NEGATIVE EMOTIONS AND ACUTE PHYSIOLOGICAL RESPONSES TO STRESS[1,2]

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ABSTRACT

One pathway through which stressors are thought to influence physiology is through their effects on emotion. We used meta-analytic statistical techniques with data from nine studies to test the effects of acute laboratory stressors (speech, star mirror-image tracing, handgrip) on emotional (undifferentiated negative emotion, anger, anxiety) and cardiovascular (CV) response. In all of the studies, participants responded to stressors with both increased CV response and increased negative emotion. Increases in negative emotion were associated with increases in CV response across tasks, however, these associations were small. The range of variance accounted for was between 2% and 12%. Thus, the contribution of negative emotion, as assessed in these studies, to physiological responses to acute laboratory stressors was limited. Although these results raise questions about the role of emotion in mediating stress-elicited physiological responses, the nature of the acute laboratory stress paradigm may contribute to the lack of a strong association.

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INTRODUCTION

The traditional psychological model of stress and disease suggests that we appraise the extent to which conditions in our environment are threatening, we react to appraised threats with negative emotion, and this emotion leads to physiological changes that may influence disease onset and progression (1–3). We commonly investigate these processes using acute laboratory stress models in which subjects are exposed to difficult cognitive, social, or psychomotor tasks such as mental arithmetic and public speaking (4). These models are thought to be successful since these tasks consistently elicit elevations in heart rate (HR) and blood pressure (BP) and in circulating levels of epinephrine and norepinephrine (5). Although we view these tasks as psychological stressors, other aspects of the tasks may contribute to the quantity and quality of physiological response. For example, stressor tasks have specific demand characteristics pulling for a cardiac output (CO) or total peripheral resistance (TPR) response due to underlying beta-adrenergic or alpha-adrenergic receptor activation (4). The specific cognitive (6) or attentional (7) foci associated with tasks may also contribute to distinct patterns of cardiovascular (CV) response. Hence, it is unclear whether these are appropriate models of psychological stress or are merely models of physiological arousal elicited by task characteristics independent of appraised stress and associated emotion.

Stressor tasks generally evoke both negative emotional and cardiovascular responses. However, few studies report on the degree of association between these responses. The magnitude of this association defines the maximal contribution of emotion to the relation between the stressor task and physiological response. In this investigation, we combine data from multiple studies to test the hypothesis that stressor-elicited increases in negative emotion mediate increases in CV response. We examine the strength of this association for nonspecific or undifferentiated negative emotion, as well as specific emotions such as anger and anxiety.

The data we report are based on nine studies of the effects of acute stressors on CV response conducted by investigators in the Pittsburgh community. We chose these studies because each includes measures of both CV and self-reported emotional response to an acute stressor. Although eight of the studies included in these analyses have been published, none of the original publications have explored the associations between CV and emotional response in the manner we were interested in. Because the complete data sets were made available to us, we were able to employ the same procedures in analyses across studies providing for maximal comparability. We used meta-analytic statistical techniques to combine data across studies. These techniques are often used in literature reviews to summarize data from a large number of studies (8). Our investigation differs from a traditional meta-analytic review in that we used these techniques to summarize results of a few specific studies.

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TABLE 1
Study Description

Emotion Measures	Study	Emotion Subscales (α)	Stressor Tasks	*N*	Sample Characteristics
Single Items	Allen et al. (1993)		Speech, Star, Handgrip	42	Young women (n = 22) and men (n = 20)
	Matthews et al. (1998)		Speech, Star	24	Young women
	Owens et al. (1993)		Speech, Star, Handgrip	46	Middle-aged women (n = 30) and men (n = 15)
	Stoney et al. (1997)		Speech, Star, Handgrip	32	Middle-aged women prior to reproductive surgery
POMS	Cohen et al. (1999)	Anger (α = .90) Anxiety (α = .85)	Speech	57	College women (n = 33) and men (n = 24)
	Marsland et al. (1995)	Anger (α = .79) Anxiety (α = .93) Depression (α = .69)	Speech	33	College men
SACL	Kamarck et al. (1998)				
	Sample 6	Stress (α = .88)	Speech	11	College women
	Sample 7	Stress (α = .82)	Speech	13	College women
	Lepore (1995)	Stress (α = .86)	Speech	52	College men (n = 26) and women (n = 26)

Note: POMS = Profile of Mood States Questionnaire; SACL = Stress/Arousal Adjective Checklist.

METHOD

Study Selection

Meta-analytic statistical techniques were used with data from nine acute laboratory stressor studies which met four criteria: (a) self-report measures of emotion were administered pretask and posttask, (b) CV measures were taken at baseline and during the task,[3] (c) studies that investigated moderators of the stress response (e.g. social support) included a control condition without the moderator variable, and (d) the stressor task was shared with at least three of the other studies. Our analyses are limited to those participants who were not subject to additional experimental manipulations. Information on measures of negative emotion, stressor tasks, sample size, and sample characteristics for each study are presented in Table 1. For more complete descriptions of study procedures, we refer readers to referenced articles (9–11[Samples 6 and 7],12–16).

Measures of Negative Emotion

Four studies used single-item measures of negative emotion (anxiety, irritation, happy [reverse-scored], and sad) (see Table 1). Items were scored on a scale from 1 (*not at all*) to 5 (*very much so*). We averaged across items to create a composite measure of undifferentiated negative emotion. Two studies used a modified version of the Profile of Mood States Questionnaire (POMS) (17), which includes subscales derived from factor analyses of adjectives in the original scale (see Table 1). Three subscales from this questionnaire assessed negative emotion including anxiety (e.g. tense, nervous, on edge), anger (e.g. hostile, angry, resentful), and depression (e.g. depressed, sad, unhappy). Participants indicated the extent to which they experienced each emotion on a scale anchored by 0 (*not at all*) and 4 (*extremely*). We averaged across subscales to create a composite measure of undifferentiated negative emotion. Three studies used the Stress/Arousal Adjective Checklist (SACL) (18), which is comprised of two subscales, the stress and arousal subscales (see Table 1). We used the stress subscale (e.g. uneasy, distressed) as a measure of undifferentiated negative emotion. Stress items were scored on a scale anchored by 0 (*definitely no*) and 3 (*definitely yes*). In eight studies, participants were asked to indicate the extent to which they were experiencing these emotions "right now" (prior to the task) and "during the task" (measured retrospectively posttask). However, one study (10) asked participants to report how they were feeling immediately after the task rather than during the task. Measures of anger and anxiety were also separately examined in the studies that included these measures.[4]

Stressor Tasks

Three types of stressor tasks were employed in the studies. The speech tasks typically involved completing a short preparation period and then delivering a videotaped speech regarding an embarrassing or stressful situation (e.g. getting caught shoplifting). The star mirror-image tracing task involved tracing the outline of a star-shaped figure with a pencil while looking at its reversed image in the mirror. The handgrip task required participants to place 30% of their maximal handgrip on a handgrip dynamometer for an extended duration. Performance was monitored by the experimenter to assure that the required handgrip strength was maintained.

Computation of Change Scores

To control for baseline differences in CV function, we regressed CV measures during each task onto corresponding CV measures at baseline and computed residual scores for each CV measure. Residual scores have been recommended over raw difference scores as estimators of change (19). Since many of the baseline negative emotion measures did not conform to normal distributions, residual analyses could not be performed. Thus, arithmetic change scores were computed for measures of negative emotion in all of the studies.

[3] In studies that employed multiple tasks, baseline CV measures were generally collected prior to and following each task. However, in one study (16), baseline CV measures were collected prior to the first task only. Thus, we used these measures as the baseline CV measures for subsequent tasks in the analyses.

[4] Six studies included both anger and anxiety measures (9,10,13–16), while three studies did not include these measures (11[Samples 6 and 7],12).

TABLE 2
Changes in CV Response from Baseline to Task

Task	*N*	SBP Baseline	SBP Task	DBP Baseline	DBP Task	HR Baseline	HR Task
Speech							
Allen et al. (1993)	42	108.5	116.3	70.7	73.1	67.8	69.9
Cohen et al. (1999)	57	108.1	127.9	62.7	76.7	64.8	80.9
Kamarck et al. (1998)							
Sample 6	11	108.1	130.2	59.4	78.0	72.3	88.7
Sample 7	13	106.4	133.8	58.4	80.7	79.0	103.4
Lepore (1995)	52	104.3	123.3	64.1	82.9	68.2	84.2
Marsland et al. (1995)	33	117.8	133.3	57.2	71.3	58.7	75.4
Matthews et al. (1998)	24	100.2	122.7	57.6	70.9	69.2	86.2
Owens et al. (1993)	46	108.8	132.7	71.0	82.7	66.2	81.3
Stoney et al. (1997)	32	109.7	132.2	71.8	85.9	70.8	86.4
Star							
Allen et al. (1993)	42	107.9	118.7	69.1	78.1	68.0	71.0
Matthews et al. (1998)	24	99.3	108.9	57.3	65.9	69.5	75.8
Owens et al. (1993)	46	108.3	122.2	70.3	78.8	67.3	74.5
Stoney et al. (1997)	32	109.7	123.3	71.8	80.8	70.7	77.6
Handgrip							
Allen et al. (1993)	42	109.1	126.3	71.0	83.9	67.3	73.5
Owens et al. (1993)	46	110.5	127.4	72.3	83.8	67.9	73.7
Stoney et al. (1997)	32	110.2	125.5	72.2	84.4	70.8	75.4

Note: All baseline to task changes are significant ($p < .01$).

ANALYSES

Overview

We used meta-analytic statistical techniques to combine data across the nine studies to address several questions. First, we examined whether participants responded to stressor tasks with increased negative emotion and CV response. Next, we estimated the size of stressor-elicited changes in negative emotion and CV response and compared the size of these changes across tasks. Finally, we examined the strength of association between stress-induced changes in negative emotion and CV response and compared the strength of association across tasks. We examined this association first with measures of undifferentiated negative emotion and then with measures of specific negative emotion (anger and anxiety). Although not a direct test of mediation, the correlation between change in emotion and change in CV response is an estimate of the maximal role of emotion in the association between stress and CV response.

Meta-Analytic Techniques

The Pearson's product–moment correlation coefficient (r) was used as the effect size (ES) estimate. In the analyses of change in emotion and CV response, an F-value was calculated and converted into a correlation coefficient (r) following procedures described by Rosenthal (8). Combined or mean ESs were computed by transforming each r into a Fisher's z coefficient, summing these zs, dividing the sum by the number of studies, and transforming the average Fisher's z back into an r (8).

RESULTS

Are There Stressor-Elicited Changes in Negative Emotion and CV Response?

Repeated measures analysis of variance (ANOVA) was used to assess within-subjects changes in CV response and emotion in each study (see Tables 2 and 3). In all cases, participants responded to tasks with increases in HR, systolic blood pressure (SBP), and diastolic blood pressure (DBP) ($p < .01$). Participants responded to all tasks with increases in negative emotion ($p < .01$) with the exception of one study (11[Sample 6]).

We were also interested in how much negative emotion was generated by the stressor tasks. The issue is whether these tasks elicit sufficient emotion to trigger CV response. To assess this, we examined the possible range of each scale in relation to the extent of emotion shown during the stressor (see Table 3). In 3 cases, the mean task negative emotion was above the midpoint of the emotion scales, while in 13 cases, the mean was below the midpoint. However, in 11 of the 16 cases, the responses during the stressor were within one point of the midpoint.

Tables 4–6 present results from the analyses that were conducted using meta-analytic statistical techniques. Each table specifies the number of studies in which relevant measures of CV response and emotion were assessed, the total number of subjects across studies, the mean ESs weighted for sample size, and the 95% confidence intervals. Because analyses of weighted and unweighted means showed equivalent effects in almost every case, we report results from only the weighted analyses. To assess the significance level of the ESs, the z statistic was computed (8).

Meta-analytic statistical techniques were used to assess the mean ES for stressor-elicited changes in CV response on each task (see Table 4). Mean ESs ranged from .81 to .87 on the speech task, .76 to .82 on the star task, and .67 to .84 on the handgrip task. These effects are considered large based on Cohen's (20) recommendation of values for small (.10), medium (.30), and large (.50) effects. Testing for differences between correlations, we found that the effects for speech on SBP and HR were larger than the effects for handgrip on SBP and HR ($p < .01$). Meta-analytic statistical techniques were also used to assess the mean ES for stressor-elicited changes in negative emotion on each task (see Table 4). The mean ESs were .74 on the speech task, .75 on the star task, and .62 on the handgrip task. Testing for differences between correlations, we found that the effect on the speech task was larger than the effect on the handgrip task ($p < .05$).

Thus, there were large and consistent increases in CV response across tasks with the variance accounted for ranging from 45% to 76%, although these changes were greater on the speech task than the handgrip task. There were also large and consistent increases in negative emotion across tasks with the total variance accounted for ranging from 38% to 56%, although these changes were greater on the speech task than the handgrip task.

Are Stressor-Elicited Changes in Negative Emotion Associated with Changes in CV Response?

Undifferentiated Negative Emotion: Across stressor tasks, increases in undifferentiated negative emotion were reliably associated with increases in BP and HR responses (see Table 5). There

TABLE 3
Changes in Negative Emotion from Baseline to Task

Task	Studies	N	Emotion Scale Range	Mean Baseline Negative Emotion	Mean Task Negative Emotion	F
Speech	Allen et al. (1993)	42	1–5	1.92	2.54	24.2**
	Cohen et al. (1999)	57	0–4	0.34	0.76	32.4**
	Kamarck et al. (1998)					
	Sample 6	11	0–3	0.72	1.25	1.7
	Sample 7	13	0–3	0.57	1.76	29.2**
	Lepore (1995)	52	0–3	0.62	1.73	126.3**
	Marsland et al. (1995)	33	0–4	0.33	1.08	35.0**
	Matthews et al. (1998)	24	1–5	1.73	2.68	41.3**
	Owens et al. (1993)	46	1–5	1.71	2.77	77.1**
	Stoney et al. (1997)	32	1–5	1.59	2.81	51.3**
Star	Allen et al. (1993)	42	1–5	1.92	3.05	54.4**
	Matthews et al. (1998)	24	1–5	1.73	2.69	53.6**
	Owens et al. (1993)	46	1–5	1.71	2.43	41.6**
	Stoney et al. (1997)	32	1–5	1.59	2.54	35.9**
Handgrip	Allen et al. (1993)	42	1–5	1.92	2.79	43.6**
	Owens et al. (1993)	46	1–5	1.75	2.19	25.8**
	Stoney et al. (1997)	32	1–5	1.59	1.94	8.6**

** $p < .01$.

TABLE 4
Change in CV Response and Negative Emotion from Baseline to Task (95% Confidence Intervals)

Task	Number of Studies	N	Cardiovascular Measure SBP	DBP	HR	Psychological Measure
Speech	9	310	.87** (.83–.89)	.86** (.83–.89)	.81** (.77–.85)	.74** (.68–.79)
Star	4	144	.82** (.75–.87)	.82** (.76–.87)	.76** (.68–.82)	.75** (.66–.82)
Handgrip	3	120	.76** (.67–.83)	.84** (.77–.89)	.67** (.56–.76)	.62** (.49–.72)

** $p < .01$.

were small to medium effects with mean ESs ranging from .13 to .16 on the speech task, from .23 to .32 on the star task, and from .24 to .34 on the handgrip task. Testing for differences between effects, we found that the ES for handgrip DBP was larger than the ES for speech DBP ($p < .05$). Otherwise, the sizes of the effects did not differ between tasks.

Overall, increases in undifferentiated negative emotion were associated with increases in CV response to stress. However, there were small to medium ESs with the total variance accounted for ranging between 2% and 12%. The strength of association generally did not vary across tasks.

TABLE 5
Relations Between Change in Undifferentiated Negative Emotion and Residual CV Response (95% Confidence Intervals)

Task	Number of Studies	N	Cardiovascular Measure SBP	DBP	HR
Speech	9	307	.16** (.05–.27)	.13* (.02–.25)	.14** (.02–.25)
Star	4	141	.25** (.09–.41)	.23** (.07–.39)	.32** (.16–.47)
Handgrip	3	120	.24** (.06–.41)	.34** (.17–.50)	.29** (.11–.45)

* $p < .05$, ** $p < .01$.

Specific Negative Emotion: Increases in anxiety were reliably associated with increases in BP and HR on the star and handgrip tasks (see Table 6). There were small to medium effects with mean ESs ranging from .22 to .30 on the star task and from .29 to .31 on the handgrip task. On the speech task, there were small associations between increases in anxiety and increases in SBP (.13) and HR (.15), but not DBP. Testing for differences between effects, we found that the ES for handgrip DBP was larger than the ES for speech DBP ($p < .05$). Otherwise, the sizes of the effects did not differ between tasks.

On the speech task, there were small associations between increases in anger and increases in SBP (.12) and DBP (.17), but not HR (see Table 6). On the star task, there were small associations between increases in anger and increases in SBP (.17) and HR (.16), but not DBP. On the handgrip task, there were medium associations between increases in anger and increases in DBP (.34) and HR (.25), but not SBP. Testing for differences between effects, we found that the ES for handgrip DBP was larger than the ES for star DBP ($p < .05$). Otherwise, the sizes of the effects did not differ between tasks.

Overall, the associations found between specific emotions and CV response were not stronger than those found with composite measures of negative emotion. There was also no evidence that anger or anxiety was associated with a particular pattern of physiological response. In the analyses with anxiety, there were small to medium ESs with the total variance accounted for ranging from 0.25% to 10%. In the analyses with anger, there were small to medium ESs with the total variance accounted for ranging from 0.64% to 12%. The strength of association generally did not vary across tasks.

DISCUSSION

Based on the traditional psychological model of stress and disease (1–3), it was hypothesized that stressor-induced negative emotional response was a primary mediator of increases in CV response to acute lab stressors. Across nine studies using three different stressor tasks, stressors consistently evoked increases in both negative emotion and CV response. Although negative emotion was generally associated with increases in CV response across tasks, it accounted for limited variability in CV response irrespective of the task. The maximum overlapping variance between changes in emotion and changes in CV response was 12%. The association between emotion and CV response was also weak when anger and anxiety were examined separately. Experimental studies on emotional imagery and CV activity suggest that

TABLE 6

Relations Between Changes in Specific Negative Emotion and Residual CV Response (95% Confidence Intervals)

Task	Number of Studies	*N*	SBP		DBP		HR	
			Anxiety	Anger	Anxiety	Anger	Anxiety	Anger
Speech	6	231	.13* (−.01–.26)	.12* (−.01–.25)	.05 (−.08–.18)	.17** (.04–.30)	.15** (.02–.28)	.09 (−.04–.22)
Star	4	141	.22** (.05–.37)	.17* (−.01–.33)	.22** (.05–.38)	.08 (−.09–.25)	.30** (.14–.45)	.16* (−.01–.32)
Handgrip	3	120	.29** (.11–.45)	.13 (−.06–.30)	.29** (.11–.45)	.34** (.16–.49)	.31** (.14–.47)	.25** (.06–.41)

$*p < .05$, $**p < .01$.

anger may be more strongly associated with increases in CV response than anxiety (21,22); however, emotional specificity in physiological responses was not evident here.

The failure to find evidence for affective mediation in these studies raises questions about the role ascribed to negative emotion as a primary mediator of physiological responses to stress (1–3). In the following sections, we discuss whether issues related to the measurement of emotion in acute stress studies may have contributed to the lack of association found between negative emotion and CV responses to stress, alternate processes that may be linking stressors to CV response in acute stress studies, conditions under which there may be a tighter coupling between emotional and CV responses to stress, and limitations of this investigation that need to be considered in interpreting these findings.

Methodological Issues in the Measurement of Emotion

A general problem in the measurement of emotion is that it may be difficult to detect and report on these subjective states accurately given their short duration (23). It has also been suggested that some emotional experiences may be unconscious making them impossible to measure (24,25); however, this is a highly debated issue (26). If we assume, for the moment, that emotions are conscious processes on which individuals report, what are the limitations of the way in which emotion is measured in acute stress studies?

In acute stress studies, emotions are generally compared pretask to posttask in order to measure emotional responses without interfering with task performance. One weakness of this approach is that physiological responses temporally precede the reporting of posttask emotions. As a consequence, the association between emotion and physiological responses can be attributed to physiological responses leading to the reporting of emotion (27). The use of retrospective measures also requires that individuals summarize their emotional experiences over time and report on their average mood retrospectively (28). To reduce the biases associated with retrospective measures, real-time assessment procedures could be employed in these studies, such as electromyographic (EMG) ratings of facial activity (29) and observer ratings of facial expressions (30,31). These measures of emotion also control for response biases potentially associated with self-report, such as the social desirability bias and extreme response styles (32).

Our data, however, suggest that adjective checklists are valid measures of negative emotion in these studies. For example, stress accounted for a substantial amount of variance (as much as 56%) in negative emotion. The magnitude of stressor-elicited change in negative emotion appeared large enough to examine the association between negative emotion and CV responses to stress.

Alternative Pathways

To the extent that negative emotion was assessed in a valid manner and still did not mediate stress-elicited CV responses, it is important to discuss alternate processes that may contribute to the association between exposure to acute stress and CV responses. It has been suggested that characteristics of acute lab stressors may influence CV responses independent of emotional processes (6,7). For example, the degree to which tasks involve active coping has been linked to patterns of CV response (6). Active coping, or the exertion of mental effort to influence the outcome of a task, has been associated with a beta-adrenergic pattern of sympathetic nervous system (SNS) reactivity (e.g. increased SBP and HR and a decline in TPR) (33,34). In our analyses, the speech task may have led to greater increases in SBP and HR than the handgrip task, because it requires greater active coping, or mental effort, than the handgrip task which is more of a physical stressor. Alternatively, it may be the specific physical demands associated with these tasks (i.e. vocalization during speech versus squeezing on a handgrip dynamometer) that contributed to differences in CV response (35). Given that these tasks differ in multiple ways, it is difficult to identify the specific coping requirements underlying task differences in CV response. However, we view it as important to recognize that there may be cognitive and behavioral demands associated with tasks that contribute to physiological response independent of emotional processes.

Moderators of the Association Between Negative Emotion and CV Response

Although the overall association between negative emotion and physiological responses to stress may be small, there may be a tighter coupling of these responses in some individuals (36). For example, high CV reactors (in the laboratory) show an association between daily diary reports of negative emotion and ambulatory BP responses, whereas low CV reactors do not show this association (37). However, it was unclear whether emotional and ambulatory BP responses were related to stressor exposure since exposure was not measured. Individual differences in traits may also moderate the relation between negative emotion and CV response to stressors. For example, cynically hostile individuals show a greater association between negative emotion and CV responses to laboratory stress than that found with less hostile individuals (38–41). Although the cause of these differences is unknown, it has been suggested that deficiencies in serotonergic function underlie increased negative emotion and increased SNS activity found in hostile individuals (42).

Contextual factors may also moderate the strength of association between negative emotion and CV response to stress (36,43).

Naturalistic lab stressors may evoke stronger emotional responses and reveal a stronger association between emotion and physiological responding than cognitive and behavioral challenges in the laboratory, particularly those that are not explicitly designed to alter emotional states. However, two studies that examined the association between negative emotion and CV response to stress in the context of a marital interaction task did not show stronger associations than those observed here (39,44).[5] This may be due to the use of coping strategies that couples develop over time to adapt to these situations (2); however, coping was not measured in these studies. Studies conducted in the field have shown that negative emotional states and ambulatory blood pressure (ABP) tend to covary during daily life, although exposure to stress is not measured in these studies and thus it is unclear whether emotion is mediating the effects of daily stress exposure on physiology (37,45–49).

Limitations

The generalizability of our findings may be limited due to the nature of the samples. Although samples varied in terms of age, gender composition, and whether they were recruited from the community versus campus, they were primarily Caucasian and had a high school or higher level of education. While it would be ideal to obtain data from a large number of studies or other communities, we had to rely on data that were made available to us to conduct the analyses of interest. Another important issue is whether a stronger association between negative emotions and CV responses to stress may be found if this relation was assessed within-subjects rather than between-subjects. The between-subject approach assumes that specific increments in negative emotion yield specific changes in CV response across subjects. The assumption of the within-subject approach is that the amount of change in negative emotion required to obtain a specific change in CV response may vary across individuals. Only small changes in emotion may be required to trigger specific CV responses in some, but large changes may be required to trigger the same response in others. Implementing the within-subject approach may be difficult in the laboratory. It requires multiple assessments of emotion and CV response and these repeated assessments are difficult to implement without interfering with task performance and sensitizing subjects to the purpose of the study. However, ecological momentary assessment (EMA) methods (50) and ABP monitoring techniques provide valuable tools for assessing within-subject change in negative emotion and CV response in the field.

CONCLUSIONS

The findings suggest that negative emotions play a small role in physiological responses to acute laboratory stressors. Negative emotions appear to be a sufficient, although not a necessary, cause of physiological responses to stressors in acute laboratory stress studies. Our confidence in this assertion comes from the examination of this association across stressor tasks and studies. However, further research is needed to assess whether the lack of evidence for affective mediation is attributable to limitations of the acute stress paradigm or is a generalizable finding when these processes are assessed within-subjects and across contexts.

[5] The reported correlations were small and nonsignificant with the exception of a correlation found between increases in anger expression and increases in SBP ($r = .44, p < .01$) among husbands in one study (39).

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