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BENEFIT OF SOCIAL SUPPORT FOR RESILIENCE-BUILDING IS CONTINGENT ON SOCIAL CONTEXT: EXAMINING CARDIOVASCULAR ADAPTATION TO RECURRENT STRESS IN WOMEN

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Abstract

Previous work on social support and stress tolerance using laboratory-based cardiovascular stress response paradigms has suggested that perceived social support may be effective in building resilience in recipients. However, such paradigms are often socially de-contextualized insofar as they fail to take account of the social aspects of stress itself. Using 90 healthy college women, the present study sought to examine the association between self-reported perceived social support and cardiovascular stress tolerance. Participants underwent two consecutive exposures to a mental arithmetic task. On second exposure to the stressor, participants completed the task under either social threat or control conditions. Social threat was manipulated using socially-salient instructions, in order to create a high social context. Adaptation to stress was established in terms of comparisons between cardiovascular responses to successive exposures. Results showed that cardiovascular responses tended to habituate across time, with perceived social support associated with the degree of habituation, but only under certain contextual conditions; high perceived support was associated with effective habituation under control conditions only. This response pattern is consistent with the view that high perceived social support buffers against stress in healthful ways, but only in asocial contexts.

Keywords: Social support; cardiovascular reactivity, cardiovascular adaptation, stress tolerance, social context

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Introduction

Over the past 25 years, interest in how stress affects bodily processes has received a lot of attention from different strands of research, with the most popular relating to the "reactivity hypothesis". The reactivity hypothesis states that prolonged or exaggerated cardiovascular reactivity to psychological stress (CVR) is linked to the development of cardiovascular disease (Obrist, 1981), with support for this hypothesis demonstrated in a range of studies, using different samples, and a wide range of follow-up time periods (Treiber et al., 2003).

Laboratory-based studies examining how stress affects cardiovascular responding generally use a traditional CVR protocol; participants undergo cardiovascular monitoring during a resting baseline period, followed by a stressor task. In general, cardiovascular measures during the stressor are compared to baseline levels with exaggerated increases from resting level taken as an indicator of how responsive a person is to stressors in their day-to-day life. The ecological validity of laboratory studies has received some support, although laboratory-based increases are often *less* than that seen in real-life settings using ambulatory monitoring (Zanstra & Johnston, 2011).

Cardiovascular Adaptation

One criticism of CVR research is that it is dependent upon the assessment of cardiovascular responses arising from single exposures to a novel laboratory-based stressor. While the use of novel stressors ensures that CVR measures are free from confounds resulting from participant familiarity with stress-tasks, physiological responses are likely to habituate (or, if the individual's coping abilities are compromised, to sensitize). As such, cardiovascular stress responses observed in laboratory experiments might not generalize smoothly to subsequent extra-laboratory contexts, despite the fact that incapacity to habituate to stress may well be a crucial element of psychosomatic pathogenesis (Kelsey, 1993). In this regard, empirical studies confirm that blood pressure elevations due to cognitive stress tail off markedly after the first minute of stress exposure (Kelsey, 1991), and on repeated exposure to the same stressor (Kelsey et al., 2000), but that CVR appears not to habituate completely (Carroll, Cross, & Harris, 1990; Turner, 1994). Nonetheless, the fact that CVR might *sometimes* habituate in the face of sustained or repeated stress threatens the external validity of studies that interpret associations between psychosocial factors and CVR as implicating such factors in the long-term etiology of cardiovascular disease.

While cardiovascular habituation (or sensitization) has been evaluated in terms of test-retest reliability over time (Carroll, Turner, Lee, & Stephenson, 1984) and within the period of a single exposure to stress (Hughes & Black, 2006), there has been little research on cardiovascular adaptation that focuses on multiple, immediately consecutive exposures to the same stressor. Research that has been conducted confirms that habituation-sensitization patterns can be highly salient features of stress responses, which can reveal influences of psychosocial factors that are not apparent from stress experiments employing novel tasks (Hughes, 2007a, 2007b; Hughes, Howard, James, & Higgins, 2011).

Perceived Social Support

Due to its reported effects on health-related outcomes, social support has received a lot of attention in CVR research. A distinction can be made between two types of social support; perceived and received. Received social support relates to support received by the individual; in laboratory studies, often provided by a friend or a confederate. Self-reported social support is often referred to as perceived social support and identifies that support that a person perceives is available to them, when needed; usually measured by self-report. Social support has been linked to a range of health-promoting benefits, including positive associations with a range of cardiovascular outcomes in clinical samples (Frasure-Smith et al., 2000; Rozanski, Blumenthal, & Kaplan, 1999), less CVR in both healthy and patient samples (Craig, Lynch,

& Quartner, 2000; Nausheen, Gidron, Gregg, Tissarchondou, & Peveler, 2007), and with reduced resting cardiovascular function in healthy females (Hughes & Howard, 2009). However, results have not been conclusive, with perceived network size sometimes associated with greater CVR (Roy, Steptoe, & Kirschbaum, 1998).

To date, one study has examined perceived social support and cardiovascular adaptation to repeated stress in the laboratory. In a sample of 92 healthy individuals, Hughes (2007b) demonstrated that high social support was associated with significant cardiovascular habituation in women only. For men, high social support was associated with increased (rather than decreased) responding on second exposure to the same stressor (i.e., sensitization). This study highlighted the potential benefits of examining patterns of cardiovascular adaptation across repeated exposures to the same stressor. In addition, it also suggested that social support may show different associations in male and females, with beneficial effects of perceived social support restricted to females.

Attempts to manipulate the context of the stressor in previous research have tended to use different laboratory tasks, with mental arithmetic or writing often used as the asocial task (Nausheen et al., 2007) and speech used as the social task (Roy et al., 1998). These tasks, however, are conceptually very different and it is questionable whether cognitive load is identical for both tasks, with just the social *context* differing. In an attempt to maintain good experimental control over the cognitive load and context of a stressor, Gallo, Smith, and Kircher (2000), employed a speech task and manipulated the social context under which a sample of 87 female participants performed the task. They found that a social context manipulation influenced the association between both systolic blood pressure (SBP) and heart rate (HR) reactivity and social support. However, these researchers examined laboratory-based reactivity during preparation for, and recovery from, one stressor. Consequently, it would be interesting to see if a subtle attempt to manipulate the social context of recurrent stress would produce similar results.

Aim of the Present Study

The aim of the present study was to examine if perceived social support is associated with decreased CVR to an asocial, mental arithmetic stressor, following a traditional CVR protocol (by comparing cardiovascular parameters at baseline to levels during a novel stressor). In addition, by extending the traditional CVR protocol and introducing a second stressor (Hughes, 2007b; Hughes & Higgins, 2010; Hughes et al., 2011; Kelsey et al., 2000), a second aim is to see if perceived social support is associated with enhanced cardiovascular habituation to the stressor. Finally, the present study aims to investigate the influence of social context on the relationship between perceived social support and cardiovascular adaptation in the laboratory.

Method

Design

The study was of a test-retest design. Participants underwent hemodynamic monitoring while at rest (baseline), during a mental arithmetic task (exposure 1), during a second rest period (recovery), and during the same mental arithmetic task (exposure 2), thereby offering the within-subjects factor of phase, with four levels. The between-subjects factor was context, with two levels (social versus control); however, this between-groups manipulation was only relevant for the last phase of the protocol (i.e., during exposure 2). Participants were randomly assigned to the experimental groups (social and control). Participants in the social group completed the second exposure to the mental arithmetic task under conditions where social comparison and the socially-salient features of the task were emphasised; the control group completed the second exposure to the mental arithmetic task under identical conditions to the first exposure.

Participants

Participants were 90 female undergraduate students of psychology, ranging in age from 18 to 36 years (mean age = 19.88, *SD* = 2.53), with mean body mass index (BMI) of 22.75 kg/m^2 (*SD* = 3.41). Practical and theoretical considerations lead to the decision that only females would be recruited for the present study. Females comprise more than 70% of the student population studying psychology, rendering it difficult to recruit sufficient numbers of biometrically comparable males. In addition, as social support has shown different associations in males and females (Hughes, 2007b; Hughes & Howard, 2009), it was decided that the addition of gender as a between-subjects factor would lead to a reduction in power to detect effects. G -Power analyses indicated that for $N = 90$, with two levels to the between-subjects factor and four levels to the within-subjects factor, at least 84% power is present for medium effects sizes (Faul, Erdfelder, Buchner, & Lang, 2009). All participants were normotensive (resting blood pressure <140/90 mmHg), physically healthy and reported no history of heart disease. Smokers were included ($n = 15$) as were oral contraceptive users ($n = 11$; 3 of whom were also smokers). While it has been reported that smoking and oral contraceptive use, alone or together, may affect blood pressure (Emmons & Weidner, 1988), other studies have found no association between oral contraceptive use or smoking and CVR to a variety of cognitive and physical stressors (Davis, 1999; Girdler, Jamner, Jarvik, Soles, & Shapiro, 1997). In the present sample Mann-Whitney *U* test indicated no differences in CVR between oral contraception users and non-users, ($U > 345$, $p > .27$) or between smokers and non-smokers ($U > 438$, $p > .11$, for all cardiovascular parameters except DBP, $U = 390$, $p = .06$, and TPR, $U = 306$, $p = .042$). Students were recruited through class announcements and received course credit for participation. Participation was voluntary and all participants signed a consent form prior to participation.

Materials and Apparatus

Self-report Measures

Perceived Social Support. Perceived social support was measured using the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, Dahlem, Zimet, & Farley, 1988). The MSPSS is a 12-item scale which assesses perceived social support from friends, family, and a significant other. Participants respond on a 7-point Likert scale from "very strongly agree" to "very strongly disagree". Items can be summed to reflect support received from each source, or alternatively a total perceived social support score can be used. For the present sample, the composite MSPSS score was used in order to adequately reflect the total amount of social support an individual perceived to be available to them. Previously, internal consistency and construct validity have been established (Zimet et al., 1988). Cronbach's alpha for the entire sample was .94, indicating excellent internal consistency.

Subjective Appraisal. Participants completed six 10-point Likert scales outlining how stressful, difficult, and enjoyable they found both laboratory tasks (completed after exposure 1 and exposure 2).

Cardiovascular monitoring equipment

Cardiovascular function was measured using a Finometer hemodynamic cardiovascular monitor (Finapres Medical Systems BV, BT Arnhem, The Netherlands). The Finometer is the successor to the TNO Finapres-model-5 and of the Ohmeda Finapres 2300e which have been used in previous research (e.g., Gregg, Matyas, & James, 2002) and offers a sophistication beyond that of traditional blood pressure monitors used in previous research as it provides continuous monitoring. The Finometer measures cardiovascular function on a beat-to-beat basis and has been shown to accurately assess absolute blood pressure in young participants (Schutte, Huisman, Van Rooyen, Oosthuizen, & Jerling, 2003) and in cardiac patients (Guelen et al., 2003). In addition, the Finometer is non-invasive and cardiovascular function is measured through use of a cuff attached to the middle finger of the non-dominant hand. Previous studies (Guelen et al., 2003; Schutte et al., 2003) have confirmed that the Finometer meets the validation criteria of the Association for the Advancement of Medical Instrumentation and the revised protocol of the British Hypertension Society.

Measures of SBP, diastolic blood pressure (DBP; both measured in millimetres of mercury), HR (beats per minute), cardiac output (CO; litres per minute), and total peripheral resistance (TPR; peripheral resistance units) are measured by the Finometer and were taken as indicators of cardiovascular function and physiological stress response throughout the procedure.

Procedure

Participants were greeted by the researcher and seated in the laboratory. The Finometer cuff was attached to the participant's middle finger of their non-dominant hand. Participants were given 30 minutes to acclimatize to the laboratory situation during which the MSPSS was completed. In addition, reading material was supplied in order to facilitate relaxation and the genuine establishment of cardiovascular baselines (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). Reading material consisted of general interest magazines supplied in order to avoid rumination and to offer some level of control over participant's cognitive processes; all participants received the same reading material and were allowed to acclimatize to the laboratory environment for an equivalent period of time. Following this acclimatization period, participants were asked to rest quietly for 10 minutes, during which baseline cardiovascular measures were taken. Following this baseline period, participants were asked to complete a computerized mental arithmetic task. Participants were presented with mental arithmetic problems on-screen and were asked to return an answer (using the keypad) within 15 seconds. The task incorporated standardized flexibility, controlling for individual mathematical ability as previously recommended for CVR assessment (Hughes, 2001; Turner, 1994; Turner et al., 1986). That is, if participants returned three correct answers in a row, the level of difficulty of the problems increased. When incorrect answers were returned, the level of difficulty decreased. Problems presented involved subtraction. Participants completed this 5-minute task twice, separated by a second 10-minute resting period. For half the sample, on second exposure to the task, the context of the stressor was manipulated in order to highlight the socially-salient features of the task and to promote a sense of social comparison or threat. To do this, participants were told that they must perform at the highest level, that their scores were being recorded, and that their scores would be compared to other participants' scores. These instructions were given immediately prior to beginning the second exposure to the task. For participants in the control group, the context of the stressor was not altered from the first exposure. Following the procedure, participants rated how stressful, difficult, and enjoyable they found the task on a 10-point Likert scale. Following completion of the study, participants were fully debriefed on the nature and purpose of the study.

Data Analysis

There were no missing data for physiological measures. For those with missing data on psychometric measures (<1%), scale total scores were replaced with the mean score on that measure, representing a conservative treatment of missing data (Tabachnick & Fidell, 2006).

Beat-to-beat measurements of cardiovascular function gathered during each phase of the procedure were reduced to phase-level means, rendering a measurement for baseline, exposure 1, recovery, and exposure 2. Excellent internal reliability consistency for each measure was observed (Cronbach's $\alpha > .85$ each cardiovascular parameter mean).

For measures of TPR a significant Kolmogorov-Smirnov test indicated that there had been a violation of the assumption of normal distribution. After examination of the outlying scores ($n = 9$) it was decided to remove these participants from the data set when examining TPR. This left a sample size of $N = 81$ when examining TPR only. As Kolmogorov-Smirnov tests confirmed that all other cardiovascular parameters were normally distributed for all phases of the experiment, the full sample of $N = 90$ was used for these variables.

Mixed ANOVAs and ANCOVAs were used to determine if (1) social support influenced reactivity to both exposures, (2) context influenced reactivity to exposure 2, and (3) participants habituated to repeated stress. In addition, mixed ANCOVA was used to determine if social support and context was associated with degree of cardiovascular habituation. In all analyses, the within-subjects factor was phase with two (baseline, exposure 1) or four (baseline, exposure 1, recovery, exposure 2) levels. The between-subjects factor was context (social versus control). Perceived social support (MSPSS) was treated as a covariate in the analyses. For analyses with more than two repeated-measures levels, sphericity assumptions were tested using Mauchley (*W*) tests, with degrees of freedom adjusted using Greenhouse-Geisser corrections (ε) where sphericity assumptions were not met.

Effect sizes are presented as partial η^2 for ANOVA effects. Partial η^2, rather than simple η^2, is recommended for ANOVA designs with multiple independent variables, as simple η^2 contains systematic variance attributable to other effects and interactions (Tabachnick & Fidell, 1989). For dependent-samples *t*-tests, effect sizes are presented as *r*. Eta-squared values of .04, .25, and .64 and *r* values of .1, .25, and .37 are taken as representing small, medium, and large effect sizes, (Cohen, 1988, 1992).

Results

Descriptive Statistics

Descriptive statistics indicated that participants gave a mean rating of 6.14 (*SD* = 1.77) on difficulty, 5.62 (*SD* = 2.26) on stressfulness, and 3.14 (*SD* = 1.79) on enjoyableness after first exposure to the task. On second exposure, participants gave a mean rating of 6.42 (*SD* = 1.89) on difficulty, 5.55 (*SD* = 2.39), on stressfulness, and 3.05 (*SD* = 1.84) on enjoyableness of the task. Paired-samples *t*-tests indicated that all participants found both exposures to the task stressful (exposure 1, $t[88] = 6.99$, $p < .001$, $r = .59$; exposure 2, $t[88] =$

6.65, $p < .001$, $r = .578$) and difficult (exposure 1, $t[88] = 9.23$, $p < .001$, $r = .70$; exposure 2, $t[88] = 9.99$, $p < .001$, $r = .73$), when compared to ratings of enjoyableness. Independent samples *t*-tests comparing those in the social group and the control group on ratings of difficulty, stressfulness, or enjoyableness of the second task, showed that context did not influence these ratings (all *p*s > .05).

Independent samples *t*-test indicated that scores on the MSPSS scale were equivalent across groups, $t(88) = .49$, $p = .646$, as would be expected given that participants were randomly assigned to experimental group. Likewise, there was no difference in age ($p = .202$) or BMI between participants in the experimental groups ($p = .367$).

Exposure 1

In order to test the hypothesis that perceived social support is associated with decreased reactivity to a novel, asocial stressor, a series 2 × 1 repeated measures ANCOVAs with phase (baseline, exposure 1) as the within-subjects factor and social support entered as covariate were conducted. ANCOVA revealed a main effect for phase on SBP, $F(1,88) = 40.75$, $p < .001$, partial $\eta^2 = .32$, DBP, $F(1,88) = 33.26$, $p < .001$, partial $\eta^2 = .27$, HR, $F(1,88) = 19.83$, $p < .001$, partial $\eta^2 = .18$, CO, $F(1,88) = 41.13$, $p < .001$, partial $\eta^2 = .32$ and TPR, $F(1,79) = 6.20$, $p = .015$, partial $\eta^2 = .07$. This confirmed that the first exposure to the stressor elicited reactivity, with elevations from baseline on SBP, DBP, HR, and CO evident, as can be seen in Table 1. For TPR, decreases from baseline levels are an indicator of reactivity.

There were no phase × social support interactions on SBP, DBP, or HR (all *p*s > .05), indicating that, contrary to our hypothesis, perceived social support is not associated with decreased reactivity to the asocial stressor. However, for both CO and TPR, the phase × social support interaction approached significance: for CO, $F(1, 88) = 3.75$, $p = .056$, partial $\eta^2 = .041$; for TPR, $F(1,79) = 3.53$, $p = .064$, partial $\eta^2 = .043$. Pearson’s correlation revealed that there was a near-significant negative correlation between CO reactivity to exposure 1 (computed by subtracting the mean values taken during baseline from the mean values taken during exposure 1) and social support scores, $r = -.20$, $p = .056$. For TPR, Pearson's correlation revealed a near-significant positive correlation between social support and TPR reactivity, $r = .21$, $p = .064$. While the approaching-significant correlation on CO is in partial support of the hypothesis (with high levels of perceived social support associated with low levels of CO reactivity), these did not attain significance and this series of ANCOVAs revealed that while exposure 1 was successful in eliciting reactivity for all cardiovascular parameters, levels of perceived social support did not influence the degree of reactivity.

Insert Table 1 here

Exposure 2

In order to test the hypothesis that social context influences CVR to the second stressor, a series of 2 × 2 mixed ANOVAs were conducted. The within-subjects factor was phase with two levels (baseline, exposure 2) and the between-subjects factor was context with two levels (social versus control).

A main effect for phase on SBP, $F(1,88) = 78.64$, $p < .001$, partial $\eta^2 = .47$, DBP, $F(1,88) = 105.02$, $p < .001$, partial $\eta^2 = .54$, HR, $F(1,88) = 17.15$, $p < .001$, partial $\eta^2 = .16$, CO, $F(1,88) = 15.14$, $p < .001$, partial $\eta^2 = .15$, and TPR, $F(1,79) = 6.11$, $p = .016$, partial $\eta^2 = .07$, confirmed that second exposure to the same stressor successfully elicited a cardiovascular response. As can be seen in Table 1, all measures showed significant change from resting baseline levels.

There was no phase × context interaction on any of the cardiovascular variables (all *p*s > .05), indicating that context did not influence CVR to the second exposure to the task.

Cardiovascular Adaptation to Repeated Stress

Stressor Context

To identify if participants showed cardiovascular habituation on repeated exposures to the same stressor and to determine if patterns of adaptation to the stressor were influenced by context, a series of 4 × 2 mixed ANOVAs were conducted. For this series of analyses, the within-subjects factor was phase and contained all four timepoints throughout the procedure (baseline, exposure 1, recovery, exposure 2). The between-subjects factor was context with two levels (social versus control). Scrutiny of the within-subjects contrasts, in particular the cubic trends based on all four time-points, revealed that individuals showed significant habituation to exposure 2 on all cardiovascular parameters; SBP, $F(1,88) = 118.11$, $p < .001$, partial $\eta^2 = .57$, DBP, $F(1,88) = 155.74$, $p < .001$, partial $\eta^2 = .64$, HR, $F(1,88) = 110.72$, $p < .001$, partial $\eta^2 = .56$, CO, $F(1,88) = 130.22$, $p < .001$, partial $\eta^2 = .60$, and TPR, $F(1,79) = 15.62$, $p < .001$, partial $\eta^2 = .002$.

There were no significant phase × context interaction effects on linear, quadratic, or cubic functions (all *p*s > .05). This demonstrates that all individuals showed significant cardiovascular habituation to repeated exposures to the stressors, despite the social context of the stressor being manipulated on second presentation.

Social Support

To determine if perceived social support influenced the degree to which individuals habituated to the second stressor, a series of 4 × 2 × 1 mixed ANCOVAs were conducted. As above, the within-subjects factor was phase with four levels (baseline, exposure 1, recovery, exposure 2) and the between-subjects factor was context (social versus control). The MSPSS score was entered as a covariate.

For SBP, after correcting degrees of freedom for sphericity ($W[5] = .64$, $p < .001$), the ANCOVA revealed a significant phase × context × social support interaction, $F(2.31, 198.73) = 3.19$, $p = .036$, partial $\eta^2 = .036$. Scrutiny of the within-subjects contrasts confirmed that while the linear effect was non-significant ($p = .11$) the corresponding phase × context ×

perceived social support cubic contrast was significant, $F(1,86) = 5.10$, $p = .036$, partial $\eta^2 = .056$. In order to graphically display this three-way interaction, the difference in reactivity to exposure 1 and reactivity to exposure 2 was computed. This involved subtracting reactivity to exposure 1 levels from reactivity to exposure 2 levels. Consequently, evidence of habituation is demonstrated by 0 to negative values while sensitization is evident on positive values. Two scatterplots are presented in Figure 1, demonstrating the association between SBP adaptation and perceived social support in the control group and in the social group, separately. As can be seen in Figure 1, social support was associated with effective habituation to the stressor in the control group only. When the context of the stressor was manipulated to enhance social threat, the adaptive effect of high social support disappeared.

The phase × context × perceived social support interaction was not evident on DBP, HR, CO, or TPR (all *p*s > .05).

Insert Figure 1 here

Discussion

The present study confirmed that healthy individuals demonstrate significant cardiovascular habituation on successive exposures to cognitive stress in the laboratory. In addition, perceived social support is associated with greater cardiovascular habituation, but only under socially-neutral conditions. When the context of the stressor is manipulated to highlight its socially-salient features, the cardio-protective benefit of social support is removed. This study highlights the importance of examining cardiovascular adaptation to stressors in the laboratory as well as suggesting that consideration of social context may have pertinent effects when scrutinizing associations between perceived social support and CVR.

The significant cardiovascular habituation demonstrated by participants on all cardiovascular parameters (SBP, DBP, HR, CO, and TPR) on second exposure to the stressor suggests that laboratory studies examining initial reactions to acute stress may overestimate the degree of physiological responsivity in daily life. Previously, research has shown that individuals demonstrate significant cardiovascular adaptation in the laboratory, both on successive exposure to the same stressors (e.g., Hughes, 2007b; Hughes et al., 2011; Kelsey, 1991) and within tasks (e.g., Frankish & Linden, 1991). These findings suggest that researchers employing a traditional reactivity protocol in the investigation of the physiological stress response should examine the pattern of reactivity demonstrated on subsequent exposures to the same stressor in the laboratory, as well as in response to novel stressors.

As in the present study, scrutiny of cardiovascular adaptation patterns on successive exposures to the same stressor may reveal important psychosocial moderators of the stress response. For example, Hughes et al. (2011) demonstrated that neuroticism influenced the degree of habituation exhibited in a sample of healthy females, with low levels of neuroticism associated with greater habituation. Likewise, Hughes (2007a) showed that levels of hostility influenced the degree of DBP habituation to recurrent stress. Together these studies indicate that examination of cardiovascular adaptation to repeated stress may be particularly revealing when examining potential psychosocial moderators of the stress response. Of course, with regard to social context and social support, it may be useful if future research accounted for neuroticism when examining the association between perceived social support and CVR under differing social contexts.

Perceived social support was associated with significant cardiovascular habituation in this female sample, a finding that echoes previous research. Examining patterns of cardiovascular adaptation, Hughes (2007b) demonstrated that social support was associated with significant cardiovascular habituation on second exposure to the same stressor in females only. However, the stressor employed by Hughes was entirely asocial in nature and the present study extended these findings, confirming earlier results, but also pointing towards the importance of the context of the stressor; social support was associated with a healthful cardiovascular response on repeated exposures to the same stressor (i.e., habituation), but only when the context of the stressor remained neutral. When a social dimension to the stressor was added, the beneficial effect of social support disappeared and instead, high social support tended to be associated with a sensitized blood pressure response to stress (see Figure 1).

This is interesting as it suggests that high perceived social support may only be associated with robust stress tolerance in socially neutral circumstances. Why this is the case, is unclear; however, it points towards a situation where social support renders positive influences when others are not present or in situations where others are not considered. For those in the social context group, the nature of the instructions emphasised comparison with others, which appeared to negate any positive influence social support had on physiological reactivity. Not only does this suggest that social support is contingent on social context it also highlights its importance in CVR research.

The use of a female-only sample, paired with use of a student-only-sample, limits the generalizability of the present study. Inclusion of males would allow direct comparison with the Hughes (2007b) study as well as offering examination of whether the protective effects of perceived social support on reactivity to asocial stress is restricted to females. However, due to practical considerations that made it difficult to recruit a sufficient number of biometrically-matched males, this was not possible. Future research could investigate if pertinent gender differences exist in the association between social support, social context, and CVR.

Of course, cardiovascular adaptation observed in the present study may be partially a result of decreased cognitive arousal as the experiment progressed. However, as the mental arithmetic task employed standardised flexibility, the task itself should have maintained a level of difficulty consistent with the participant's performance. While it is not likely that the demonstrated cardiovascular adaptation to recurrent stress is wholly attributable to a decrease in cognitive arousal, the possibility that it played a role cannot be ruled out. Of course, in itself, this represents an important finding of etiological significance that should be considered in future laboratory-based research employing the reactivity hypothesis as a guiding framework in stress responsivity studies.

Overall, the present study confirmed that examination of patterns of cardiovascular adaptation may be particularly pertinent when investigating potential psychosocial moderators of the physiological stress response. Perceived social support is one such moderator and this study highlights that consideration of stressor context is important when investigating the cardio-protective effects of social support in the laboratory. High perceived social support is associated with robust stress tolerance in socially-neutral circumstances; an effect that is negated under social contexts. Such findings highlight the damaging effects of social threat and its capacity to undermine the benefits of supportive relationships, particularly when stressors are acute and when threat is contemporaneous to stress exposure.

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Table 1. Mean (with *SD*) cardiovascular parameters during each phase of the procedure

	Phase									
	Resting		Exposure 1		Recovery		Exposure 2			
							Experimental Group			
							Social Threat Group ($n = 46$)		*Control Group* ($n = 44$)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
SBP[a]	120.62	13.83	130.27	15.38	123.12	13.84	131.18	16.12	127.42	13.69
DBP[a]	70.57	8.63	77.27	9.52	72.55	8.48	79.02	10.22	75.65	8.58
HR[b]	81.12	10.13	88.44	12.37	78.62	10.01	83.00	11.22	83.98	9.74
CO[c]	5.99	1.11	6.87	1.48	5.87	1.12	6.27	1.34	6.39	1.42
TPR[d]	.92	.15	.90	.17	.96	.17	.95	.16	.94	.19

Notes: [a]mmHg; [b]bpm; [c]lpm; [d]pru

Figure 1. Association between perceived social support and systolic blood pressure (SBP) adaptation. SBP is measured in millimetres of mercury (mmHg). Linear trend (with mean confidence intervals) are indicated. Positive values indicate sensitization and negative values indicate habituation.