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Cardiovascular reactivity to acute stress: Attachment styles and invisible stranger support

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A B S T R A C T

While the benefits of social support for physiological health are well established, the underlying pathways by which support can influence cardiovascular reactivity (CVR) are still being elucidated. In the present study, we adapted an attachment framework to further explore the support-CVR link. Specifically, we experimentally tested the effect of attachment and social support on CVR by manipulating the provision of invisible support from a stranger, across individuals with secure, anxious and avoidant attachment styles. Employing a 3 × 2 design, a sample of young adults ($N = 138$) from across each of the three attachment styles were randomly assigned to either an invisible support (from a stranger), or no support, condition. All participants were subject to an acute standardised stress testing protocol where cardiovascular indices were monitored throughout. Results from a factorial ANOVA showed no significant interaction between support and attachment on any cardiovascular reactivity parameter (SBP, DBP, HR) or any main effect of attachment or support. These findings suggest that, in this case, social support was not effective in buffering the effects of stress across various attachment styles. The benefits of incorporating a developmental perspective to the study of social support and health are discussed.

1. Introduction

1.1. Stress and cardiovascular reactivity

The adverse impact of stress on physiological health has been well established (e.g., Dougall and Baum, 2012; Steptoe and Ayers, 2004; Steptoe and Kivimäki, 2012; Turner, 1994). One pathway by which this process occurs is via cardiovascular reactivity (CVR). CVR refers to a physiological change in heart rate (HR), blood pressure (BP) or other measures of cardiovascular function between a resting period, and during the presence of an external stressor (Blascovich and Katkin, 1993). Extensive evidence has supported the CVR hypothesis (e.g., Obrist, 1981; Manuck, 1994; Phillips and Hughes, 2011), which posits that exaggerated cardiovascular responses to psychological stress contributes to the development of cardiovascular disease (CVD), an increased risk of hypertension, and poorer cardiovascular risk status (for a review see Chida and Steptoe, 2010). Further, prospective studies have indicated that reactivity to acute psychological stressors within the laboratory is predictive of future blood pressure status and disease outcomes (Carroll et al., 2001; Matthews et al., 2003; Treiber et al., 2001). While it had been assumed that lower levels of reactivity were indicative of a healthy, adaptive response, recent research has suggested that this may not be the case. In fact, comparatively *lower* levels of cardiovascular responses than what would typically be seen during stress (termed 'blunted reactivity') (Phillips et al., 2013) are also associated with negative health outcomes (Carroll et al., 2017; Phillips et al., 2013; Turner, 1994) such as poor self-reported health, depression and obesity (Carroll et al., 2008; de Rooij, 2013; Phillips, 2011). Although it is widely accepted that atypical cardiovascular responses are linked to CVD and poorer physiological health (Lovallo, 2005; Treiber et al., 2003; Matthews et al., 1993), questions remain as to the underlying factors that explain these associations (Uchino, 2004). One such factor that has received considerable attention in this domain is social relationships; and in particular, the social support they provide (Holt-Lunstad et al., 2010).

1.2. Social support and CVR

Extensive research has highlighted the benefits of social support for health (e.g., Berkman and Glass, 2000; Cohen, 2004; Uchino, 2006; Uchino et al., 1996; Lepore et al., 1993). Specifically, the stress-buffering hypothesis proposes that social support can reduce or buffer

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the damaging effects of stress on physiological health (Cohen and Wills, 1985). When support is available to us as a coping resource during stressful periods, this may help us reappraise the stressor in a more positive way, which in turn can lower blood pressure responses to stress and reduce the risk of cardiovascular disease (Kamarck et al., 1990; Lovallo, 2005; Uchino et al., 2011). Indeed, experimental manipulations of social support suggest that receiving support is associated with attenuated CVR (Gallagher et al., 2014; Howard et al., 2017; O'Donovan and Hughes, 2007). It has been suggested however, that the association between social support and health might be more nuanced than originally expected (Stanton and Campbell, 2014); the pathways behind such association are not yet fully understood, and contradictory findings within the literature are evident. For example, some research has yielded no association between support and CVR, while others have demonstrated that support has resulted in exaggerated reactivity that has been damaging for health (see Lepore, 1998; Taylor, 2011 for reviews). With a view to better understand the mechanisms at play between relationships and health, a new line of inquiry has adapted a developmental framework by incorporating individual differences in attachment style to the physiological reactivity research (e.g. McMahon et al., 2020; Pietromonaco et al., 2013).

1.3. Attachment, social support and CVR

Attachment is defined as the secure emotional bond between people over time and space (Ainsworth, 1979; Bowlby, 1969). While attachment theory predominantly focuses on childhood development, the importance of attachment in adulthood has also been recognized (Hazan and Shaver, 1987); as children seek out their primary caregiver for comfort, security, or a 'safe haven' in times of fear, uncertainty or illness, similarly, adults turn to their attachment figures in times of stress. Unsurprisingly, then, individuals with different attachment styles differ in how they engage with social support interactions (Campbell et al., 2001; Collins and Feeney, 2010). For example, those who have secure attachment bonds (i.e., people who are confident that others will be there for them and are comfortable for others to depend on them) report an increased perceived availability of social support (Collins and Feeney, 2004; Sarason et al., 1990). In contrast, those with anxious attachment (i.e., individuals who long for intimacy and fear rejection from others) or avoidant attachment (i.e., those uncomfortable with closeness and intimacy because they fear being hurt) report receiving less support (Collins and Feeney, 2004; Davila and Kashy, 2009; McLeod et al., 2020). While both attachment and social support are key aspects of our relationships, little is known about their combined effect on CVR. Pietromonaco et al. (2013), however, have proposed that both attachment styles and other relationship processes such as social support can work together in influencing physiological responses to stress.

Although this research area is in its infancy, some studies have suggested that attachment style and support interact in various ways to influence physiological reactions, such as cortisol (Ditzen et al., 2008; Meuwly et al., 2012) and heart rate variability (Kordahji et al., 2015). For example, it has been proposed that securely attached individuals would benefit from receiving support because of their self-confidence to rely on others, and their positive and comforting interactions with supportive figures (Mikulincer and Shaver, 2009); which in turn can decrease stress and attenuate physiological responses to stress. Specifically, Kordahji et al. (2015) found that receiving support can reduce the physiological stress responses of highly anxious individuals. This group may be most reactive because of their amplified responses to threat and increased need for comfort, and thus, view support as an indication of safety, which can reduce HR responses (Kordahji et al., 2015). In contrast, however, research has shown that those with avoidant attachment style do not benefit from receiving support in the same way, and do not exhibit lower reactivity when they receive support. These findings suggest that such individuals may cope with stress better without support - for those who prefer to be independent and tend to avoid closeness and intimacy, receiving support may be damaging if it is perceived as unnecessary, unhelpful, or a threat to their self-esteem (Kordahji et al., 2015). While research has begun to examine support and attachment on physiological health, studies focusing on CVR (i.e., BP and HR reactivity) in particular, are warranted.

Although previous studies have often employed relationship-specific stressors (e.g., Wright and Loving, 2011) or address support in the presence of a romantic partner (e.g., Kim, 2006), less is understood about the attachment-support interaction in relation to non-relationship related stressors or dyadic conflict (Kordahji et al., 2015). In comparison to these studies however, we previously found that, using self-reported measures of attachment bonds to key relationship figures (mother, father, partner, best friend), anxious and avoidant attachment was associated with lower levels of perceived social support, which in turn was associated with lower cardiovascular (SBP, DBP) responses to an acute psychological stressor (i.e., completion of a maths task (Paced Auditory Serial Addition Test) and speech task as a modified version of the Trier Social Stress Test) (McMahon et al., 2020). While this provided some insight into the mechanisms by which attachment and social support are linked to CVR, the observational design means that causality cannot be inferred. Building on this research, the aim of the present study is to experimentally test the interaction between attachment and social support on CVR to a standardised psychological stress task.

1.4. Present study

Specifically, the current study aims to manipulate the provision of social support across individuals with secure, anxious and avoidant attachment styles within a standardised stress-testing protocol. Based on the above evidence, we anticipate that those with secure and anxious attachment styles may benefit most from receiving support, while those with avoidant attachment styles may not benefit from support at all, or indeed, be damaged by the receipt of support. Of note, much of this research on support and attachment refers to lower levels of reactivity as a more adaptive or 'beneficial' response, and exaggerated as damaging. As such, we hypothesise that individuals with secure and anxious attachment styles who receive support will exhibit lower levels of reactivity (i.e., buffering an exaggerated cardiovascular response, beneficial for physiological health), while those with avoidant attachment styles who receive support will demonstrate higher levels of reactivity (i.e., exaggerated cardiovascular response, damaging for physiological health), in comparison to their counterparts who do not receive support.

2. Methods

2.1. Design

A 3 × 2 factorial design was employed. This first independent variable, attachment style, was categorised into three groups: anxious, avoidant and secure. The second independent variable, social support, had two conditions: support and no support. In total, this created six conditions (Anxious Attachment – Support; Anxious Attachment – No Support; Avoidant Attachment – Support; Avoidant Attachment – No Support; Secure Attachment – Support; Secure Attachment – No Support). Physiological health outcomes were measured by systolic (SBP) and diastolic (DBP) blood pressure, and heart rate (HR) responses to an acute psychological stressor (modified Trier Social Stress Task (TSST); details of task in Section 2.5).

2.2. Participants

A sample of healthy young adults ($N = 138$) were recruited from our local university via an online credit system. Based on power calculations, a minimum sample size of 128 participants was required to detect a medium effect size ($F = 0.25$, $p = .05$) at 80% power. However, to account for attrition and/or potential outliers, additional participants were recruited with a view to achieve a sample size of $n > 20$ in each of the six conditions. To ensure a healthy sample, people with a diagnosis of cardiovascular disease, hypertension, or an immune disorder, people taking medication that is known to influence cardiovascular (e.g., beta blockers), women who were pregnant, and those under 18 were excluded from participation.

In addition, participants were asked to refrain from vigorous exercise and consuming alcohol for 12 h before the procedure, and from caffeine consumption and smoking 2 h prior to the procedure; in line with previous research noting these lifestyle factors as influential on blood pressure (e.g. Savoca et al., 2005; James and Richardson, 1991). The current sample consisted of 31 (22.5%) men and 107 (77.5%) women ($Range_{age}$ = 18 to 29; M_{age} = 19.35, SD = 2.07) (see Table 1 for participant characteristics). Our local university's research ethics committee granted ethical approval for the study.

2.3. Measures/materials

2.3.1. Attachment style

To measure attachment style, participants completed a one-item Relationships Questionnaire (RQ; Bartholomew and Horowitz, 1991), commonly used to categorise attachment styles among young adults (You and Malley-Morrison, 2000). Participants were provided with brief descriptions of secure, anxious, fearful-avoidant and dismissive-avoidant attachment styles, and asked to indicate which best describe how they feel in relationships in general. However, in line with Ainsworth (1979) model of attachment we focused on the three major categorisations (secure, anxious and avoidant); dismissive-avoidant and fearful-avoidant classifications were then merged to yield one category, avoidant attachment.

2.3.2. Social support manipulation

Participants were randomly allocated to either the support or no support condition using a random number generator (www.random.org). A single blind procedure was adapted; the participants were unaware of which condition they were in, while the confederate (a female research assistant) was made aware of the condition allocation at the latest possible point during testing (i.e., immediately before the reciting the script) to mitigate any experimenter effects.

The social support manipulation (support vs no support) was adapted from an experimental paradigm of received emotional support conducted by Bolger and Amarel (2007). In their multi-experimental study, Bolger and Amarel report that a subtle approach to received support, termed 'invisible support', was most influential in reducing stress. Specifically, they highlight that support that occurs "between the lines" (Bolger and Amarel, 2007, p. 459) mitigates the emotional cost of receiving support for the recipient. Given the focus on individual attachment styles in the current study, we believe that a subtler, although not entirely 'invisible' approach, may be more effective, particularly for those with insecure attachment styles. As such, the script was adapted to the specifics of this context, and the manipulation designed to appear credible, genuine and appropriate for provision by the confederate.

For those in the support condition, the confederate continued to say "*I have actually done this task before; it's not that bad at all so you don't have to worry! Best of luck, you'll do great!*", before turning task on the computer, and returning to their position behind a partition in the laboratory, out of view from the participant. The tone in which the confederate provided the support was in an empathetic and caring manner. The confederate was trained to be consistent in their delivery and to display a compassionate and gentle demeanour.

Alternatively, in the no support condition, after receiving notice that the task was about to begin and reminded to speak clearly, the confederate and participant did not engage in any further dialogue; the task began, and the confederate continued behind the partition out of view from the participant. The study continued as per the stress-testing procedure outlined below.

To ensure that the manipulation was effective, all participants completed a post task questionnaire where they were asked to rate how supportive, helpful and friendly they perceived the confederate, and to indicate how stressful they felt having the confederate present was. These were measured on a Likert scale ranging from 1 (*Not at all*) to 10 (*Extremely*) and allowed for differential analyses on the perception of the received support between conditions as a manipulation check; it was expected that those in the support condition would rate the confederate

Table 1
Descriptive statistics on participant demographic variables.

	N = 138			N = 82		
	N	%	*M (SD)*	*N*	%	*M (SD)*
Ethnicity						
White	131	94.90%		78	95.1	
Asian	3	2.20%		2	2.4	
Black	1	0.70%		–	–	
Latino	1	0.70%		1	1.2	
Other	2	1.40%		1	1.2	
Relationship status						
Single	76	55.10%		46	56.1	
In a relationship	58	42.00%		35	42.7	
Cohabiting	3	2.20%		1	1.2	
Married	1	0.70%				
Year in university						
1st	118	85.50%		71	86.6	
2nd	2	1.40%		2	2.4	
3rd	4	2.90%		1	1.2	
4th	13	9.40%		7	8.5	
Erasmus	1	0.70%		1	1.2	
Baseline scores						
Systolic			141.34 (18.34)			130.3 (8.57)
Diastolic			92.80 (17.49)			82.26 (8.91)
Heart rate			84.36 (11.39)			83.7 (11.64)
Reactivity scores						
Systolic			21.54 (9.84)			22.83 (9.61)
Diastolic			13.36 (5.06)			13.74 (5.14)
Heart rate			11.21 (9.58)			10.18 (8.97)
BMI (kg/m^2)			24.17 (5.44)			24.66 (5.89)

as more supportive, friendly and helpful, and also report it as less stressful.

2.3.3. Psychological stress reactivity

To confirm that the task was psychologically stressful, participants completed a pre-task questionnaire where they indicated how stressful they expected to find the stress task, and a post-task questionnaire to indicate how stressful they found it. These items were scored on a 7-point Likert scale (0 = *Not at all* to 6 = *Extremely*). This approach was used in previous studies (e.g., Gallagher et al., 2014) as a manipulation check.

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 monitor comprises of a finger-cuff and an arm-cuff, which is placed on the non-dominant hand of the participant, and a finger-cuff attached to the participants' middle finger to detect changes in the diameter of the arterial wall. The Finometer is an effective apparatus for measuring cardiovascular function used in similar CVR research (e.g., Howard et al., 2011) and the Association for the Advancement of Medical Instrumentation and the British Hypertension Society (according to Schutte et al., 2004) supports the use of the Finometer as an accurate and validated method of measuring cardiovascular functioning.

2.5. Stress task

An adapted version of the Trier Social Stress Task (Kirschbaum et al., 1993) was employed in the current study. Participants were asked to give a 4-minute speech on three of their best and three of their worst characteristics, giving real-life examples of each. A two-minute preparation time was allowed beforehand, but participants were not permitted to make notes. The instructions were pre-recorded and presented on a laptop. Participants were asked to speak clearly in order for the researchers to hear their responses; however, responses were not recorded the researcher and the confederate were out of view of the participant, behind a partition, throughout the task. Moreover, the main laboratory light is switched off and the area was dimly lit with only a desk lamp focusing on the participant. This aimed to heighten the participant's feelings of stress. Participants were prompted by the experimenter to '*Please continue until the end of the task*' if their speech ended before the designated time. The speech task, and stress testing protocol, was used as an effective method of eliciting physiological stress responses used in previous studies (e.g., Gallagher et al., 2018).

2.6. Procedure

Prior to the testing session, participants were sent an information sheet which highlighted the exclusion criteria, and the specific requirements that they should adhere to before attending the lab, such as refraining from alcohol, exercise, smoking, etc. At this point, participants were also asked to complete a pre-screen questionnaire: the Relationships Questionnaire (Bartholomew and Horowitz, 1991). Pre-screening allowed for the categorisation of attachment styles in advance of the stress-testing session, with a view to recruiting relatively equal numbers across the three attachment style categories (secure, anxious and avoidant). Participants were then randomly allocated to either the support or no support condition. Those who were eligible and agreed to take part were invited to attend a 1-hour stress-testing session at our health and psychophysiology laboratory.

On arrival to the laboratory, they were introduced to the experimenter and the research assistant (confederate). To ensure that participants adhered to the restrictions, they were asked to complete a checklist, and written consent was obtained. Height and weight were recorded along with other demographic information, such as age, gender, ethnicity, etc. Once completed, participants were asked to sit at a desk and place their feet in a box on the floor to restrict movement, as this has been shown to alter CVR measurements (Pickering et al., 2005). The blood pressure equipment, the Finometer Pro Haemodynamic monitor, was connected and a test-measure recorded.

From the time participants entered the laboratory, a 20-minute acclimatization period began to allow participants to habituate to the lab and to allow for a more accurate baseline reading. This was then followed by a vanilla baseline (Jennings et al., 1992), stress task and recovery periods, detailed in Fig. 1. During a 10-minute baseline period, participants sat quietly out of view from the researcher completing questionnaires and were provided with neutral magazines to occupy time until the stress task. Prior to the stress task, participants completed a pre-task questionnaire to record anticipatory psychological stress. At this point, the confederate began informing the participants (both support and no support condition) that the stress task was about to begin, while they prepared the task on the computer: "*Okay, the task is going to begin shortly. All of the instructions will appear on this screen in front of you. I just want to remind you to speak clearly so that we can hear your responses*".

In addition to the dimly lit room during the task, the experimenter wore a white laboratory coat throughout the whole procedure. These actions aimed to heighten the participant's feelings of stress and to create a psychological divide between the participant and experimenter. Following a 10-minute recovery period, the apparatus was removed from the participants' arm. Participants were debriefed, the experimenter described the true nature of the study, and any questions were answered.

2.7. Statistical analyses

The data was screened prior to analyses to ensure a healthy sample of young adults. From the initial sample (N = 147), 7 participants were removed due to missing blood pressure data, 1 was removed for being outside the young adult age range (18–35) and 1 was removed for taking medication that may impact CVR, reported after participating. Moreover, a number of participants (n = 56) were identified as having a resting blood pressure of greater than 140/90 (Stage 2 hypertension according to the American Heart Association, 2020). While this has been an exclusion criterion in previous research (e.g., McMahon et al., 2020; Howard et al., 2011), several studies have tested CVR on hypertensive populations (Alderman et al., 1990; Kovács et al., 2010; Li et al., 2018). It is not unusual to see hypertension in young adults with approximately 19% of young adults having high blood pressure, according to the NIH funded National Longitudinal Study of Adolescent Health (Add Health) (Nguyen et al., 2011); however, our figure was relatively high at 40.6%. For transparency, we conducted analyses on the overall sample (n =

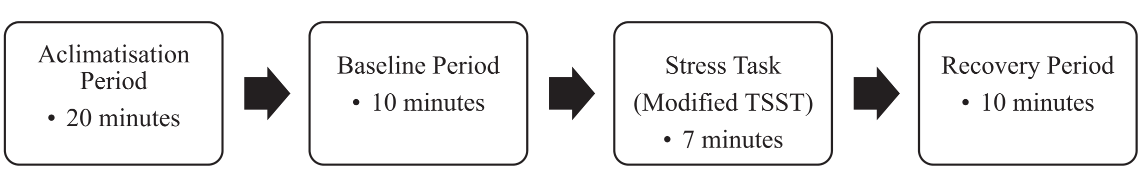

Fig. 1. Standardised stress testing protocol timeline, using a revised version of the Trier Social Stress Test.

Table 2
Descriptive statistics on attachment × support condition, including gender.

Condition		Anxious attachment – Support	Anxious attachment – No support	Avoidant attachment – Support	Avoidant attachment – No support	Secure attachment – Support	Secure attachment – No support
$N = 138$	n (%)	23 (16.70%)	25 (18.10%)	22 (15.90%)	25 (18.10%)	19 (13.80%)	24 (17.40%)
	Gender	M = 5, F = 18	M = 6, F = 18	M = 5, F = 17	M = 5, F = 20	M = 5, F = 14	M = 5, F = 19
$N = 82$	n (%)	15 (18.51%)	13 (16.05%)	16 (19.75%)	12 (14.81%)	11 (13.58%)	14 (17.28%)
	Gender	M = 4, F = 11	M = 3, F = 10	M = 3, F = 13	M = 1, F = 11	M = 3, F = 8	M = 2, F = 12

138) as planned a priori, as well as post hoc sensitivity analysis excluding participants who recorded elevated values during the baseline period ($n = 82$). Both analyses are presented below. The inclusion of such sensitivity analyses is solely for the purpose of transparency and no major interpretation of results will be based on these findings.

Mean baseline scores were calculated by averaging SBP, DBP and HR measures recorded at 30 second intervals throughout the 10 minute baseline. Similarly, task scores were calculated by averaging SBP, DBP and HR measures during the 6 minute task at 30 second intervals. Reactivity scores were then calculated by subtracting baseline measures from task measures (Task − Baseline). A series of manipulation checks (repeated measures analysis of variance: ANOVA) were conducted to ensure that the task was both psychologically and physiologically stressful, and to examine the effectiveness (both perceived and physiological response) of the support manipulation. Further, correlation analyses and *t*-tests examined any potential confounding health and socio-demographic variables that might impact CVR, such as age, gender BMI, etc., detailed below (Section 3.1.4). Finally, for the main analyses, between-subjects factorial ANOVAs examined differences in cardiovascular reactivity across attachment styles and support conditions. Partial eta squared (η^2_p) is reported as a measure of effect size.

3. Results

3.1. Preliminary analyses

3.1.1. Descriptive statistics

Participant characteristics are noted in Table 1. From the overall sample ($N = 138$), 43 (31.2%) participants were categorised as having a secure attachment, 47 (34.1%) as avoidant attachment and 48 (34.8%) as anxious attachment style. The random allocation of these participants to either the support ($n = 64$, 46%) or no support condition ($n = 74$, 53.6%) resulted in a relatively equal breakdown across all six conditions (see Table 2). Overall, more women participated ($n = 107$ (77.5%)) which resulted in relatively unequal gender breakdown across each condition (see Table 2). However, no statistically significant difference between difference between men and women across attachment styles (χ^2 (2) = 0.08, $p = .96$) or support condition was evident (χ^2 (1) = 0.05, $p = .83$).

3.1.2. Manipulation check: stress task

Results from a series of repeated measures ANOVAs demonstrate an increase in cardiovascular responses from baseline to task across each parameter; SBP: $F(1, 137) = 661.38$, $p < .001$, $\eta p^2 = 0.83$; DBP: $F(1, 137) = 961.75$, $p < .001$, $\eta p^2 = 0.88$ and HR: $F(1, 137) = 188.72$, $p < .001$, $\eta p^2 = 0.58$, confirming that the task was physiologically stressful. Moreover, results yielded a statistically significant increase of self-reported stress from pre to post task ($F(1, 137) = 113.59$, $p < .001$, $\eta p^2 = 0.45$) demonstrating that the task was also psychologically stressful.

3.1.3. Manipulation check: support condition

Between subjects ANOVAs showed no statistically significant difference between the support and no support condition across each CVR parameter; SBP: $F(1, 137) = 0.000$, $p = .99$; DBP: $F(1, 137) = 0.003$, $p = .96$; HR: $F(1, 137) = 1.19$, $p = .28$. This suggests that the support manipulation did not have an effect on physiological outcomes. Additionally, a series of between subjects ANOVAs also revealed that there was no statistically significant difference between the support and no support groups in terms of post-task stress ratings of the task ($F(1, 137) = 1.17$, $p = .28$), while there was also no difference between conditions on ratings of how supportive the confederate was perceived ($F(1, 135) = 0.004$, $p = .95$).

3.1.4. Covariates

There are a wide range of potential confounding health and socio-demographic variables that can influence CVR, including gender (Allen et al., 1993), baselines measures (Matthews et al., 1993), age (Uchino et al., 2010), BMI (Singh and Shen, 2013), contraceptive use and smoking status (Straneva et al., 2000). Preliminary analyses demonstrated that baseline HR was statistically associated with HR reactivity ($r = -0.21$, $p = .02$) and a gender difference in terms of SBP reactivity ($t(135) = 2.04$, $p = .04$) was evident, with men ($M = 24.71$, $SD = 10.96$) displaying higher SBP responses to stress than women ($M = 20.64$, $SD = 9.39$). All other potential variables listed above (i.e., age, BMI, contraceptive use and smoking status) were not statistically associated with any CVR parameter (all p's $> .05$). As a result, only baseline measures and gender (i.e., covariates that were statistically significant) were controlled for within the main analyses.

3.2. Main analyses: factorial ANOVA

A series of two-way factorial ANOVAs were conducted to test the effect of attachment style and social support on each CVR parameter. Baseline measures and gender were controlled for in these analyses. The results revealed no significant main effect for attachment ($F(2, 130) = 2.91$, $p = .058$, $\eta^2_p = 0.04$), or support condition ($F(1, 130) = 0.002$, $p = .97$, $\eta^2_p = 0.000$) on SBP reactivity. Moreover, there was no statistically significant Attachment × Support interaction effect on SBP reactivity, $F(2, 130) = 0.05$, $p = .96$, $\eta^2_p = 0.00$. Similarly, no significant main effect for attachment ($F(2, 130) = 1.67$, $p = .19$, $\eta^2_p = 0.03$), or support condition ($F(1, 130) = 0.008$, $p = .97$, $\eta^2_p = 0.000$) on DBP reactivity, nor was there a significant attachment x support interaction effect on DBP reactivity ($F(2, 130) = 0.10$, $p = .91$, $\eta^2_p = 0.001$). For HR reactivity, no significant main effect for attachment ($F(2, 130) = 0.26$, $p = .77$, $\eta^2_p = 0.004$), no significant main effect for support condition ($F(1, 130) = 1.04$, $p = .31$, $\eta^2_p = 0.008$) on DBP reactivity, or an attachment x support interaction effect on HR reactivity ($F(2, 130) = 0.67$, $p = .51$, $\eta^2_p = 0.01$) was found.

3.3. Post hoc sensitivity analyses

3.3.1. Descriptive statistics

Participant characteristics (for sample with non-elevated baseline values: $n = 82$), including baseline and reactivity blood pressure measures for the sub-sample, are noted in Table 1. From this sample, 25 (30.5%) participants was categorised as having a secure attachment style, 29 (35.4%) as having an anxious attachment style, and 28 (34.1%) as having an avoidant attachment style. The random allocation of these participants to either the support ($n = 42$, 51.2%) or no support condition ($n = 40$, 48.8%) resulted in a relatively equal breakdown across all six conditions (see Table 2 for details). Though there was predominantly more females in the sample ($n = 65$ (79.3%)), there was no statistically significant difference between men and women across attachment styles ($\chi^2 (2) = 1.02$, $p = .60$) or support conditions ($\chi^2 (1) = 0.91$, $p = .34$).

3.3.2. Manipulation check

Similar to the manipulation checks for overall sample, results from a series of repeated measures ANOVAs confirmed that the task was physiologically stressful, across each cardiovascular parameter (SBP: $F(1, 81) = 461.93$, $p < .001$, $\eta p^2 = 0.85$; DBP: $F(1, 81) = 585.47$, $p < .001$, $\eta p^2 = 0.88$ and HR: $F(1, 81) = 105.55$, $p < .001$, $\eta p^2 = 0.57$), as well as psychologically stressful ($F(1, 81) = 87.12$, $p < .001$, $\eta p^2 = 0.52$). Moreover, between-subjects ANOVAs showed no effect of the support manipulation on each CVR parameter; SBP: $F(1, 81) = 0.96$, $p = .33$; DBP: $F(1, 81) = 0.1.98$, $p = .16$; HR: $F(1, 81) = 2.51$, $p = .12$, or on the post-task stress ratings of the task ($F(1, 81) = 0.45$, $p = .51$). There was also no difference between conditions on ratings of how supportive the confederate was perceived ($F(1, 79) = 0.26$, $p = .61$).

3.3.3. Covariates

Taking into consideration potential confounding by health and socio-demographic variables correlation analyses and independent samples t-test were conducted; similar to the approach taken to the overall sample. Unlike the overall sample, no association between age, BMI, ethnicity, or baseline measures were associated with SBP, DBP or HR reactivity. Moreover, no differences were noted across gender, smoking status or contraceptive use, and thus, were not included as covariates within the subsequent analyses.

3.3.4. Main analyses

Again, a series of two-way factorial ANOVAs were conducted to test the effect of attachment style and social support on each cardiovascular reactivity parameter. The results revealed no significant main effect for attachment ($F(2, 76) = 1.73$, $p = .18$, $\eta^2_p = 0.04$), or support condition ($F(1, 76) = 0.76$, $p = .34$, $\eta^2_p = 0.01$) on SBP reactivity. Moreover, there was no statistically significant Attachment x Support interaction effect on SBP reactivity, $F(2, 76) = 0.54$, $p = .58$, $\eta^2_p = 0.01$. Similarly, no significant main effect for attachment ($F(2, 76) = 0.56$, $p = .58$, $\eta^2_p = 0.01$), or support condition ($F(1, 76) = 1.70$, $p = .20$, $\eta^2_p = 0.02$) on DBP reactivity, nor was there a significant attachment x support interaction effect on DBP reactivity, $F(2, 76) = 0.62$, $p = .54$, $\eta^2_p = 0.02$. For HR reactivity, no significant main effect for attachment ($F(2, 76) = 0.82$, $p = .45$, $\eta^2_p = 0.02$), no significant main effect for support condition ($F(1, 76) = 2.34$, $p = .13$, $\eta^2_p = 0.03$), or an attachment × support interaction effect on HR reactivity ($F(2, 76) = 0.36$, $p = .70$, $\eta^2_p = 0.01$) was found.

Overall, there is no difference in main findings when examining the overall sample ($N = 138$), or the sub-sample excluding those who recorded elevated values during the baseline period ($n = 82$); both samples yield statistically insignificant results. Moreover, no statistically significant difference were noted between the overall sample, or the sub-sample for sensitivity analyses across any reactivity parameter (SBP: $t(81) = 0.33$, $p = .75$; DBP: $t(81) = 0.17$, $p = .87$ HR: $t(81) = -0.39$, $p = .70$).

4. Discussion

The present study aimed to examine if attachment styles could provide further insight into the effects of social support on CVR. Specifically, we tested the effect of attachment and social support on reactivity, by manipulating the provision of support across individuals with secure, anxious, and avoidant attachment styles within a stress-testing protocol. Contrary to our expectations, our results indicated no interaction between support and attachment styles on any cardiovascular reactivity parameter. Moreover, the results showed no difference between anxious, avoidant and secure attachment styles on CVR, or between those who received support, and those who did not receive support, during an acute psychological stress task. Overall, the main findings from this study suggest that none of the participants, regardless of attachment style, benefited from receiving support in times of stress.

Despite limited research in the area of attachment, support and reactivity, we had anticipated differential responses in reactivity across attachment styles. Specifically, we expected those with secure attachment styles to benefit from receiving support due to their comfort with interactions and ability to rely on support in times of stress (Collins and Feeney, 2010). Similarly, we hypothesised that anxiously attached individuals would benefit because of their increased need for comfort (Kordahji et al., 2015). On the contrary, we expected that individuals with avoidant attachment styles would benefit least because of their preference for independence (Kordahji et al., 2015); however, no such effect was found within the present study. There may be a number of reasons for this.

First, much of the existing attachment literature has focused on relationship specific stressors such as conflict-inducing encounters between romantic partners (e.g., Wright and Loving, 2011); a limitation acknowledged by Kordahji et al. (2015). Thus, we incorporated a neutral stressor (i.e., a stressor not related to a specific relationship figure) using a modified version of the Trier Social Stress Test, a commonly used and well-validated stress test utilised with the CVR literature (e.g., Allen et al., 2017; Kirschbaum et al., 1993; Kudielka et al., 2007). However, it may be that received support is most influential across various attachment styles for relationship specific stressors only, as prior research has suggested that the type of stressor can have implications for reactivity (e.g., Brown et al., 2019; Cacioppo et al., 2002; Griffin and Howard, 2020; McMahon et al., 2020). While the type of stressor may play a role in explaining variations in the current findings, future research should continue to focus on different types of stressors, both relationship specific and otherwise.

Secondly, and in a similar vein, much of the previous research examining attachment style in adulthood has focused on dyadic interactions (e.g., Diamond and Fagundes, 2008; Laurent and Powers, 2007; Powers et al., 2006; Quirin et al., 2008), and in particular, romantic partners (e.g., Campbell et al., 2001; Collins and Feeney, 2010). On the contrary, however, for the current study, a stranger (peer confederate) provided social support. While it has been shown that stranger support can be effective in buffering negative effects of stress (e.g., Bolger and Amarel, 2007), it is worth noting that when adapting an attachment perspective, perhaps receipt of support from a stranger may not be as influential as a close relationship figure. Regardless, it is important to understand how the provision of support from different people (i.e., both strangers and various relationships figures) is important for individuals with different attachment styles as they encounter stress. Therefore, future studies should aim to experimentally test the effectiveness of support among various dyadic frameworks (e.g., parents, peers, and strangers).

Although the findings were contrary to our expectations, the transparency in the reporting of results, and methodological rigour utilised in the current study, should be highlighted. Indeed, the reporting of sensitivity analyses provided additional transparency for the unusual proportion of the sample presenting with elevated blood pressure levels. Further, a strict standardised stress testing protocol was employed where numerous confounding variables were controlled for either within the lab or subsequent analyses, and a validated and effective support manipulation was utilised. While we have aimed to account for key confounding variables, there are additional extraneous variables (e.g., diets, nutrient intake) that can also influence CVR (e.g., Jakulj et al., 2007) that were not assessed within the current study, and should be considered within future research. Indeed, research has highlighted that cardiovascular (Baker et al., 2016; Charkoudian et al., 2017) and cortisol (Maki et al., 2015) reactivity are associated with hormonal changes during the menstrual cycle. Given that 77.5% of participants were women of reproductive age, the influence of neurohormonal condition (i.e., phase of the menstrual cycle) on cardiovascular reactivity could be considered an important covariate. While such effect would, to some extent, be mitigated by the random allocation to groups within the current study, it was not directly assessed, and future reactivity research should measure, and account for, neurohormonal condition.

A number of other limitations to the current study should also be discussed. Firstly, while 'invisible' support may provide a useful framework for understanding the effects of social support on health, there may also be limitations to its effectiveness in specific situations. In other words, if the level of support received is considered on a continuum for example, perhaps there is a balance between overtly supportive and damaging, and too subtle and ineffective; a balance that may vary depending on individual difference factors like attachment. This may warrant further exploration in future studies. Secondly, the support provider (confederate) in this study was female, yet the sample consisted of both men (22.5%) and women (77.5%). Research has highlighted gender differences between the provider and recipient of support in cardiovascular responses to stress, however. For example, Phillips et al. (2009) showed that among young women, support from a male stranger or a female friend increased cardiovascular reactivity. This again highlights the difference in support provider (friend v stranger) discussed previously, but also demonstrates how gender differences, or 'gender matching' between the provider and recipient can also influence stress reactivity; a further consideration for future research.

In conclusion, this study examines a gap within the existing research that incorporates an attachment framework to the social support literature, and provides useful insights for future research examining support, attachment and CVR. Given that reactivity research incorporating both social support and attachment is a relatively new area of interest, this study adds to the expanding literature merging two distinct fields of research, health and developmental psychology.

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