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Effects of Sex, Gender Role Identification, and Gender Relevance of Two Types of Stressors on Cardiovascular and Subjective Responses

Sex and Gender Match and Mismatch Effects

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The authors tested the hypothesis that a match between the gender relevance of a stressor and one's sex or gender role identification would elicit higher cardiovascular responses. Healthy female and male undergraduates (n = 108) were exposed to two stressors: the Cold Pressor Test (CPT) and the n-back task. Stressor relevance was manipulated to be masculine or feminine relevant or gender neutral. Data were analyzed using a Bayesian model selection procedure. The results showed stronger cardiovascular responses for the CPT in the case of a gender match effect. In contrast, results for the n-back task revealed stronger cardiovascular responses for sex and gender mismatch effects. These discrepant match and mismatch effects are discussed in terms of differential task appraisal (i.e., threat vs. challenge). Additional results (a) support the success of measuring gender role identification indirectly by means of the Gender Implicit Association Test, (b) do not show that the effect of stressor relevance is more pronounced on those hemodynamic parameters typically increased by the stressor, and (c) reveal differential effects of stressor relevance for subjective and cardiovascular stress responses. Taken

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together, it can be concluded that the process of the cognitive appraisal of stressor relevance outlines individual variability in cardiovascular responding to acute stress.

Keywords: *cardiovascular responses; hemodynamic profile; sex; gender role identification; implicit association test*

Relatively heightened cardiovascular reactivity (CVR) has been proposed to act as a risk marker for the development of cardiovascular diseases (Krantz & Manuck, 1984; Manuck, Kasprowicz, & Muldoon, 1990). Therefore, CVR research has focused on reactivity as an individual difference factor by which individuals who are at increased risk for cardiovascular diseases can be identified (e.g., Turner, 1994). Traditionally, the focus was on responsiveness during stress, but more recently, cardiovascular changes in anticipation to and in recovery from stress have gained increasing interest (Gregg, James, Matyas, & Thorsteinsson, 1999; Kamarck & Lovallo, 2003; Linden, Earle, Gerin, & Christenfeld, 1997). Laboratory studies on sex differences in CVR have revealed mixed findings. Most researchers have reported that men are more reactive than women, whereas others have found the opposite pattern or reported no sex differences (e.g., Girdler, Turner, Sherwood, & Light, 1990; Stoney, Davis, & Matthews, 1987).

According to Lazarus and Folkman's (1984) transactional model of stress, whether and to what extent a situation elicits a stress response depends on the interaction between the person and the situation. On the basis of this model, Lash and colleagues (Lash, Eisler, & Southard, 1995; Lash, Gillespie, Eisler, & Southard, 1991) argued that because men and women differ in their appraisal of situations as being stressful to them (Eisler & Skidmore, 1987; Gillespie & Eisler, 1992), sex differences in cardiovascular responses should be understood in relation to the gender relevance of the stressful encounters. It is assumed that a gender-relevant stressor activates gendered information in memory. By tapping socially constructed roles about what is appropriate for either men or women, a gender-relevant stressor is assumed to differentially influence men's and women's appraisals of that stressor as relevant (i.e., success importance) and to automatically elicit sex differences in cardiovascular responses as a result. Lash et al. (1991, 1995) manipulated the gender relevance of the cold pressor test (CPT) to be masculine relevant, feminine relevant, or gender neutral. The results of these studies showed that Lash et al. were able to manipulate the cognitive appraisal of the stressor as relevant and to induce sex differences in cardiovascular responses accordingly. That is, women were more reactive than men when the stressor was presented as feminine relevant, whereas men were more reactive than women when the stressor was presented as masculine relevant (sex match). Moreover, no sex differences were found in the gender-neutral administration. Similar results have been reported with regard to gender role identification. The more individuals identify with a gender role, the higher their levels of cardiovascular stress in response to gender-relevant situations that match their gender role identification (gender match; Lash, Eisler, & Schulman, 1990; Martz, Handley, & Eisler, 1995).

Some researchers replicated the sex and gender match effects on cardiovascular responding (e.g., Cosenzo, Franchina, Eisler, & Krebs, 2004), whereas others failed to do so (e.g., Matthews, Davis, Stoney, Owens, & Caggiula, 1991). Yet others have reported mismatch effects that indicated relatively higher levels of cardiovascular stress in response to situations that were relevant to the opposite sex or the opposite gender (Davis & Matthews, 1996; Wright, Murray, Storey, & Williams, 1997). To understand the conditions in which a match or a mismatch is likely to be predictive of higher levels of cardiovascular response, Wright et al. (1997) proposed to conceptualize gender relevance in gender-specific ability terms as opposed to success importance. The results of their study suggest that easy tasks produce mismatch effects because task engagement is higher for mismatched individuals (low-ability individuals), whereas tasks of relatively moderate difficulty produce match effects because task engagement is higher for matched individuals (high-ability individuals).

Supplementing previous research, recently, Kolk and van Well (2007) tested sex and gender match effects in one study. Unfortunately, they did not apply a fully crossed design but tested the sex and gender match effects in two independent analyses. Nevertheless, the results revealed higher effect sizes for gender match effects than for sex match effects. In the present study, we intended to replicate and expand on the findings of Kolk and van Well (2007) in several ways. To do so, we (a) used an orthogonal sex-by-gender design to examine the surplus value of gender match effects over sex match effects; (b) covered a relatively direct as well as an indirect gender role identification measure; (c) included a subjective rating of stress; and (d) included two stressors, that is, the CPT and the n-back task (a reaction time task with a numerical memory component).

Both stressors are assumed to be of moderate task difficulty. In accordance with Wright et al.'s (1997) ability perspective, it was hypothesized that these stressors would elicit match rather than mismatch effects. In case of a sex match, women and men would reveal stronger cardiovascular responses in the condition relevant to their own sex than in the condition relevant to the other sex or the neutral condition, and in case of a gender match, feminine and masculine participants would demonstrate stronger cardiovascular responses in the condition relevant to their own gender role than in the condition relevant to the other gender role or the neutral condition. Congruent with the results of Kolk and van Well's (2007) study, gender match effects were expected to be stronger than sex match effects. Furthermore, because the laboratory stressors are assumed to differ in the hemodynamic response patterns they elicit (Gregg et al., 1999), it was expected that match effects would be more pronounced on vascular parameters on the CPT (e.g., total peripheral resistance [TPR]) and on cardiac parameters on the n-back task (e.g., cardiac output [CO]).

To assess gender role identification, researchers thus far have used relatively direct measurement procedures (i.e., self-report questionnaires). However, indirectly measured concepts are better predictors of automatic behavior than their direct measured counterparts (Fazio, 1990). Therefore, it could be argued that in examining gender match effects on cardiovascular response (a relatively automatic process), it would be more appropriate to assess gender role identification using a more indirect measurement procedure, such as the Gender Implicit Association Test (GIAT; cf. van Well, Kolk, & Oei, 2007).

In sum, the results of the present study were intended to advance understanding of cardiovascular stress responses as a function of sex, gender role identification, and the gender relevance of a stressor. The main hypothesis was that a match between the gender relevance of a stressor and one's sex or gender role identification would elicit relatively stronger cardiovascular responses. To test this hypothesis, a 2 (sex: men, women) × 2 (gender role identification: masculine, feminine) × 3 (condition: masculine relevant, feminine relevant, neutral) × 4 (stress phase: baseline, anticipation, stressor, recovery) design was used, in which individual differences in exposure to daily hassles were held constant. The findings will contribute to the understanding of gender role–determined behavior and vulnerability to health problems.

Method

Participants

The study sample consisted of 60 female and 48 male undergraduate students aged 17 to 49 years (*M* = 21.5 years, *SD* = 4.6 years). Eligibility criteria included no history of hypertension (i.e., blood pressure not higher than 140/90 mm Hg) or cardiovascular disease, no chronic disease requiring medical attention, no current use of prescribed medication, and a body mass index between 17 and 29 kg/m^2. Prior to the experiment each participant gave signed informed consent. The ethics board of our department approved the study protocol. Participants received course credit or were paid (€14) for taking part in the study.

Stressors

The CPT. This task required participants to immerse their right hand up to the wrist in a bucket of ice water for 2 minutes. The ice water was maintained in a small ice cooler at a temperature of 4 ± 1°C.

The n-back task. A set of 100 randomly generated digits was presented in a fixed order. The task required participants to indicate whether each digit was similar to the one presented three digits before, by pressing a "yes" or a "no" key. Digits appeared in the center of a computer screen for 500 ms, followed by an interstimulus interval of 2,500 ms. Wrong or missing answers were followed by an unpleasant beep. The task consisted of 30% targets and took 5 minutes.

Gender relevance manipulation. Gender relevance was manipulated by varying the introduction to the stressors in masculine-relevant, feminine-relevant, or neutral terms (Kolk & van Well, 2007; Lash et al., 1991, 1995). The masculine-relevant introduction appealed to the masculine gender role; that is, it suggested a research-related association between the ability to keep the hand in the ice water and to be in good physical and mental condition. The feminine-relevant introduction appealed to the feminine gender role and included references to being able to form close and lasting relationships and to be emotionally supportive. The neutral introduction instructed participants to perform the task to obtain proper physiological measurements. Introductions were of the same length. The literal introductions are available on request.

Measures

Cardiovascular responses. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded using a Finapres 2300 blood pressure monitor (Ohmeda, Englewood, CO). The Finapres enables noninvasive, continuous, beat-to-beat monitoring of the finger arterial pressure waveform using a finger cuff applied to the middle phalanx of the middle finger. The accuracy of the Finapres 2300 has been validated against intra-arterial and noninvasive but intermittent blood pressure measurements (for review, see Imholz, Wieling, van Montfrans, & Wesseling, 1998), and reliability is supported because of the large number of readings (Gerin, Pieper, & Pickering, 1993).

Hemodynamic measures of CO (1/ min) and TPR dyn.s/cm^5 were derived from the Finapres data with BeatScope Version 1.1 (TNO-Biomedical Instrumentation, Amsterdam, the Netherlands). BeatScope is a software package for the analysis of arterial pressure waveforms. It provides the computation of hemodynamic measures (e.g., CO, TPR, stroke volume) with the Modelflow method on the basis of the simulation of a model of aortic input impedance (Wesseling, Jansen, Settels, & Schreuder, 1993). Good agreement of these parameters has been obtained with intra-arterial measures (Jellema, Imholz, van Goudoever, Wesseling, & van Lieshout, 1996).

Subjective response. The arousal dimension of the Self-Assessment Manikin (SAM; Bradley & Lang, 1994), a nonverbal pictorial assessment technique, was used to measure the subjective experience of stress. The arousal dimension consists of a row of five graphic figures ranging from an excited, wide-eyed figure to a sleepy, relaxed figure. Participants were instructed to rate their experiences of stress on the pictorial dimension using a 9-point, Likert-type scale. Bradley and Lang (1994) reported good psychometric properties of the SAM. Cronbach's α on the arousal dimension was .83 and .86 for the CPT and the n-back task, respectively.

Gender role identification. To measure gender role identification indirectly, the GIAT (Aidman & Carroll, 2003; Greenwald & Farnham, 2000) was used. The GIAT is a computerized categorization task that measures gender role identification by assessing automatic association strength between the concepts of me (relative to not me) and feminine and masculine. The task was constructed on the basis of the procedure described by van Well et al. (2007). It required participants to categorize stimuli belonging to one of four categories using only two response keys. Categories and regarding stimuli are (a) me: I, self, me, my, mine; (b) not me: they, them, it, their, other; (c) feminine: woman, girl, lady, madam, daughter; and (d) masculine: man, boy, sir, gentlemen, son. After practicing the me–not me discrimination and the feminine-masculine discrimination separately, the two categorization tasks were combined. This combined block represented the experimental task and was administered twice, first with the categories of me and feminine sharing the left response key and the categories of not me and masculine sharing the right response key, and second with the categories of me and masculine assigned to the left response key and the categories of not me and feminine assigned to the right response key. Key assignment and administration order of the combined blocks were counterbalanced. Each combined block consisted of 20 practice trials, followed by three "warm-up" trials and a block of 40 experimental trials. The discrepancy in response latencies between the two combined blocks represents gender role identification.

Data were treated in accordance with the procedure described by Greenwald, McGhee, and Schwartz (1998) (a) practice trials and the first three trials of each experimental block (warm-up trials) were deleted; (b) response latencies below 300 ms and those above 3,000 ms were recoded to 300 and 3,000 ms, respectively; and (c) resulting response latencies were log transformed to normalize the distribution. Thereafter, the log-transformed response latencies of the two experimental blocks were averaged and the resulting means were subtracted. The difference score (GIAT score) was computed such that positive or relative higher scores indicated stronger masculine gender role identification, whereas negative or relative lower scores reflected stronger adherence to the feminine gender role.

To classify participants as masculine or feminine, a median split procedure was applied to the GIAT score. Participants who scored above the median were classified as masculine, whereas those who scored below the median were classified as feminine (median = 35 and –110 for male and female participants, respectively). Although analyses on the GIAT were conducted on log-transformed data, untransformed means are reported in the text.

The validity of various implicit association measures has been supported, and the reliability has found to be satisfactory, with good internal consistency figures but poorer test-retest reliabilities (Bosson, Swann, & Pennebaker, 2000; Fazio & Olson, 2003). On the basis of present data, Cronbach's α was .89. This reliability figure reflects the internal consistency in the tendency to associate masculine, relative to feminine, with the self and was computed following procedures described by Bosson et al. (2000).

Furthermore, gender role identification was measured in a relative direct manner by means of the Masculine and Feminine Gender Role Stress (GRS) scales (Eisler & Skidmore, 1987; Gillespie & Eisler, 1992). A median split procedure was applied to the GRS scales to classify individuals as masculine or feminine. However, main analyses using this measurement procedure did not support our main hypothesis. Therefore, and to save text space, details of this relatively direct classification of gender role identification and its related analyses are not reported here. A summary of results is available on request.

Daily hassles. Exposure to daily hassles was assessed by the shortened 41-item version of the Survey of Recent Life Experiences (SRLE; Kohn & Macdonald, 1992; Dutch translation by de Jong, Timmerman, & Emmelkamp, 1996). Each item describes a daily hassle (e.g., "too many things to do at once"). Participants rated the extent to which each item had been part of their lives over the past month on a 4-point, Likert-type scale ranging from 1 (*not at all part of my life*) to 4 (*very much part of my life*). Kohn and Macdonald (1992) reported good internal consistency (Cronbach's $\alpha = .90$ for the short version) and good construct validity. For the Dutch version, de Jong et al. (1996) reported similar reliability (Cronbach's $\alpha = .89$). In addition, in the present sample, Cronbach's α was .90.

Postexperimental questionnaire (PEQ). To assess whether the manipulation of the stressor relevance was successful, participants were asked to indicate how much they thought each stressor required the ability to be emotionally supportive and to form close and lasting relationships (feminine items) as well as how much they thought each stressor required being in good physical and mental condition (masculine items). Participants also indicated the extent of effort, adequate coping, challenge, and threat during each stressor. Each item was rated on a 7-point, Likert-type scale that ranging from 1 (*not at all*) to 7 (*very much*).

Procedure

Selection and screening. The GRS scales were administered to a total of 1,136 students, retaining for further analyses only those who adhered to the masculine or feminine gender role ($n = 254$). The invitation did not reveal the selection procedure and carefully avoided any reference to sex or gender differences. The study was presented as one about individual differences in physiological responses to stress. Volunteers were screened for eligibility criteria over the telephone. They were asked to refrain from caffeine and alcohol for 12 hours and from smoking and exercising for 2 hours prior to the laboratory session (Shapiro et al., 1996).

Laboratory session. Each participant was tested individually by one of two female experimenters. On a participant's arrival at the laboratory, the experimenter checked the criteria pertaining to caffeine, alcohol, smoking, and exercising. None of the participants had to be rescheduled; they all met these criteria. Then, the experimenter explained the study protocol, again carefully avoiding any reference to sex or gender differences. Participants read and signed the informed consent form, in which confidentiality, anonymity, and the opportunity to withdraw without penalty were assured. Thereafter, the experimenter attached an appropriately size Finapres finger cuff to the midphalanx of the third finger of the participant's left hand and positioned the arm at heart level. She then went to an adjacent room, where she determined the administration order and experimental conditions of the stressors using a sealed-envelope method (randomization was stratified according to sex). Subsequently, she started the computerized protocol using the VSRRP98 software package developed at our department.

Participants first completed the SRLE and were then introduced to the SAM pictorial assessment technique. Thereafter, they were instructed to minimize all movement during the physiological recordings. A 15-minute baseline period followed in which participants were asked to rest quietly while watching a relaxing aquatic video (Piferi, Kline, Younger, & Lawler, 2000). Then, the gender relevance of the CPT was manipulated. A 3-minute anticipation period followed in which participants waited for the CPT to begin. Subsequently, participants were instructed to put their right hands in the ice water. After 2 minutes, they were told to remove their hands from the water. If participants withdrew their hands earlier, they were required to say so over the intercom. A 15-minute recovery period followed, during which participants were asked to rest quietly while watching a sequel to the video. After a 5-minute break in which the Finapres was switched off, participants were exposed to the n-back task, with successive baseline, manipulation, anticipation, stress, and recovery periods. Stressor order was counterbalanced. Physiological responses were recorded continuously, whereas SAM ratings were obtained after each stress phase. Next, the experimenter started the GIAT using the WESP software package developed at our department. Participants were instructed to categorize targets as they appeared on the monitor and to respond as quickly and accurately as possible. Finally, participants completed the PEQ and were debriefed. The laboratory visit took about 120 minutes.

Data Analyses

Data reduction. Computing averages for each baseline, anticipation, stressor, and recovery period reduced the physiological data. For baseline and recovery periods, means were calculated over the last 5 minutes only. By using the last 5 minutes of the 15-minute recovery phase, we focused on relatively long-term rather than immediate recovery.

Initial analyses. Data were examined for each stressor and for each measure of stress separately. Differences in data loss and sample characteristics across conditions were examined using χ^2 tests or univariate analyses of variance (ANOVAs) with condition as the between-subjects variable. Then, a manipulation check on stress induction was conducted with repeated-measures ANOVAs with stress phase (baseline, anticipation, stress, recovery) as the within-subjects variable. Significant effects of stress phase were followed by planned repeated contrasts. These analyses were also performed controlling for stressor order. However, because stressor order did not change the results, the variable was dropped. To test the effectiveness in manipulating stressor relevance, ANOVAs were conducted on the PEQ items, with condition, sex, and gender role identification as between-subjects variables. Moreover, to check for baseline differences, ANOVAs with sex and condition as between-subjects variables were conducted on baseline levels. To test whether the GIAT was sensitive to sex differences, an ANOVA was performed on the GIAT score, with sex as the between-subjects variable.

Effect size was computed as Cohen's *d*, representing the magnitude of difference between two groups (Cohen, 1977), or as η_p^2, reflecting the proportion of the effect plus error variance that is attributable to the effect. Where appropriate, Greenhouse-Geisser corrections were applied to control for violation of the sphericity assumption.

Main analyses. Data were further examined for each stress phase (anticipation, stressor, recovery) separately, with baseline level entered as a covariate. Sex and gender match and mismatch effects were evaluated using a Bayesian model selection procedure for inequality-constrained models. For an elaborate explanation as well as some illustrations of the Bayesian model selection approach for inequality-constrained models, see Klugkist, Laudy, and Hoijtink (2005). Note that an important issue in Bayesian analyses is the (subjective) specification of prior distributions. However, in the context of inequality-constrained models, Klugkist et al. showed that under some specification rules, the model selection is hardly affected by the prior specification and therefore is considered objective.

Each match and mismatch effect was modeled directly by imposing inequality constraints on adjusted group means (i.e., one or more group means were expected to be larger or smaller than one or more other group means). Within each model, the inequality constraints were imposed for both men and women, without imposing any constraints across the sexes. Model 1 represented a sex match effect; that is, participants would be most reactive in the condition that matched their sex (i.e., the mean response for men would be higher in the masculine than in the feminine or neutral condition, and the mean response for women would be higher in the feminine than in the masculine or neutral condition). In a similar way, gender match (Model 2), sex mismatch (Model 3), and gender mismatch (Model 4) effects were defined. In addition, Model 5 was included, which did not impose any constraints on the parameters. This model did not represent a theory or hypothesis but served as a control model.

After confronting the set of models with the data, the Bayesian model selection approach provided each model with a so-called posterior model probability (PMP). PMP reflects the probability of a model taking into account a correction for complexity. Note that if none of a group of constrained models is (clearly) supported by the data, the unconstrained model receives a high PMP and that the PMPs within a set of models add up to 1 (i.e., 100%). Each model probability should therefore be interpreted in context of PMPs in the total model set and the unconstrained model in specific. With regard to Models 1 to 5, PMPs of, for example, .50, .50, .00, .00, and .00, respectively, reflected substantial sex and gender match effects, whereas PMPs of, for example, .60, .00, .00, .00, and .40, respectively, reflected a less strong sex match effect (even though .60 > .50).

Results

Sample

CPT data from 10 participants were excluded because of technical problems with the Finapres ($n = 1$), participants' failure to keep their hand in the ice water for at least 30 seconds ($n = 4$), or participants' self-reported total disengagement from the task (PEQ effort = 1; $n = 5$). N-back data from 7 participants were removed because of technical difficulties with the Finapres ($n = 2$) or the n-back task ($n = 4$) or an n-back task error rate that exceeded 50% ($n = 1$). All participants reported having taken at least some effort performing the n-back task. Furthermore, following Greenwald et al. (1998), data from 4 participants were excluded because of a mean GIAT response latency above 2,000 ms ($n = 1$) or error rates that exceeded 20% ($n = 3$). Finally, data from 94 and 97 participants were included in the CPT and n-back analyses, respectively.

Distribution across conditions of female and male participants, respectively, was as follows (with percentages of feminine gender role adherents in parentheses): for the CPT, $n = 17$ (53%) and $n = 15$ (40%) in the feminine-relevant condition, $n = 17$ (47%) and $n = 14$ (64%) in the masculine-relevant condition, and $n = 20$ (50%) and $n = 11$ (45%) in the neutral condition; for the n-back task, $n = 13$ (46%) and $n = 15$ (47%) in the feminine-relevant condition, $n = 20$ (50%) and $n = 13$ (46%) in masculine-relevant condition, and $n = 20$ (60%) and $n = 16$ (50%) in the neutral condition. Sample characteristics (sex, gender role identification, age, body mass index, and SRLE score) and data loss did not significantly differ across conditions.

Manipulation Checks

Stress induction. Table 1 presents means and standard errors of cardiovascular and subjective stress measures for each stressor and each stress phase separately. For the CPT and the n-back task, all stress measures revealed a significant main effect of stress phase, with F values ranging from 4.31 to 227.33, p values < .05, and η_p^2 values ranging from .04 to .71, indicating that both stressors were able to produce significant changes in cardiovascular and subjective responses.

For the CPT, physiological measures demonstrated a vascular response pattern. That is, SBP, DBP, and TPR increased stepwise from baseline to anticipation to the CPT and decreased thereafter (p values < .001, d values ranging from 0.25 to 0.98). Moreover, HR levels showed no change between baseline and anticipation but then increased from anticipation to the CPT ($p < .01$, $d = 0.15$) and decreased from the CPT to recovery ($p < .001$, $d = 0.36$). CO showed no increase at all but demonstrated a decrease from the CPT to recovery ($p < .01$, $d = 0.19$). Physiological measures on the n-back task, on the other hand, revealed a vascular response pattern during anticipation but a cardiac response pattern during the actual stressor. SBP, DBP, and TPR increased from baseline to anticipation (p values < .001, d values ranging from 0.20 to 0.46). Then, SBP, DBP, HR, and CO increased from anticipation to the n-back task, and these four parameters decreased thereafter (p values < .001, d values ranging from 0.15 to 0.43). TPR showed no change from anticipation to the n-back task but increased from the n-back task to recovery ($p < .05$, $d = 0.09$).

In addition, participants' self-reported experience of stress (a) increased from baseline to anticipation ($p < .001$, $d = 0.49$), remained elevated during the CPT, and decreased thereafter ($p < .001$, $d = 0.54$) and (b) increased stepwise from baseline to anticipation to the n-back task and decreased thereafter (p values < .01, d values ranging from 0.23 to 0.62).

Gender relevance stressor. As for both stressors, PEQ items revealed no significant main effect of condition nor interaction effects of condition with

Table 1
Means (*SE*s) of Cardiovascular and Subjective Measures by Stressor and Stress Phase

	Cardiovascular					Subjective
Stressor/Phase	SBP (mm Hg)	DBP (mm Hg)	HR (beats/min)	CO (L/min)	TPR (dyn s/cm^5)	SAM Arousal[a]
CPT (*n* = 94)						
Baseline	130.8 (1.5)	73.6 (1.1)	75.5 (1.2)	5.80 (0.11)	1,291 (35)	2.58 (0.12)
Anticipation	138.7 (1.6)	78.4 (1.2)	74.9 (1.2)	5.81 (0.12)	1,384 (41)	3.17 (0.13)
Stressor	154.8 (1.8)	89.8 (1.4)	76.7 (1.2)	5.83 (0.13)	1,640 (55)	3.17 (0.13)
Recovery	138.1 (1.7)	77.9 (1.2)	72.7 (1.1)	5.61 (0.11)	1,416 (40)	2.51 (0.12)
N-back task (*n* = 97)						
Baseline	129.6 (1.5)	72.7 (1.1)	74.7 (1.1)	5.78 (0.11)	1,277 (31)	2.67 (0.14)
Anticipation	137.1 (1.8)	76.9 (1.2)	75.1 (1.1)	5.80 (0.11)	1,341 (35)	3.11 (0.13)
Stressor	142.2 (1.9)	80.0 (1.3)	76.8 (1.2)	6.00 (0.12)	1,353 (33)	3.41 (0.13)
Recovery	134.6 (1.7)	76.0 (1.2)	73.1 (1.1)	5.59 (0.11)	1,385 (39)	2.62 (0.13)

Note: SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate; CO = cardiac output; TPR = total peripheral resistance; SAM = Self-Assessment Manikin; CPT = Cold Pressor Test.
a. 1 = *relaxed*, 9 = *stressed*.

sex or gender role identification. But, significantly more than men, women rated the CPT as requiring good physical condition (*M* = 3.76 vs. 2.94), $F(1, 82) = 6.09$, $p < .05$, $d = 0.50$, along with the ability to be emotionally supportive (*M* = 2.53 vs. 1.82), $F(1, 82) = 4.90$, $p < .05$, $d = 0.46$. Women also reported a higher degree of effort on the CPT than men (*M* = 4.62 vs. 3.62), $F(1, 82) = 14.46$, $p < .001$, $d = 0.80$.

Baseline Differences

Baseline levels preceding the CPT and the n-back task showed a main effect of sex for HR, CO, and TPR, with *F* values ranging from 4.14 to 16.19, *p* values < .05, and *d* values ranging from 0.40 to 0.82. For the CPT and the n-back task, baseline levels in men, relative to those in women, were lower for HR (*M* = 72.3 vs. 77.5 beats/min and *M* = 72.2 vs. 76.5 beats/min, respectively) and for TPR (*M* = 1,180 vs. 1,373 dyn · s/cm^5 and *M* = 1,171 vs. 1,364 dyn · s/cm^5, respectively) but higher for CO (*M* = 6.27 vs. 5.43 L/min and *M* = 6.27 vs. 5.37 L/min). In addition, CO and TPR baseline levels preceding the CPT differed by condition, $F(2, 88) = 4.80$, $p < .05$, $\eta_p^2 = .10$, and $F(2, 88) = 3.80$, $p < .05$, $\eta_p^2 = .08$, respectively. At baseline, CO was lower in the masculine-relevant condition (*M* = 5.39 L/min) than in the feminine-relevant (*M* = 6.10 L/min; $p < .05$, $d = 0.70$)

and neutral (M = 6.05 L/min; $p < .05$, d = 0.64) conditions, whereas TPR was higher in the masculine-relevant condition than in the neutral condition (M = 1,404 vs. 1,199 dyn · s/cm^5; $p < .05$, d = 0.64). Subjective baseline levels, however, were similar across sex and conditions. Furthermore, no interactions between condition and sex were found.

Gender Role Identification

The GIAT was able to differentiate between men and women, $F(1, 102)$ = 101.15, $p < .001$, d = 1.99, revealing a more positive GIAT score for men (M = 32) and a more negative one for women (M = –106). That is, men adhered more strongly to the masculine gender role, whereas women did so more strongly to the feminine one. Key assignment and the order of experimental blocks did not change this finding.

Bayesian Model Selection Procedure: Sex and Gender Match and Mismatch Effects

The CPT. Table 2 shows PMPs for all five models, presented for each stressor, stress phase, and parameter of stress separately. In summary, cardiovascular parameters supported the expected gender match effects (see Figure 1). Specifically, SBP and DBP revealed gender match effects in anticipation of (PMP = .71 and .57) and during the actual CPT (PMP = .81 and .62). In addition, HR and CO showed gender match effects during anticipation (PMP = .61 and .35) and recovery (PMP = .36 and .51). HR responses during the actual CPT, on the other hand, supported a sex mismatch effect (PMP = .34). It should be noted that the gender match effects for HR and CO do not imply a relative increase of responses in the match condition but indicate the lack of decreases in these parameters in the match condition relative to the other conditions (see Figure 1). Furthermore, TPR showed no clear support for any of the match or mismatch models. There was a moderate probability for a gender mismatch effect during recovery (PMP = .40), but this PMP hardly exceeded the probability of the unconstrained model (PMP = .37). Contrary to most physiological measures revealing match effects, the self-reported stress rating revealed a sex mismatch effect during anticipation (PMP = .83).

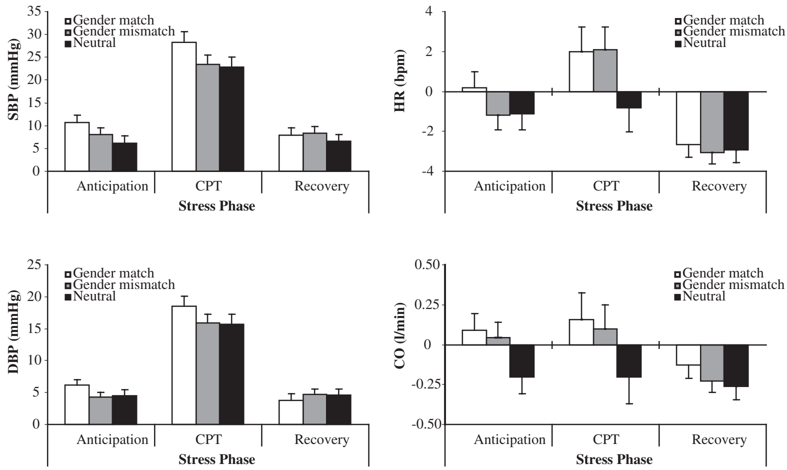
The n-back task. Responses on CO during recovery only gave rise to the expected gender match effect (PMP = .75). Nevertheless, physiological

Table 2
Posterior Model Probabilities on Cardiovascular and Subjective Measures by Stressor, Stress Phase, and Model

	CPT (n = 94)						N-Back Task (n = 97)					
	Cardiovascular					Subjective	Cardiovascular					Subjective
Stress Phase/Model	SBP	DBP	HR	CO	TPR	SAM	SBP	DBP	HR	CO	TPR	SAM
Anticipation												
Model 1: sex match	.02	.00	.02	.26	.00	.00	.01	.01	.23	.09	.00	.09
Model 2: gender match	.72	.57	.61	.35	.02	.02	.14	.06	.01	.25	.03	.36
Model 3: sex mismatch	.22	.35	.03	.08	.02	.83	.75	.75	.03	.26	.51	.10
Model 4: gender mismatch	.01	.00	.00	.05	.01	.06	.05	.08	.62	.09	.08	.02
Model 5: unconstrained	.03	.08	.34	.27	.95	.09	.05	.10	.11	.31	.38	.43
Stressor												
Model 1: sex match	.04	.04	.13	.28	.00	.20	.00	.01	.02	.01	.02	.29
Model 2: gender match	.81	.62	.21	.23	.03	.17	.00	.00	.00	.01	.00	.29
Model 3: sex mismatch	.01	.03	.34	.07	.01	.12	.53	.26	.05	.05	.16	.06
Model 4: gender mismatch	.00	.00	.19	.05	.00	.14	.37	.60	.54	.03	.74	.05
Model 5: unconstrained	.14	.31	.11	.37	.96	.37	.10	.13	.39	.91	.08	.32
Recovery												
Model 1: sex match	.25	.16	.28	.01	.22	.28	.08	.03	.02	.02	.01	.10
Model 2: gender match	.15	.03	.36	.51	.00	.14	.02	.01	.02	.75	.00	.48
Model 3: sex mismatch	.10	.05	.05	.33	.00	.04	.10	.11	.01	.01	.14	.03
Model 4: gender mismatch	.22	.25	.04	.01	.40	.08	.60	.68	.01	.00	.79	.00
Model 5: unconstrained	.28	.51	.26	.15	.37	.45	.19	.17	.94	.22	.06	.38

Note: CPT = Cold Pressor Test; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate; CO = cardiac output; TPR = total peripheral resistance; SAM = Self-Assessment Manikin. The posterior model probabilities of Models 1 to 5 add up to 1. The posterior model probability of each model should be interpreted in the context of the probabilities of the total set of models.

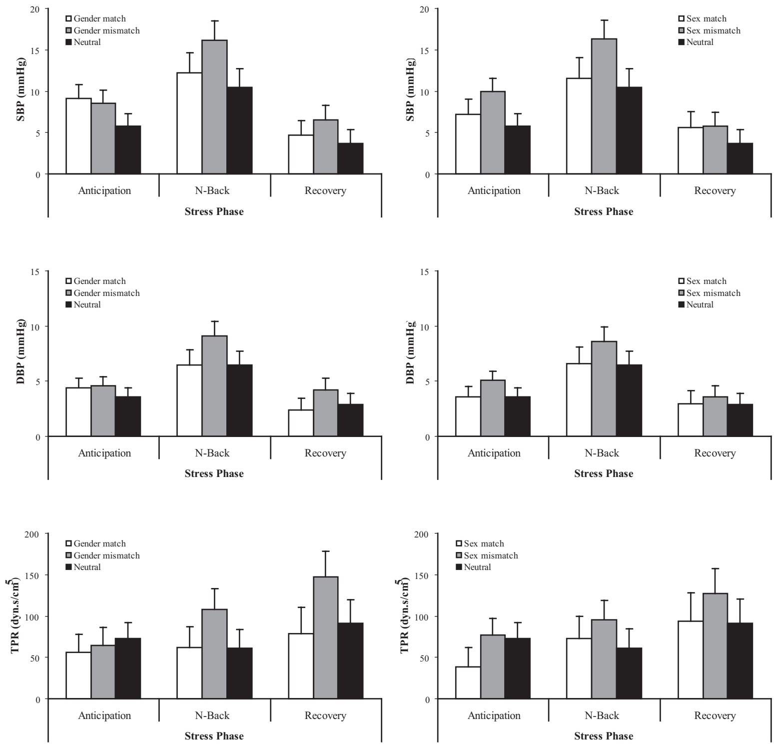
Figure 1
Cold Pressor Test (CPT): Mean Gender Match Effects in Change From Baseline by Stress Phase



Note: CO = cardiac output; DBP = diastolic blood pressure; HR = heart rate; SBP = systolic blood pressure.

parameters generally supported mismatch effects (see Figure 2). The vascular measures, SBP, DBP, and TPR, demonstrated a similar pattern of results. That is, these parameters revealed sex mismatch effects during anticipation (PMP = .75, 75, and .51, respectively), along with sex and gender mismatch effects during the actual n-back task (PMPs ranging from .16 to .74). Note that the model probabilities for the sex mismatch effects on DBP and TPR seem small (PMP = .26 and .16), but that support for these sex mismatch models was 2 times larger than support for the unconstrained models (PMP = .13 and .08). In addition, during recovery SBP and DBP revealed gender mismatch effects (PMP = .60 and .68), and TPR showed a gender mismatch effect (PMP = .79), as well as a sex mismatch effect (PMP = .14). Furthermore, HR revealed a gender mismatch effect in anticipation of and for the actual stressor phase (PMP = .62 and .54). And again, contrary to most physiological measures revealing mismatch effects, the self-reported stress rating revealed a gender match effect for recovery (PMP = .48).

Figure 2
The N-Back Task: Mean Gender Mismatch Effects (left plots) and Sex Mismatch Effects (right plots) in Change From Baseline by Stress Phase



Note: DBP = diastolic blood pressure; SBP = systolic blood pressure; TPR = total peripheral resistance.

Discussion

Taken together, our results further support the assumption that cardiovascular stress responses are in part a function of the interaction between one's sex or gender role identification and the gender relevance of the stressor. However, which combination (i.e., match or mismatch) increased the cardiovascular stress response differed by stressor type. As expected, the results for the CPT support the match hypothesis. In line with previous studies demonstrating gender match effects (Kolk & van Well, 2007; Lash et al., 1990; Martz et al., 1995), participants showed relatively increased physiological stress responses in the condition that matched their gender role identification. Nevertheless, in demonstrating more pronounced cardiovascular responses in the condition that mismatched participants' sex or gender, the results for the n-back task support a mismatch model, contrary to expectations. This latter finding is nevertheless consistent with those of Davis and Matthews (1996) and Wright et al. (1997).

Wright et al. (1997) proposed that the impact of the gender relevance of a stressor depends on the difficulty of the stressor. Following Wright et al.'s ability perspective, tasks of relatively moderate difficulty should elicit match effects, whereas easy tasks should demonstrate mismatch effects. For the present study, task demands on the CPT and the n-back task were estimated to be of moderate difficulty, presuming match effects on both stressors. Thus, the ability hypothesis seems inadequate to account for the reported mismatch effects on the n-back task.

An explanation for the discrepant match and mismatch effects on the CPT and the n-back task could be a difference in task demands, that is, passive versus active coping, respectively. Because active stressors require participants to actively engage in task performance, whereas passive stressors (more or less) simply have to be endured, the former type of stressors are assumed to elicit challenge appraisals, whereas the latter are assumed to induce threat appraisals (Tomaka, Blascovich, Kelsey, & Leitten, 1993). Following Tomaka et al. (1993), individuals perceive threatening situations in terms of the potential for loss but challenging situations in terms of the potential for gain as well as loss. Therefore, it could be argued that under threatening task demands, sex- or gender-matched individuals may perceive failure as a bigger threat to their self-worth, try harder, and consequently show greater increases in cardiovascular response to the task than mismatched individuals (a match effect). However, when task demands are challenging, matched individuals may perceive success as possible and feel capable to deal with the task, whereas mismatched individuals may feel less capable, perceive the task as more difficult, try harder, and accordingly reveal more responsiveness than their matched counterparts (a mismatch effect). Additional analyses on the postexperimental questions regarding threat and challenge support this assumption. On the CPT, relative to the n-back task, participants reported having experienced more threat ($M = 2.45$ vs. 2.12), $F(1, 107) = 3.84$, $p < .05$, $d = 0.24$, and less challenge ($M = 4.42$ vs. 5.02), $F(1, 107) = 9.26$, $p < .005$, $d = 0.38$. Nevertheless, the reported discrepant match and mismatch findings need to be interpreted cautiously and await replication. Future research should be further focused on the conditions under which match or mismatch effects occur, taking into account active versus passive coping task demands. Another issue that could be examined within this regard is the role of feedback. Incorrect responses on the n-back task were followed by an unpleasant beep, whereas feedback on the CPT was absent.

To allow for a detailed analysis of blood pressure responses, the underlying parameters of CO and TPR were examined. Regardless of condition, the CPT and the n-back task elicited vascular and cardiac response patterns, respectively. However, with regard to the hypothesis that the effect of stressor relevance would be more pronounced on those hemodynamic parameters typically increased by the stressor, findings were negative. Contrary to the results of Kolk and van Well (2007) demonstrating match effects on the vascular parameters of the CPT, the present CPT revealed gender match effects on CO but not on TPR. In addition, n-back task results showed sex and gender mismatch effects on TPR rather than on CO. Why these hemodynamic response patterns emerged remains to be elucidated. Nevertheless, these results might have implications for future research considering the association between variations in hemodynamic response patterns and health risks. However, because these results are the first of their kind, they indicate a need for replication.

As expected, the indirect classification of gender role identification through the GIAT proved to be more useful in examining gender match and mismatch effects than the more direct classification of gender role identification by the GRS scales. Because match and mismatch effects on cardiovascular responding are assumed to be relatively automatic processes, this finding is in line with the double-dissociation model postulated by Fazio (1990), in which direct and indirect attitudes are better predictors of controlled and automatic behavior, respectively. The finding is also consistent with the study of van Well et al. (2007) in which GIAT score was a significant predictor of SBP responses to a relatively masculine stressor, whereas more direct measurement procedures of gender role identification, including the GRS scales, had no such predictive power. Together, these data support the GIAT as a useful tool for identifying people who adhere to gender role values and who are likely to become more stressed when they encounter situations that are relevant to their own or the opposite gender role.

Stressor relevance differentially affected cardiovascular and subjective stress responses. The physiological stress measures generally supported match effects on the CPT and mismatch effects on the n-back task, whereas the subjective stress rating supported a mismatch effect on the CPT along with a match effect on the n-back task. We assumed that the appraisal of the stressor as relevant and the subsequent heightened cardiovascular responses are rather automatic processes. The subjective rating of stress, on the other hand, is a relatively more controlled process. Therefore, it is not striking to find the effects of stressor relevance on the subjective experience of stress to fall out of line with those on cardiovascular responding. Additional correlation analyses revealed that the subjective response levels generally dissociated from the physiological response levels (average $r = .09$ and .07, for the CPT and the n-back task, respectively, all p values > .05). This dissociation further indicates that participants' self-reported experience of stress did not reflect their physiological responding.

Our unconventional statistical approach, the Bayesian model selection procedure for inequality constrained models (2005), proved to be valuable. A Bayesian model selection procedure determines which theory (translated into one or more models imposing inequality constraints on group means) fits the data best. That is, it provides a measure for the relative fit for each of the models. The major appeal of this approach is that match and mismatch effects could be tested directly and that these competing theories could be evaluated within one and the same analysis. Interpretation of the data depends on which models one chooses to consider. Removing or adding models could have changed the results.

The findings of the present study should be interpreted in the light of some limitations. A first limitation is the use of a student sample. Because gender role identification is less strong in a student population than in a more heterogeneous group of participants, the inclusion of students only may have weakened the effects. An additional limitation is that for both stressors, the self-reported PEQ ratings did not indicate that the experimental manipulation altered participants' perceptions of the stressor. That is, participants in the feminine- and masculine-relevant conditions did not rate the task as requiring more feminine- and masculine-related characteristics, respectively. However, because it is assumed that the appraisal of the gender relevance of a stressor occurs automatically, it could be argued that this direct check on participants' perceptions of the task is ineffective. Therefore, the value of the manipulation check could, at least, be questioned.

In sum, we tested the hypothesis that a match between sex or gender role identification and the gender relevance of a stressor would lead to relatively heightened cardiovascular responding. In general, our findings provide further evidence that the magnitude of cardiovascular stress depends on a combination between individual characteristics, on one hand,

and situational demands on the other. Which combination (i.e., match or mismatch) increased the stress response differed by stressor type. Nevertheless, it can be concluded that the process of cognitive appraisal of a stressor outlines an individual variability in the stress response. Because it is assumed that individual differences in cardiovascular response may (partially) account for cardiovascular disease risks, the combined effect of individual characteristics and situational demands might account for differential health risk. Then, as Lash et al. (1990) pointed out, "one cannot characterize individuals as hyperreactive without first specifying the situation" (p. 18). Nonetheless, in specifying the situation, much research still lies ahead.

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