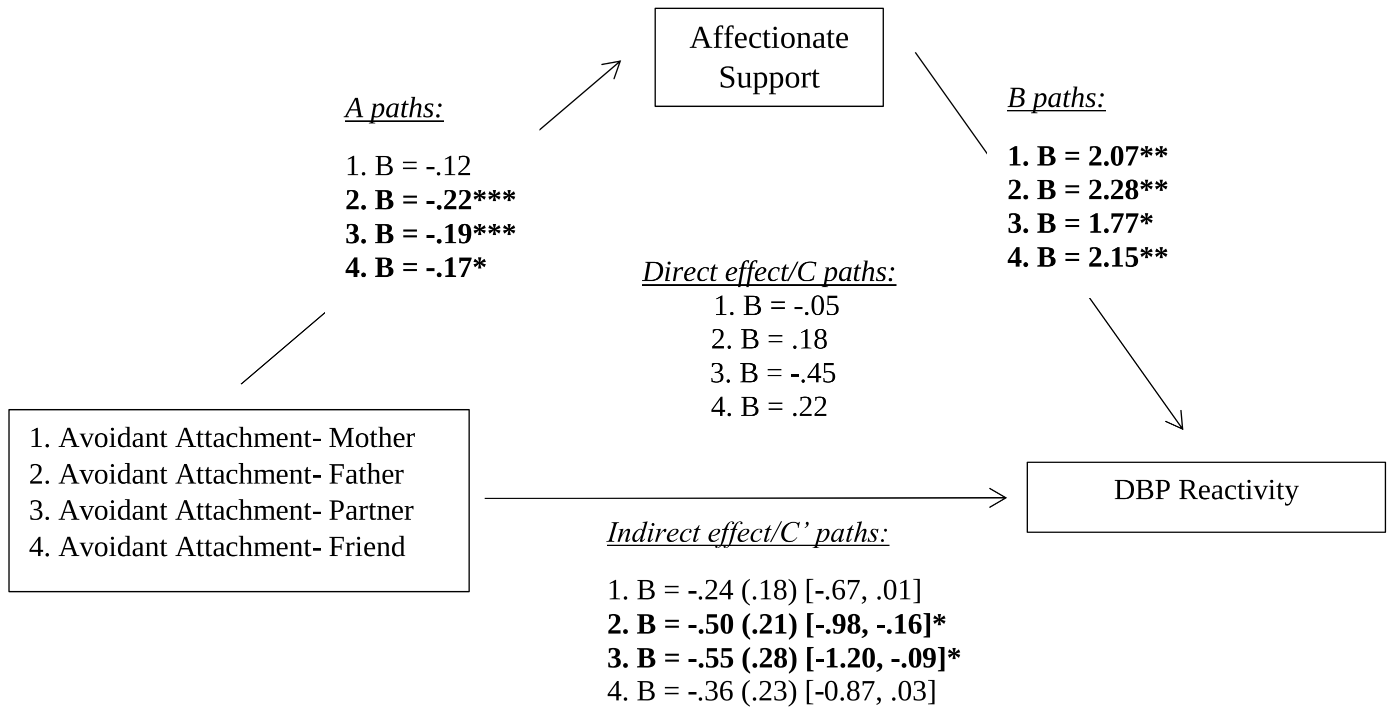

Figure 9. Mediation Path Diagram: Avoidant Attachment and DBP Reactivity to Maths Task

Note: Each mediation analysis includes age and gender as covariates (relationship status is only included as a covariate for partner attachment styles). Statistics refer to unstandardized betas (B), and standard error (in brackets) and 95 % confidence intervals at the lower and upper limit for indirect effects. The A path represents the association between each independent variable and the mediator. Path B reflects the association between the mediator and DBP reactivity to the maths task. Path C represents the direct effect between each independent variable and SBP reactivity (while holding the mediator and covariates constant). Finally, Path C' represents the indirect effect of each independent variable on DBP reactivity through social support. $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.