Effects of a Supportive or an Unsupportive Audience on Biological and Psychological Responses to Stress

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Although social support is related to substantial benefits for health and well-being, research has uncovered qualifications to its benefits. In a test of the psychological and biological impact of an audience on responses to laboratory stress challenges, 183 participants going through the Trier Social Stress Test experienced either (a) an unsupportive audience, (b) a supportive audience, or (c) no audience. Both audience conditions produced significantly stronger cortisol, heart rate, and blood pressure responses to the stress tasks, relative to the no-audience control, even though the supportive audience was rated as supportive. Contrary to hypotheses offered by several theories, these effects were not moderated by self-esteem, individual differences in psychological resources, or baseline social support. Psychological resources and baseline social support were, however, tied to more beneficial biological and psychological profiles at baseline and at recovery in some cases. It was concluded that when one must perform stressful tasks in front of an audience, evaluative concerns may outweigh the potential benefits of a supportive audience.

Keywords: stress, social support, biological stress responses, psychological resources

Supportive social contact with others is one of human beings' greatest resources. Social support is defined as the perception or experience that one is loved and cared for by others, esteemed and valued, and part of a social network of mutual assistance and obligations (Wills, 1991). Contacts with others and participation in social groups have been tied to a broad array of mental and physical health benefits. In times of stress, social support can reduce psychological distress, such as depression or anxiety; reduce autonomic and neuroendocrine stress responses; and promote psychological adjustment to chronically stressful conditions, as numerous reviews reveal (e.g., Taylor, 2007; Thoits, 1995; Thorsteinsson & James, 1999; Uchino, Cacioppo, & Kiecolt-Glaser, 1996).

However, some qualifications to these beneficial effects have recently emerged. Social support of the wrong kind or from the wrong person, for example, can exacerbate stressful circumstances (e.g., Cohen & Wills, 1985). Bolger and colleagues (Bolger & Amarel, 2007; Bolger, Zuckerman, & Kessler, 2000) have suggested that invisible support, namely, support provided by a person without the recipient's awareness, may be more beneficial to the emotional functioning of a recipient in stressful times than social support efforts that are recognized by both the giver and the recipient as intended. Awareness that one is being supported by others can represent a threat to self-esteem, because it implies that one is unable to manage stressful circumstances on one's own (Bolger et al., 2000). Bolger's theoretical position is psychological in orientation, addressing distress in the context of social support transactions. An additional important question is whether the receipt of social support can exacerbate biological indicators of stress, such as autonomic reactivity (e.g., heart rate and blood pressure) and hypothalamic–pituitary–adrenal (HPA) axis responses to stress. Given that the beneficial effects of social support have generated literally hundreds of social support interventions to help people cope with stressors and trauma (e.g., Helgeson & Cohen, 1996; Taylor, 2007), understanding the circumstances under which social support exacerbates stress is an important issue.

Potential Moderators of Efforts to Provide Social Support on Stress Responses

Several factors may moderate the impact of efforts to provide social support on biological and psychological stress responses. These include psychological resources, such as self-esteem, and social resources, such as an enduring sense of social support.

Psychological resources refer to personal dispositions that help people perceive potentially threatening events as less so or help

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This research was supported by Grant SES-0525713 from the National Science Foundation.

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Journal of Personality and Social Psychology, 2010, Vol. 98, No. 1, 47–56
 0022-3514/10/$12.00 DOI: 10.1037/a0016563

them to manage their responses to events perceived to be threatening. Both laboratory and field investigations have shown that psychological resources are associated with reduced psychological and biological responses to stress (e.g., Ryff & Singer, 1996; Taylor et al., 2008; Taylor, Lerner, Sherman, Sage, & McDowell, 2003). Among the resources most reliably related to these beneficial outcomes are optimism, mastery, and self-esteem. Typically measured by the revised Life Orientation Test (Scheier, Carver, & Bridges, 1994), optimism refers to outcome expectancies that good things rather than bad things will happen to the self (see Carver & Scheier, 2002, for a review). Personal control or mastery refers to whether a person feels able to control or influence his or her outcomes, and research suggests a relationship between a sense of mastery and both better psychological and better physical health outcomes (e.g., Seeman & Lewis, 1995; Thompson, 1981). A positive sense of self is also protective against adverse mental and physical health outcomes. Self-esteem is consistently tied to better psychological well-being and to lower biological reactivity to stressful events (e.g., Creswell et al., 2005; Taylor et al., 2003). Because of their conceptual and empirical overlap, these individual differences are often treated as a composite of psychological resources (e.g., Creswell et al., 2005; Taylor et al., 2003).

Although psychological resources typically benefit people in times of stress, the arguments raised by Bolger and colleagues (Bolger & Amarel, 2007; Bolger et al., 2000) suggest potential qualifications to these effects. Specifically, when social support is provided by others, people with high levels of psychological resources may be especially distressed as a result of self-esteem threat, rather than comforted. However, an alternative hypothesis can be derived from Brown's research on self-esteem. Brown and McGill (1989) offered an identity disruption model of stress that holds that stressful experiences inconsistent with the self-concept lead to emotional and physical health risks. For example, their studies showed that desirable life changes were associated with increases in illness among those with low self-esteem; among people with high self-esteem, positive events were linked to better health. Following from this logic, it may be that social support from others, especially in the form of positive feedback, is a benefit expected by people high in self-esteem but inconsistent with identity for those low in self-esteem. The present research provided an opportunity to test these two perspectives.

With respect to social resources, people who already have a strong sense of social support may not be additionally benefitted by social support during stress. That is, the experience of social support is not only the result of specific supportive transactions but also represents a stable view that the world is supportive and that others are available to provide help or emotional solace, should that be needed. From this vantage point, social support may be more in the perception of it than in the use of it. Indeed, research suggests that perceived social support without its enactment confers many of the psychological and biological benefits typically attributed to social support transactions (Thoits, 1995). Accordingly, the hypothesis can be ventured that perceived social support is more beneficial for coping with stressful events than the actual receipt of social support and that people chronically high in perceived social support may experience supportive efforts by others as neutral or even aversive (cf. Bolger & Amarel, 2007).

Overview of Research

To address these issues, we conducted a multipart investigation. Participants first completed individual difference measures online. They then reported their experiences of socially supportive or unsupportive interactions each day of a 9-day period using a daily diary format. At the end of this time, they participated in standardized laboratory stress tasks from the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993), under one of three conditions: observation by an unsupportive audience, the typical paradigm of the TSST designed to enhance stress; a no-audience control condition in which the tasks were completed in the presence of an experimenter sitting off to the side and out of direct view; or a supportive audience condition in which audience members expressed nonverbal indications of positive feedback for the person going through the stressful tasks, as by forward leaning, nodding, and smiling.

The social support literature would predict that biological and psychological stress responses would be lower in the positive audience condition, relative to the negative audience condition and the control group. However, Bolger and colleagues' (Bolger & Amarel, 2007; Bolger, Zuckerman, & Kessler, 2000) analysis and evidence would predict elevated biological and psychological stress responses in the positive audience condition as well as the negative audience condition, relative to the control group.

Research on psychological resources consistently suggests that they provide benefits in stressful times. To the extent that people high in dispositional psychological resources expect more of the same, social support in the form of positive feedback may be consistent with these expectations and thus the benefits of social support would accrue to those with stronger rather than weaker psychological resources (cf. Brown & McGill, 1989). However, the reasoning of Bolger and colleagues described above (Bolger et al., 2000) suggests a different hypothesis: Under circumstances in which people are the obvious recipients of help from another person, those with more psychosocial or social resources might experience the support as a threat to self-esteem and thus be less benefitted than those with low psychosocial resources.

Method

Participants

Students and employees at a large university responded to an ad offering $120 in return for participating in the study. Prospective participants with the following conditions were excluded: mental or physical health problems, use of medications affecting cardiovascular or endocrine function, current treatment from a mental health professional, diagnosis of posttraumatic stress disorder, and current use of mental health–related medications (e.g., Prozac). In addition, because the study required neuroendocrine measures, pregnant and lactating women were excluded. One hundred eighty-three participants (71 men and 112 women) constituted the final sample. All were affiliated with the university as students, employees, or both. Participants ranged in age from 18 to 35 years, with a mean age of 21.3 years. The sample was 2% African American, 37% Asian American, 22% European American, 16%

Latino, and 23% mixed, a pattern that reflects the composition of this university.[1]

Questionnaire Session

Participants logged in to an online computer laboratory and completed informed consent forms and individual difference measures. The psychological resource measures included the revised Life Orientation Test (Scheier, Carver, & Bridges, 1994), a measure of dispositional optimism; the Rosenberg Self-Esteem Scale (Rosenberg, 1965); and the Pearlin Mastery Scale (Pearlin & Schooler, 1978). A principal components factor analysis with a varimax rotation confirmed that these three measures constituted a meaningful psychological resources factor with acceptable reliability ($\alpha = .81$) when averaged together.

The social resources measures included the UCLA Loneliness Scale (reverse coded; Russell, Peplau, & Cutrona, 1980), the Extraversion scale of the Eysenck Personality Inventory (Eysenck & Eysenck, 1975), and the Social Rejection Scale (reverse coded; Mehrabian, 1976). A principal components factor analysis with a varimax rotation confirmed that these three measures constituted a meaningful social resources factor with acceptable reliability ($\alpha = .64$) when averaged together.

Daily Experience Sampling Methodology

To assess social support during daily social interactions, we loaned participants a PalmOne Zire 31 running the Experience Sampling Program (Barrett & Barrett, 2000), which administered the relevant questions. Over the course of a 9-day period, participants were randomly signaled at different times during the day to answer questions on the PalmOne Zire 31 regarding the supportiveness of their most recent social interaction partner.[2]

Participants were asked to identify their relationship with the interaction partner, the person's gender, and the approximate length of the interaction. To enable us to assess experiences of social support, participants were asked to rate, on 7-point scales, the extent to which the person was someone that they perceived to be generally *not close to me* (1) or *close to me* (7), *threatening* (1) or *comforting* (7), and *unsupportive* (1) or *supportive* (7). These ratings were summed across the three questions for all interactions across all days to yield a measure of daily general support ($\alpha = .67$). Participants were also asked to rate, on 7-point scales, the extent to which, during the interaction, their most recent interaction partner was *threatening* (1) or *comforting* (7) and *unsupportive* (1) or *supportive*. These ratings were summed across the two questions for all interactions across all days to yield a measure of daily partner support ($\alpha = .80$). Finally, participants were asked to rate, on 7-point scales, the extent to which, during the interaction, they felt *disconnected* (1) or *connected* (7), *rejected* (1) or *accepted* (7), *distressed* (1) or *calm* (7), and *anxious* (1) or *comfortable* (7). These ratings were summed across the four questions for all interactions across all days to yield a measure of daily specific support ($\alpha = .92$).

Participants were signaled eight times per day. Of these eight signals, participants did not respond to approximately two signals ($M = 2.33$) and indicated that they had had no new interaction after approximately two signals ($M = 1.68$). On average, they completed approximately four assessments of social support per day ($M = 3.82$).

Stress Challenge Tasks and Procedures

Within 4 days of completion of the daily diaries, participants reported to the university's General Clinical Research Center for the second part of the study. Sessions were scheduled in the mid- to late afternoon to control for diurnal variation in cortisol (Van Cauter, Leproult, & Kupfer, 1996).

Setting and apparatus. Participants sat at a table adjacent to cardiovascular recording equipment and directly in front of a video camera. A Critikon Dinamap Vital Signs Monitor Model 1846SX (Tampa, FL) automatically and continuously recorded heart rate and blood pressure every 2 min throughout the laboratory session. The physiological readings were not visible to the experimenter until printed out by the Dinamap printer.

Rest and stress-challenge tasks. When participants arrived at the laboratory, they were screened for the laboratory portion of the study and gave a first saliva sample after 10 min. A passive drool method was used to collect saliva in a 2.0 ml Corning cryovial (Corning, Inc., Corning, NY). Saliva samples were immediately placed on ice and transferred within the next few minutes to a freezer. The nurse then inserted an indwelling catheter and took a blood draw. After a 30-min screening for medical problems, a second saliva sample and oral mucosal transudate sample (OMT; cheek scrapings) were collected. Participants were then fitted with a blood pressure cuff and completed a pretask Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988).

Each participant then took part in the TSST, a widely used laboratory stress challenge known to elicit autonomic and HPA

[1] In addition to the 183 participants who completed the entire protocol, 16 participants were discontinued during the course of the laboratory stress tasks. Eight could not be fitted with catheters, 2 showed blood pressure increases that exceeded safety guidelines, 4 showed adverse vasovagal reactions, and 2 asked to discontinue the procedures.

[2] Social interactions were defined as any interaction with one or more individuals that lasted for 5 min or longer, but not including e-mail or Web-based interactions. Participants were given a limited amount of time to respond to each signal; if they did not respond during that time, the PalmOne Zire 31 turned off. If participants responded to a signal within the time window, they were first asked whether they were able to complete an interaction entry; if participants answered no, the PalmOne Zire 31 turned off. If they answered yes, they were then asked if they had had a new interaction since the last signal. If participants answered no, the questionnaire ended; if participants answered yes, they completed the questionnaire and could not return to previously answered questions. Again, if participants did not respond to a question item within a certain time window, the PalmOne Zire 31 turned off, preventing participants from returning to a questionnaire at a later point in time. The PalmOne Zire 31 was set so that it would signal participants only during hours when they reported they would typically be awake. Participants were also told that they could turn off the volume on the PalmOne Zire 31 when they could not be disturbed. Consequently, participants were signaled frequently to ensure that enough assessments were collected when the PalmOne Zire 31's volume was on. To obtain approximately four daily assessments, we set the PalmOne Zire 31s to go off at eight different times during the day (regardless of when the volume was on or off). Similar techniques have been validated and used widely (Reis & Gable, 2002).

axis stress responses (Kirschbaum et al., 1993). Participants were first asked to prepare and deliver a speech on why they would be a good administrative assistant, a popular campus job for students and employees, under one of three conditions. In the no-audience condition, participants simply delivered the speech to the experimenter, who sat off to the side and out of direct view of the participant. In the negative audience condition, two members of an evaluative panel gave nonverbal indications of frustration over the quality of the speech. They indicated nonverbal signs of boredom and exchanged glances with each other that communicated mutual negative assessments. This manipulation represents a slightly stronger version of the standardized audience condition for the TSST. In the positive audience condition, the two audience members leaned forward, smiled, and gave nonverbal indications of support. They occasionally exchanged glances with each other that communicated mutual positive assessments, and when they were not explicitly communicating positive assessments, their demeanor communicated interest in what the participant was saying. The two audience conditions mirrored each other precisely in terms of the timing and type of feedback, with the exception that the nonverbal feedback was positive in one condition and negative in the other. All panels included one man and one woman, and measures were taken to ensure the participant and audience members were unacquainted.

In all three conditions, the experimenter had been instructed to sit off to the side and out of direct view of the participant and to give no verbal or nonverbal indications of positive or negative reactions to the participant's performance. The experimenter was blind to the hypotheses and blind to the audience condition until the audience began to demonstrate its supportiveness or lack of support; after this point, the experimenter had minimal contact with the participant except to distribute and collect questionnaires.

Participants then completed difficult mental arithmetic tasks, specifically, counting backward by 7s and by 13s from 2,935 out loud, during which time they were urged by the experimenter to try to go faster. Participants in the two audience conditions completed these arithmetic tasks in the presence of the audience, and participants in all conditions were videotaped.

Approximately 25 min after the commencement of the TSST, participants provided a third saliva sample and a second OMT sample and blood sample. This time lag falls within the recommended window for observing stress-related increases in cortisol (Kirschbaum et al., 1993). Participants then completed posttask questionnaires, including the posttask PANAS, after which a fourth saliva sample was collected. Levels of cortisol from the third and fourth saliva samples were averaged to assess cortisol response to the task. A 45-min recovery period then took place, after which the fifth (recovery) saliva sample was taken as well as a third OMT data collection and blood draw. This time lag is typically associated with significant declines in cortisol levels from peak stress, although not always with full return to baseline. The participant was then debriefed and dismissed.

Salivary Cortisol Assay Procedures

Saliva samples were shipped for overnight delivery on dry ice to the Behavioral Endocrinology Laboratory at Pennsylvania State University where the cortisol assays were conducted. Salivary cortisol levels were determined from a 25-μl sample, which was assayed in duplicate by radioimmunoassay using the HS-cortisol High Sensitivity Salivary Cortisol Enzyme Immunoassay Kit (Salimetrics LLC, State College, PA). The HS-cortisol assay allows for robust results when the saliva samples have a pH within the range of 3.5–9.0. All samples were within this pH range.

Results

Preliminary Analyses

As a manipulation check, we examined whether the TSST was effective as a stressor by conducting a repeated-measures analysis of variance, with one within-subjects factor of three levels (baseline, peak, and recovery cortisol). This test was significant, $F(2, 364) = 46.424$, $p < .001$, $\eta_p^2 = .203$, indicating a significant difference among cortisol levels at baseline, peak, and recovery. Planned two-way comparisons revealed significant differences between baseline and peak cortisol ($p < .001$) and between peak and recovery ($p < .001$; see Table 1).

To assess whether the TSST reliably increased heart rate, we compared baseline heart rate (averaged across baseline readings) with stress task heart rate (averaged across the tasks) with recovery heart rate (averaged across recovery). A main effect for time showed strong differences in heart rate across the three time periods, $F(2, 364) = 433.471$, $p < .001$, $\eta_p^2 = .704$. Heart rate increased substantially from baseline to the stress tasks ($p < .001$), returning to baseline during recovery ($p < .001$; see Table 1).

To assess whether the TSST reliably increased blood pressure, we compared the average of the two baseline blood pressure readings with the average of the two task blood pressure readings and the average of the recovery blood pressure readings for systolic and diastolic blood pressure separately. There was a significant effect for time, $F(2, 364) = 845.554$, $p < .001$, $\eta_p^2 = .823$, indicating that systolic blood pressure increased significantly from baseline to peak stress ($p < .001$) and declined again during recovery ($p < .001$); there was a significant difference between baseline systolic blood pressure and recovery as well (recovery is higher; $p < .001$). There was also a significant effect for time, $F(2, 364) = 1{,}136.196$, $p < .001$, $\eta_p^2 = .862$, for diastolic blood pressure reflecting the same pattern of increase from baseline to peak stress ($p < .001$), a decline again during recovery ($p < .001$), and baseline to recovery difference ($p < .001$). Thus, the TSST was an effective stressor (see Table 1) from which recovery was incomplete.

Table 1
Mean Ratings of Affect and Biological Measures by Time

Measure	Baseline	Task	Recovery
Cortisol	0.150_a	0.244_b	0.154_a
Heart rate	67.810_a	84.263_b	68.458_a
Systolic blood pressure	103.258_a	131.458_b	108.807_c
Diastolic blood pressure	59.038_a	78.567_b	63.097_c
PANAS			
Positive affect	3.423		3.346
Negative affect	1.725		1.535

Note. Means within rows not sharing subscripts are significantly different from each other. PANAS = Positive and Negative Affect Schedule.

We next examined whether the positive audience condition was, in fact, perceived to be supportive, relative to the negative audience condition, by averaging the answers to three posttask questions answered on 7-point scales: "How supportive (7) or hostile (1) did the panel seem to you initially?" "How receptive do you think the panel was to your presentation?" and "By the time your speech was over, how supportive (7) or hostile (1) did the panel seem?" ($\alpha = .92$). The positive audience condition was rated as significantly more supportive ($M = 5.316$, $SD = 1.084$) than the negative audience condition ($M = 2.678$, $SD = 0.959$), $F(1, 116) = 196.190$, $p < .001$, $\eta_p^2 = .628$. We also examined whether psychological resources and social resources were associated with how the positive audience condition was perceived. The only significant relation was between psychological resources and perceived social support, $r(59) = .289$, $p < .027$: People with greater psychological resources perceived the positive audience to be more supportive.

Cortisol Analyses

To test the effects of the audience manipulation on cortisol responses to the stress tasks, we conducted a 3 × 3 analysis of variance, with condition (positive, negative, no audience) as the between-subjects variable and time of cortisol measure as a repeated measure. In addition to the time main effect just reported, the analysis revealed a significant interaction between condition and time, $F(4, 360) = 6.167$, $p < .001$, $\eta_p^2 = .064$. As Figure 1 shows, peak cortisol responses to the TSST were highest in the supportive audience condition ($M = .313$, $SD = .285$), somewhat lower in the negative audience condition ($M = .251$, $SD = .166$), and lowest in the no audience condition ($M = .175$, $SD = .122$). Individual comparisons revealed that both the positive audience peak cortisol level ($p < .001$) and the negative audience peak cortisol level ($p < .036$) were significantly different from the no-audience peak cortisol level; the difference between the positive and negative audience peak cortisol levels approached significance ($p = .099$).

To ensure that the results were not distinctive to a particular gender or cultural group, we conducted follow-up analyses. Although men had slightly higher cortisol levels than did women ($F < 1$), the pattern was the same for both men and women. We also examined responses for the two largest cultural groups, Asian Americans ($n = 68$) and European Americans ($n = 41$): Although the cortisol levels for Asian Americans were slightly higher ($F < 1$), the pattern of means was the same for both groups. To ensure that variability in baseline cortisol levels did not contribute to the results, we reexamined the peak cortisol effects by condition, controlling for baseline; the comparison continued to be significant, $F(2, 179) = 8.212$, $p < .001$.

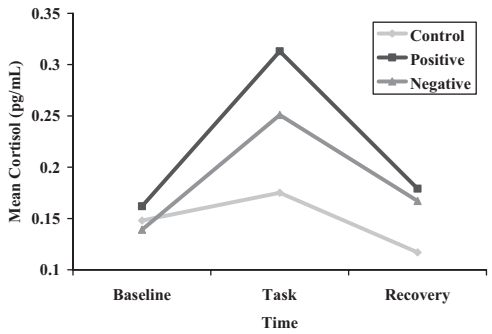

Figure 1. Cortisol levels as a function of audience condition and time.

Autonomic Reactivity

Heart rate. To examine whether heart rate increases varied by condition, we conducted a 3 × 3 analysis of variance with condition (positive, negative, no audience) as the between-subjects variable and time as the repeated measure. In addition to the time main effect, there was a significant Condition × Time interaction, $F(4, 360) = 8.152$, $p < .001$, $\eta_p^2 = .083$, indicating that the increase in heart rate was highest in the negative audience condition ($M = 87.220$, $SD = 14.688$), at an intermediate level in the positive audience condition ($M = 85.153$, $SD = 11.829$), and at its lowest in the control condition ($M = 80.415$, $SD = 13.668$). Individual comparisons among conditions revealed a significant difference only between the negative audience condition and the control condition ($p < .006$) during the stress tasks; the difference between the positive audience condition and the control condition approached significance ($p < .052$). There was no main effect of gender, nor were the effects significantly moderated by gender. When the two largest cultural groups were compared (Asian Americans and European Americans), there was a significant interaction between time and culture, $F(2, 206) = 5.317$, $p < .006$, and a significant three-way interaction, $F(4, 206) = 2.504$, $p < .044$. Inspection of the means revealed that European Americans had somewhat higher heart rates than did Asian Americans during the stress tasks, a pattern that was especially pronounced in the positive audience condition.

Blood pressure. A 3 × 3 analysis of variance revealed a significant Condition × Time interaction, $F(4, 360) = 7.865$, $p < .001$, $\eta_p^2 = .080$, indicating that the increase in systolic blood pressure was especially pronounced in the audience conditions relative to the control condition. Individual comparisons revealed significant differences between the positive audience condition ($M = 134.831$, $SD = 15.593$) and the control condition ($M = 126.185$, $SD = 18.068$), $p < .006$, and between the negative audience condition ($M = 133.441$, $SD = 17.810$) and the control condition, $p < .02$, during the stress tasks. No other individual difference comparisons were significant. The results were unqualified by gender, although men had significantly higher ($M = 117.127$, $SD = 10.662$) systolic blood pressure than did women ($M = 103.455$, $SD = 10.014$), $F(1, 177) = 72.782$, $p < .001$. When the two main cultural groups were compared, a main effect for culture was found such that European Americans' systolic blood pressure responses to the tasks were higher ($M = 112.976$, $SD = 12.795$) than Asian Americans' ($M = 107.235$, $SD = 10.441$), $F(1, 103) = 6.681$, $p < .012$.

A 3 × 3 Condition × Time analysis of variance was also conducted for diastolic blood pressure. A significant Condition × Time interaction, $F(4, 360) = 6.654$, $p < .001$, $\eta_p^2 = .069$, indicated that the increase in diastolic blood pressure was more pronounced in the audience conditions than in the control condition. Individual comparisons revealed that during the stress tasks, diastolic blood pressure was significantly higher in the positive audience condition ($M = 80.356$, $SD = 7.124$) relative to the

control group ($M = 75.954$, $SD = 8.289$), $p < .005$, and between the negative audience condition ($M = 79.390$, $SD = 8.684$) and the control group, $p < .022$. No other individual difference comparisons were significant. There was no main effect or moderation of the diastolic blood pressure effects by gender or culture.

Affect Ratings

The PANAS items had been split into two parts, and half had been administered before the TSST and half administered after to enable a repeated-measures analysis. A 3 (condition) × 2 (time) × 2 (affect valence) analysis of variance revealed a main effect of affect valence such that participants reported less negative affect ($M = 1.631$, $SD = 0.500$) than positive affect ($M = 3.382$, $SD = 0.663$), $F(1, 180) = 666.060$, $p < .001$, $\eta_p^2 = .787$. Additionally, there was a main effect of time such that participants reported more affect overall in the pretask PANAS ($M = 2.574$, $SD = 0.352$) than in the posttask PANAS ($M = 2.439$, $SD = 0.433$), $F(1, 180) = 55.517$, $p < .001$, $\eta_p^2 = .236$. A significant Time × Affect Valence interaction, $F(1, 180) = 9.911$, $p < .003$, $\eta_p^2 = .052$, revealed that the positive PANAS items showed a decline in positive affect from pretask PANAS ($M = 3.423$, $SD = 0.630$) to posttask PANAS ($M = 3.456$, $SD = 0.743$) that was less pronounced than the decline in negative affect from pretask PANAS ($M = 1.726$, $SD = 0.529$) to posttask PANAS ($M = 1.535$, $SD = 0.523$). Positive and negative affect did not differ by condition, nor did change in positive and negative affect differ by condition (all Fs < 1).

Psychological Resources

We examined whether psychological resources were related to baseline measures of cortisol and autonomic reactivity.[3] Psychological resources were negatively although not significantly correlated with baseline cortisol, $r(181) = -.126$, $p < .089$, and were significantly correlated with baseline negative affect, $r(181) = -.446$, $p < .001$, and positive affect, $r(181) = .449$, $p < .001$, as assessed by the PANAS (see Table 2). Psychological resources were positively correlated with baseline systolic blood pressure, $r(181) = .251$, $p < .001$. They were not correlated with cortisol, autonomic, or affective responses to the stress tasks or at recovery. Psychological resources did not moderate the audience condition differences in cortisol, autonomic, or affective responses to the stressors.

We next examined the specific relationship between self-esteem and cortisol responses to the TSST in the positive audience condition only. The identity disruption perspective implies a negative relation between self-esteem and cortisol responses to stress, whereas Bolger and colleagues' (Bolger & Amarel, 2007; Bolger et al., 2000) invisible support perspective implies a positive relationship. Neither perspective was conclusively supported, as peak cortisol and self-esteem were not significantly related to each other.

Social Resources

We examined whether social resources were related to baseline measures of cortisol and autonomic reactivity. Controlling for baseline levels, social resources were tied to lower heart rate during the recovery period, $r(180) = -.152$, $p < .040$; to lower systolic blood pressure during recovery that approached significance, $r(180) = -.144$, $p < .052$; and to a significantly lower diastolic blood pressure during both the stress tasks, $r(180) = -.149$, $p < .044$, and recovery, $r(180) = -.167$, $p < .025$. Social resources were also correlated with lower baseline cortisol, $r(181) = -.161$, $p < .03$; more positive affect at baseline, $r(181) = .383$, $p < .001$; and less negative affect at baseline, $r(181) = -.404$, $p < .001$, but not with posttask positive or negative affect.

Social resources did not moderate cortisol responses to the stress tasks or systolic or diastolic blood pressure during the tasks, but they did moderate diastolic blood pressure during recovery when controlling for baseline diastolic blood pressure, $\Delta R^2 = .022$, $p = .007$. The form of this moderation was no relation between recovery diastolic blood pressure and social resources in the control condition, $\beta = .052$, $p = .520$, or in the positive audience condition, $\beta = -.087$, $p = .283$, and a strong negative correlation in the negative audience condition, $\beta = -.315$, $p < .001$. Thus, greater social resources were associated with lower diastolic blood pressure at recovery in the negative audience condition.

To further explore the potential impact of social support, we also examined the composite measures of daily general support, daily partner support, and daily specific support calculated from the daily diaries for their relations to psychological and biological measures. The daily general support measure was positively correlated with participants' baseline diastolic blood pressure, $r(177) = .166$, $p < .027$, and negatively correlated with participants' posttask negative affect when controlling for baseline negative affect, $r(176) = -.161$, $p < .033$. The daily partner support measure was positively correlated with participants' baseline diastolic blood pressure, $r(177) = .183$, $p < .015$, and participants' baseline positive affect, $r(177) = .176$, $p < .020$, and was negatively but not significantly correlated with participants' baseline negative affect, $r(177) = -.134$, $p < .076$. The daily specific support measure was positively correlated with participants' baseline systolic blood pressure, $r(177) = .215$, $p < .005$; baseline diastolic blood pressure, $r(177) = .212$, $p < .005$; and baseline positive affect, $r(177) = .235$, $p < .003$, and it was negatively correlated with participants' baseline negative affect, $r(177) = -.271$, $p < .001$.

The three daily diary measures were tested as possible moderators of the impact of audience condition on the dependent measures. The impact of condition on cortisol levels at recovery were moderated by daily general support ($\Delta R^2 = .033$, $p = .030$), daily partner support ($\Delta R^2 = .041$, $p = .013$), and daily specific support ($\Delta R^2 = .044$, $p = .009$). The interaction pattern for the three significant moderations was very similar (see Figure 2). In the control condition, cortisol levels at recovery were not associated with daily general support ($\beta = .049$, $p = .639$), daily partner support ($\beta = .038$, $p = .707$), or daily specific support ($\beta = .037$, $p = .719$). In the negative audience condition, cortisol levels at recovery were negatively associated with daily general support ($\beta = -.289$, $p = .023$), daily partner support ($\beta = -.303$, $p =$

[3] The moderator variables were formed on the basis of a priori conceptual groupings, but because the reliabilities were not especially high, we also examined whether any of the individual measures moderated the Condition × Time interactions. They did not.

Table 2
Correlation of Factors With Baseline Measures

Measure	Psychological resources	Social resources	Daily general support	Daily partner support	Daily specific support
PANAS negative affect					
Baseline	−.446***	−.404***	−.089	−.134	−.271***
Posttask[a]	−.084	−.100	−.161*	−.015	−.045
PANAS positive affect					
Baseline	.449***	.383***	.034	.176*	.235**
Posttask[a]	.142	.083	.107	.017	.067
Cortisol					
Baseline	−.126	−.161*	.018	.040	−.013
Task[a]	.098	.045	.019	.031	.043
Posttask[a]	.040	.013	−.026	−.009	−.028
Heart rate					
Baseline	−.046	.010	−.034	−.044	−.059
Task[a]	−.021	−.014	.059	−.016	.041
Posttask[a]	.030	−.152*	−.026	−.009	−.028
Systolic blood pressure					
Baseline	.251**	.137	.062	.075	.215**
Task[a]	−.007	−.099	.001	−.043	.046
Posttask[a]	−.032	−.144†	−.079	.012	.021
Diastolic blood pressure					
Baseline	.081	.069	.166*	.183*	.212**
Task[a]	−.036	−.149*	.056	.026	.054
Posttask[a]	−.108	−.167*	−.046	−.019	−.086

Note. PANAS = Positive and Negative Affect Schedule.
[a] Controlling for baseline.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

.021), and daily specific support ($\beta = -.387$, $p = .006$). In the positive audience condition, cortisol levels at recovery were not significantly associated with daily general support ($\beta = .165$, $p = .195$), daily partner support ($\beta = .236$, $p = .065$), or daily specific support ($\beta = .157$, $p = .179$). This pattern suggests that social resources facilitated cortisol recovery in the negative audience condition, consistent with a buffering role of social resources.

Discussion

Social support typically protects against stress, with both psychological and biological responses to threatening events found to be lower among people who indicate that they have strong social support. Accordingly, the fact that social support exacerbates stress under some conditions comes as a surprise (for reviews, see, e.g., Bolger & Amarel, 2007; Taylor, 2007). The present study builds on and adds to these previous findings by demonstrating strong biological responses to a supportive audience during laboratory stress tasks. When people completed stressors in the presence of an audience that was either supportive or unsupportive, the responses of participants were very much the same: high cortisol levels and strong heart rate and blood pressure responses. These findings suggest that even a supportive audience can make stressors worse. Bolger and colleagues (e.g., Bolger & Amarel, 2007; Bolger et al., 2000) have argued that social support transactions in which the giver and the recipient are both aware of the action can exacerbate psychological distress, and the present study found that this is true of biological stress responses as well.

Several theoretical positions suggest that these effects might be moderated by psychological and social resources. From an identity disruption perspective (Brown & McGill, 1989), one might expect that people with high self-esteem would benefit more than people low in self-esteem from positive feedback during stressful tasks. An alternative prediction from Bolger and associates' research (e.g., Bolger & Amarel, 2007; Bolger et al., 2000) is that the receipt of social support can be a threat to self-esteem; thus, people high in self-esteem might experience efforts to provide social support as more aversive than would those low in self-esteem. Neither of these positions was supported, as self-esteem was unrelated to cortisol, blood pressure, heart rate, and affective responses to the stress tasks.

There was some differentiation in psychological and biological responses to the stress tasks on the basis of whether the audience was a supportive or an unsupportive one. People who came into the study having reported more positive interactions over the previous 9 days had lower cortisol responses at recovery if they had been confronted with an unsupportive audience during the stress tasks. If they had encountered a positive audience, however, their cortisol levels remained somewhat elevated, suggesting that receiving support when a person already feels supported may be aversive. On the whole, though, the two audience conditions evoked very similar reactions. It appears that going through stressful events while other people who are not under stress are observing one's predicament is inherently stressful, regardless of whether others are trying to be supportive. Thus, evaluative concerns induced by an audience appear to offset any beneficial effects of a supportive audience, instead exacerbating stress as much as an unsupportive audience does (cf. Dickerson & Kemeny, 2004).

The question arises as to whether an audience of supportive strangers has the same effects as an audience of supportive inti-

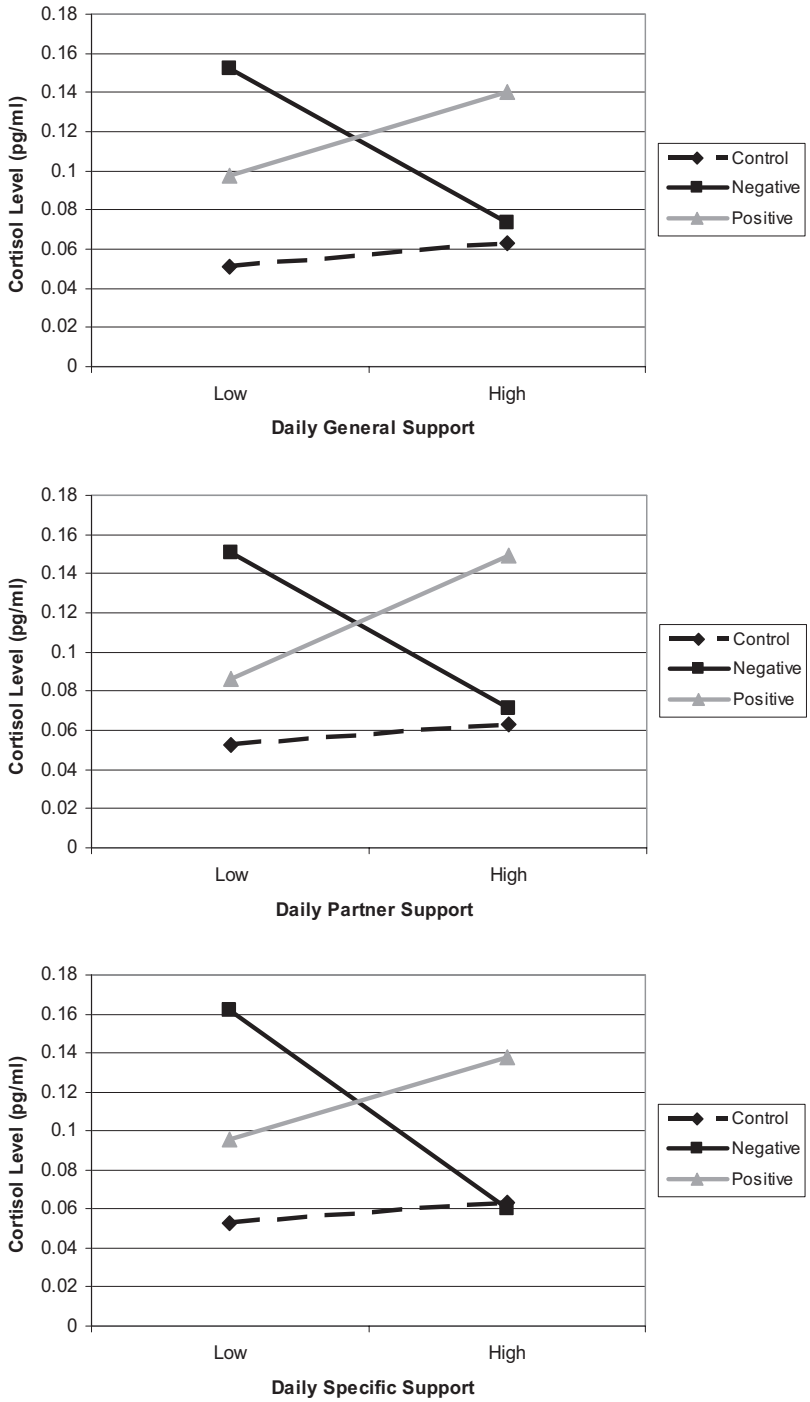

Figure 2. Moderation of audience condition by daily general support (top panel), daily partner support (middle panel), and daily specific support (bottom panel) on cortisol responses to the Trier Social Stress Test controlling for baseline cortisol levels.

mates or acquaintances. The present study does not address this issue. However, some previous studies have found either no reduction in or exacerbation of biological stress responses when a close other provides support during laboratory stressors; these effects appear to be especially true for women whose male partners are present during the tasks (for reviews, see Kiecolt-Glaser & Newton, 2001; Taylor, 2007). Our suspicion is that any stressful task with the potential to engage evaluative concerns, particularly those requiring performance as the present tasks did, could exacerbate biological stress responses, whether supportive strangers or

intimates are present. However, a definitive answer to this question awaits additional research.

Psychological and social resources did appear to be somewhat protective before and/or after the stress tasks. Psychological resources were associated with somewhat lower baseline cortisol, lower negative affect, and higher positive affect prior to the stress tasks. Baseline social support was tied to lower heart rate during recovery, somewhat lower diastolic blood pressure during the tasks and during recovery, and higher positive affect and lower negative affect at baseline. It appears, then, that stress-protective resources may exert some protective effects before and after stressful events but may be less impactful during stressful events themselves.

This conclusion is qualified by a few unexpected findings in the study, however. Psychological and social resources were associated with higher baseline blood pressure, although some measures of social support were associated with lower diastolic blood pressure during the stressful tasks and at recovery. It is not clear why social support and psychological resources would predispose participants to higher blood pressure responses. A second unexpected finding was little change in positive and negative affect across the study. This pattern may have to do with when affect was measured. At baseline participants had not yet gone through the stress tasks, and once the tasks were over participants were likely relieved. Measures of affect had not been taken at peak stress because of the complexity of the procedures, but, in retrospect, such measures would have been desirable. Overall, integrating more and better assessments of potential mediators into the protocol would be desirable in future studies.

We have argued that the adverse effects of both audience conditions on biological stress responses, relative to the no-audience control, are due to evaluative concerns. An alternative explanation draws on social facilitation, such that participants may have been more motivated and worked harder in the audience conditions, accounting for their stronger biological responses. For example, perhaps participants in the audience conditions performed the arithmetic task more rapidly. Unfortunately, individual differences in underlying abilities swamp condition differences, and so without pretests on essay writing or arithmetic skills, which we did not have, this possibility cannot be directly addressed. However, several factors argue against this interpretation. An internal analysis of the poststress PANAS items revealed no condition differences on any items, including "attentive" and "enthusiastic." Furthermore, cortisol increases are reliably related to evaluative concerns and to perceptions of threat but not to differential motivation and effort.

The results are consistent with the conclusion that social and psychological resources may be better for the having of them than the using of them, at least at the time that a stressful event is occurring (cf. Thoits, 1995). It may be that psychological and biological responses to ongoing stress are largely event driven, whereas psychological and social resources may aid in the management of daily well-being, possibly by controlling anticipatory responses to stressful events and their aftermath but not necessarily by controlling psychological and biological responses to events while they are in progress. The present tasks reflect only one set of challenging events, however, and so the generality of those conclusions needs to be further explored. Moreover, the substantial elevations in cortisol, heart rate, and blood pressure seen in response to the stress tasks in this study suggest that the tasks were experienced as very stressful by the participants. Previous research has found that psychological and social resources may be most protective at relatively low or moderate levels of stress and less so at high levels of stress (e.g., Whisman & Kwon, 1993).

The present results have implications for understanding the impact of the TSST, the most widely used laboratory stress challenge paradigm in the research literature. Specifically, does the TSST manipulate threat or does it manipulate social evaluation? The present results support the view that social evaluation is a key component of the stressfulness of the TSST, inasmuch as only modest biological stress responses were found when no audience was present but strong biological stress responses were found when the evaluative audience was present, regardless of whether it was supportive (cf. Dickerson & Kemeny, 2004).

To what kinds of social support experiences might the present findings be generalized? The present study is distinguished by the fact that the supportive audience was also evaluative. Although these conditions do not always occur in naturalistic conditions when social support is provided, many circumstances do arise when those who provide social support are also evaluative. The terror that children, adolescents, or even adults experience when performing in a play, recital, or academic contest in front of a supportive audience represents one such situation. Being supported by others when one is going through trying times, such as a job loss or taking exams, can also temper the experience of support due to concerns that others are evaluating how one is handling the stress. In short, evaluative concerns may be intrinsic to a range of circumstances of social support provided during stressful times.

The results accordingly raise a question: When is support not supportive? When the wrong type of support is provided to a person in the wrong situation, the supportive efforts can backfire, as was the case in the present study. Accordingly, a fine-grained understanding of social support transactions is clearly needed, which would entail the examination of such issues as the timing of supportive transactions, their implicit or explicit nature, whether they include a likely evaluative component, and whether support can be reciprocated, among other dimensions. For example, is it better to support another person before or after a stressful event rather than while it is going on? The present results imply that this may be the case. Under what circumstances does the fact that one may not be able to reciprocate another's support undermine the value of support? In the present study, participants clearly had no opportunity for reciprocation. Gleason, Iida, Bolger, and Shrout (2003) found that even in close relationships, receiving support without reciprocation was associated with increases in negative mood, whereas reciprocity in support transactions was associated with positive mood. What role do individual differences in psychological and social resources play in these processes? The present study found no effect of self-esteem and only modest effects of individual differences in psychological and social resources on these processes.

Resolution of these issues is vital not only for theories of social support but also for understanding the practical implications and limitations of interventions. For example, at one time, supportive interventions were routinely recommended after traumatic incidents, but reviews now suggest that confidence in such interventions may have been misplaced (e.g., Rose, Bisson, & Wessely, 2003). Thus, understanding when social support efforts are and are not experienced as supportive, especially from strangers, is vital

for identifying whether and when social support interventions will be effective.

Conclusions

Social support is widely considered to be beneficial for muting psychological and biological responses to stress. Recent findings suggest qualifications to these assertions, however. Consistent with those qualifications, the present study found strong cortisol, blood pressure, and heart rate responses to stress when performance was evaluated by either a supportive audience or an unsupportive audience, responses that were largely unameliorated by psychological and social resources. The findings call into question the idea that social support and social support interventions have unmitigated benefits.

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Received December 3, 2008
Revision received April 16, 2009
Accepted May 14, 2009 ■