Cardiovascular responses across stressor phases: The match of gender and gender-role identification with the gender relevance of the stressor

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Abstract

Objective: To test the hypothesis that cardiovascular responses across stressor phases (anticipation, stressor, recovery) are higher when gender or gender-role identification match with the gender relevance of the stressor than in case of a mismatch and gender irrelevance which are not supposed to differ.

Methods: In a double-blind design, 151 healthy women and men were assigned to the Cold Pressor Test with feminine, masculine, or gender-irrelevant introductions.

Results: The pattern of responding was vascular [high on systolic blood pressure (SBP), diastolic blood pressure (DBP), and total peripheral resistance (TPR), and relatively low on heart rate, stroke volume, and cardiac output] across stressor phases. SBP, DBP, and TPR responses supported the gender match hypothesis, although men showed higher TPR responses to irrelevance than to mismatch. DBP and TPR responses supported the gender-role identification match hypothesis.

Conclusion: The match–mismatch–irrelevance paradigm contributes to the understanding of gender differences in stress responses and related health risks.

Keywords: Cardiovascular responses; Gender; Gender-role identification; Anticipation; Cold Pressor Test; Recovery

Introduction

Health differences between women and men are well documented [1–3]. One of the underlying mechanisms may be a differential response to stressful situations, which in due course may damage health (e.g., higher rates of cardiovascular disease in younger men may be explained by differences in stress response). However, research on cardiovascular reactivity to laboratory stressors showed mixed results with regard to gender differences [4–8]. These inconsistent findings have been attributed to the type of stressor under investigation [i.e., cognitive stressors (reaction time, memory tests) vs. social stressors [9–11]. It was then assumed that these stressor-related differences in reactivity should be understood in relation to their gender relevance. A gender-relevant stressor is characterized by contexts associated with sociocultural norms about what is appropriate for women and men in regard to which it is more important to succeed for women and men, respectively, thereby having distinct effects on effort. The impact of a gender-relevant stressor depends on what gendered information is represented in memory and on how this information is organized. Differences among men and among women are then reflected by differences in gender-role identification (i.e., the adherence to gender-appropriate behavior). Higher cardiovascular responses are then expected when a stressor is automatically appraised as gender-relevant and taps the importance of maintaining the integrity of gender-role identification, that is, in case of a match between gender (role identification) and gender relevance of the stressor.

Three studies found gender match effects on systolic blood pressure (SBP), whereas findings were mixed on diastolic blood pressure (DBP) and heart rate (HR) [10–12]. One study found no effects [13]. However, their negative findings have been attributed to order effects [11] and the
The present study expanded upon earlier studies by addressing most of the above issues. In a double-blind design we tested match effects on six cardiovascular parameters over four stressor phases in adult women and men while controlling for age, BMI, hormonal status, and daily stress. The CPT was chosen as a relatively gender-neutral stressor of relatively high difficulty. Gender relevance was manipulated by feminine, masculine, and neutral introductions to the CPT, suggesting a research-related association between hand in the water and personal characteristics related to gender stereotypes, but without any reference to men or women, masculinity or femininity, or hormones. It was assumed that cardiovascular responses across stressor phases would be stronger in case of a gender match than a gender mismatch and irrelevance, whereas responses in case of mismatch and irrelevance were not expected to differ. In addition, we examined match effects of indirectly measured gender-role identification, determined post hoc.

Methods

Participants

Participants were recruited via advertisements in local newspapers and word of mouth. Of 238 respondents screened over the telephone, 169 (71%) met the criteria for eligibility. They were included in the study if they were between 18 and 60 years old, were normotensive (blood pressure less than 140/90 mm Hg), and had a BMI (kg/m²) between 18 and 27. They were excluded if they had a history of cardiovascular disease or chronic disease requiring medical attention or any current use of prescribed medication. Of the 169 respondents scheduled to the laboratory session, 14 did not show up because they forgot, did not have time, or did not want to attend. Participants had to refrain from cigarettes, caffeine, and alcohol for at least 8 h before the session as well as from food and exercise for at least one and a half hours before the session. One participant was rescheduled for not meeting these last criteria. Three participants withdrew from the study during the laboratory session for reasons of anxiety. Data of one subject were excluded because of measurement failure. The final sample consisted of 75 white men and 76 white women between 19 and 57 years old (mean = 32.22, S.D. = 10.5). The ethical board of our department approved the study protocol. Participants gave signed informed consent in which anonymity and the opportunity to withdraw were assured. They were paid $12 for their participation.

Experimental conditions

In addition to the general introduction that the study was about stress and the aim was to measure heart rate and blood pressure in response to ice water, the introductions to the CPT [hand up to the wrist in a container filled with ice water maintained at a temperature of 4°C (±1°C)] were varied and used to manipulate the gender relevance of the stressor. The
essence of the introductions was the suggestion of a research-related association between keeping the hand in the water and personal characteristics associated with gender stereotypes. In the masculine-relevant introduction, keywords were good physical condition and good sexual performance. In the feminine-relevant introduction, keywords were emotional supportiveness and the tendency to form close and lasting relationships. In the gender-irrelevant introduction, participants were instructed to keep their hand in the water in order to get proper physiological measures. All three introductions shown to the participants were of the same length and differed in formulation with regard to the keywords only.

Cardiovascular measurements

Blood pressure and heart rate were measured continuously and noninvasively using the Finapres 2300 monitor (Ohmeda, Englewood, CO). Finapres measurements were obtained via a finger cuff applied to the mid-phalanx of the third finger of the left hand. Accuracy and precision of changes in blood pressure as measured with the Finapres have been shown sufficiently reliable (e.g., [26]). Finger artery pressure wave was analyzed using Beatoscope software that includes the Modelflow method generating hemodynamic parameters like SV, CO, and TPR (TNO Biomedical Instrumentation, Amsterdam, The Netherlands). Good agreement of these parameters has been obtained with intra-arterial measures (e.g., [27–31]). This study measured SBP (mmHg), DBP (mmHg), TPR [mmHg·s/ml (MU)], HR (bpm), SV (ml), and CO (l/min).

Subjective measurements

Person Characteristics Questionnaire

According to current classification, a short questionnaire assessed age, gender, educational level, marital status, length, weight, BMI, and right/left-handedness [32,33]. In addition, the questionnaire assessed menopausal status, use of oral contraceptives, and menstrual cycle phase (follicular or luteal) derived from cycle length and first day of last menstruation period.

Gender Role Stress questionnaire

The Gender Role Stress (GRS) questionnaire consists of two subscales: the Masculine Gender Role Stress (MGRS) scale [34] and the Feminine Gender Role Stress (FGRS) scale [35]. The MGRS scale contains 40 statements describing situations that refer to failure to meet the standards of the masculine gender role, for example, “appearing less athletic than a friend.” The FGRS scale consists of 39 items regarding situations that refer to failure to meet the standards of the feminine gender role, for example, “being perceived by others as overweight.” Items were rated on a six-point Likert scale ranging from 0 (not stressful) to 5 (extremely stressful). Several studies found the reliability to be satisfactory to good and supported the validity of both scales [34–39]. The GRS was translated into Dutch according to back-translation rules [40,41]. This version was found highly reliable and cross-culturally valid [42]. Similar to the reviewed studies, gender-role identification was operationalized with median splits on the scores of the MGRS and FGRS scales (2.33 and 3.18, respectively). This resulted in two categories, that is, feminine (high FGRS + low MGRS) and masculine (high MGRS + low FGRS).

Survey of Recent Life Experiences

Exposure to daily hassles was assessed by the shortened version of the Survey of Recent Life Experiences (SRLE), containing 41 items [43]. Each item describes a daily hassle, such as “being let down or disappointed by friends” or “too many things to do at once.” Items were rated on a four-point Likert scale ranging from 1 (not at all part of my life) to 4 (very much part of my life over the past month). The SRLE proved highly reliable and valid [43–45]. The SRLE was translated into Dutch according to back-translation rules. The Dutch version was found highly reliable and cross-culturally valid [46].

Postexperiment ratings

Participants were asked to what extent they considered the research-related associations suggested in the introduction to the CPT to be true. In addition, they indicated the extent of effort, adequate coping, challenge, and threat during the CPT. All items were rated on a seven-point scale.

Procedure

Screening

Respondents were first informed about the study over the telephone. They were told that the study was about stress and that the aim was to measure their heart rate and blood pressure in response to ice water while carefully avoiding any reference to sex or gender differences. After that, inclusion and exclusion criteria were applied. If they met the criteria they were invited to our department to be tested individually.

Preparation

Participants arrived at the laboratory between 8:45 a.m. and 1:30 p.m. Start of the session did not significantly differ across experimental conditions or genders and did not significantly correlate with increase above baseline levels. One of the two female experimenters again informed the subject and showed the laboratory. Participants were seated in one room of a sound-attenuated, temperature-controlled suite. Next, inclusion and exclusion criteria were checked again. Then, participants read and signed the informed consent form and completed the Person Characteristics Questionnaire. After that, the experimenter attached an appropriate-sized finger cuff of the Finapres. Finger and arm
were positioned so that they were on a level with the heart, with the use of towels if necessary. Participants were told to minimize all movement while seated and that questionnaires and all further instructions would be provided on the monitor placed opposite to the subject, but that the session would be monitored using the intercom. She then went to the adjacent room.

Randomization

One of the authors (A.K.) developed the randomization code stratified according to gender using a random-number table and two sets of sealed envelopes, each bearing only a sequence number, representing the assigned condition and order of questionnaires. Directly after the first experimenter had returned to the experimenter’s room, the other opened the envelope with the appropriate number and started the relevant computer program with the prescribed instructions and order of questionnaires. Thus, the experimenters were blind with regard to the condition to which the subject was assigned until they opened the envelope and started the computerized protocol. They had no contact with the subject until the end of the experiment unless something went wrong. Participants were randomly assigned to two of four female experimenters. Gender of experimenter was not varied because gender has been shown to have no significant effect in an earlier study [11] and contact between participant and experimenter was minimal.

Questionnaires

First, GRS and SRLE were administered in random order (maximum duration, 30 min each). No significant effects of order of questionnaires on the dependent variables were found. The questionnaires were presented item by item on the computer monitor. Participants were instructed to respond to each item by pressing the appropriate key on the keyboard. Once a question was answered, the next question was automatically presented.

Stressor phases

After adaptation to the Finapres and completion of the questionnaires, participants were asked via the monitor to relax for 10 min (baseline). Following baseline measurement, the gender relevance of the stressor was manipulated. Participants were shown a masculine-relevant, feminine-relevant, or gender-irrelevant introduction of the CPT and a 3-min measurement was conducted (anticipation). Following the anticipation phase, participants were instructed to put and keep their right hand in the ice water. During the immersion, a 2-min measurement was performed (CPT). After the CPT, participants were instructed to remove their hand from the water and relax for 10 min (recovery).

Postexperiment ratings and debriefing

Postexperiment items were presented item by item on the computer monitor. Participants rated each item on a seven-point scale by pressing the appropriate key on the keyboard. Then, one of the experimenters removed the finger cuff, informed the participants about the true aim of the study, asked them if there were any questions, and paid them.

Data reduction and statistical analyses

SBP, DBP, TPR, HR, SV, and CO data were averaged into 3-min means for baseline, 3-min means for anticipation, 2-min means for CPT, and 4-min means for recovery. Differences between conditions with regard to sample characteristics, postexperiment ratings, and baseline data were tested with $\chi^2$ tests or univariate analyses of variance (ANOVA).

Repeated-measures ANOVAs on cardiovascular variables were separately conducted. The effectiveness of stress induction was tested with condition (feminine, masculine, irrelevant) or gender as between-subjects factor and stressor phase (baseline, anticipation, CPT, recovery) as within-subjects factor. The gender match hypothesis was tested with gender and condition as between-subjects factors and stressor phase (anticipation, CPT, recovery) as within-subjects factor and baseline levels as covariate.

The Greenhouse–Geisser was applied to correct for the violation of the sphericity assumption where appropriate. Significant univariate $F$ ratios for the expected Gender-$\times$Condition interactions or stressor phase were followed by planned contrasts for repeated-measurement designs, whereas post hoc contrasts were tested by pairwise comparisons with Bonferroni adjustments. Effect sizes were computed as Eta squared ($\eta^2$) values or partial Eta squared ($\eta^2_p$) representing the proportion of the effect + error variance attributable to the effect. The gender-role identification match hypothesis was separately tested accordingly [22,47–50]. All analyses were conducted using SPSS 11 for Mac OS X.

Results

Sample characteristics

Twenty-two participants did not complete the 2-min CPT. Six pulled their hands out during the first minute, whereas 16 did so during the second minute. However, removal of the hand from the water did not significantly differ across experimental conditions and genders. In addition, as cardiovascular measurements were continuously obtained, sufficient data were available to include their data in subsequent analyses. Age, dominant hand, educational level, and marital status did not significantly differ between experimental groups and genders. Hormonal status (oral contraceptive, follicular and luteal phases, menopause), gender-role identification, and BMI did not differ between conditions, whereas SRLE did not differ between genders. As expected, a gender difference was found with regard to
gender-role identification \( \chi^2(3)=30.10, P<.0005 \); that is, more women had feminine gender-role identification, whereas more men had masculine gender-role identification. A gender difference was found on BMI \( F(1,145)=10.84, P=.001 \). Women had a lower BMI than men (mean=21.77, S.D.=1.95 and mean=22.84, S.D.=2.00, respectively). A condition effect was found on SRLE \( F(2,148)=3.01, P=.05 \). However, pairwise comparisons indicated that there were no significant differences between conditions. Both BMI and SRLE did not significantly correlate with increases above baseline levels.

### Stress induction

The CPT effectively induced cardiovascular arousal in the three experimental conditions. Whereas conditions did not significantly differ, significant differences between stressor phases were found for all six cardiovascular variables. Moreover, Stressor phase\(\times\)Condition interactions were significant for HR and CO, both due to nonsignificant differences between anticipation and CPT in the gender-irrelevant condition. As expected, planned contrasts indicated that SBP, DBP, and TPR values significantly increased from baseline to anticipation \( (P's<.0003, \eta^2_p=0.05–0.39) \), to CPT \( (P's<.0003, \eta^2_p=0.77–0.80) \), and then declined in the recovery phase \( (P's<.0005, \eta^2_p=0.75–0.78) \) to anticipation level, that is, above baseline \( (P's<.0005 \text{ to } <.003) \). HR and CO values did not significantly increase from baseline to anticipation, but then significantly increased to CPT \( (P's<.0003, \eta^2_p=0.10–0.23) \) and after that declined in the recovery phase \( (P's<.0003, \eta^2_p=0.20–0.43) \) to a level under \( P<.0005 \) and on baseline, respectively. SV values did not significantly change from baseline to anticipation as well, but then significantly decreased to CPT \( (P=.008, \eta^2_p=0.04) \) and after that increased in the recovery phase \( (P=.004, \eta^2_p=0.05) \) to baseline level. Overall, as effect sizes for SBP, DBP, and TPR were substantially higher than for HR, SV, and CO in all three stressor phases and the relatively moderate increase in CO (HR increase compensated by SV decrease) compared to TPR, the pattern of responding was vascular rather than myocardial.

With regard to gender differences in cardiovascular responses, no significant differences or interactions with condition or stressor phase were found on SBP and TPR. Men, overall, showed higher responses on DBP, SV, and CO than women \( [F's(1,149)=11.39–27.07, P's<.001 \text{ to } .005, \eta^2_p=0.07–0.15] \), whereas women, compared to men, showed higher responses on HR \( [F(1,149)=9.19, P=.003, \eta^2_p=0.06] \). These gender differences are explained by differences in baseline levels, not their reactivity. Relative

### Table 1

Adjusted means and standard errors of hemodynamic variables by condition, gender, and stressor phase \( (n=151) \)

<table>
<thead>
<tr>
<th></th>
<th>SBP (mmHg) Mean (S.E.)</th>
<th>DBP (mmHg) Mean (S.E.)</th>
<th>TPR (MU) Mean (S.E.)</th>
<th>HR (bpm) Mean (S.E.)</th>
<th>SV (ml) Mean (S.E.)</th>
<th>CO (l/min) Mean (S.E.)</th>
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<tbody>
<tr>
<td><strong>Feminine-relevant</strong></td>
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<tr>
<td>Women</td>
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<tr>
<td>Anticipation</td>
<td>133.0 (1.1)</td>
<td>74.2 (0.5)</td>
<td>1.089 (0.018)</td>
<td>71.3 (0.5)</td>
<td>78.0 (0.9)</td>
<td>5.48 (0.08)</td>
</tr>
<tr>
<td>Cold Pressor</td>
<td>155.8 (2.3)</td>
<td>88.1 (1.4)</td>
<td>1.811 (0.056)</td>
<td>77.7 (1.3)</td>
<td>77.6 (1.7)</td>
<td>6.00 (0.13)</td>
</tr>
<tr>
<td>Recovery</td>
<td>133.8 (1.4)</td>
<td>74.1 (0.8)</td>
<td>1.089 (0.024)</td>
<td>68.1 (0.6)</td>
<td>80.9 (1.5)</td>
<td>5.43 (0.10)</td>
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<tr>
<td><strong>Masculine-relevant</strong></td>
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<tr>
<td>Men</td>
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<tr>
<td>Anticipation</td>
<td>131.7 (1.1)</td>
<td>72.4 (0.5)</td>
<td>1.002 (0.018)</td>
<td>71.6 (0.6)</td>
<td>83.0 (0.9)</td>
<td>5.86 (0.08)</td>
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<tr>
<td>Cold Pressor</td>
<td>149.3 (2.3)</td>
<td>81.8 (1.5)</td>
<td>1.586 (0.057)</td>
<td>74.9 (1.3)</td>
<td>81.6 (1.7)</td>
<td>6.04 (0.13)</td>
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<tr>
<td>Recovery</td>
<td>132.1 (1.5)</td>
<td>73.4 (0.8)</td>
<td>1.006 (0.025)</td>
<td>69.1 (0.6)</td>
<td>85.1 (1.5)</td>
<td>5.80 (0.11)</td>
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<tr>
<td><strong>Gender-irrelevant</strong></td>
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<tr>
<td>Women</td>
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<tr>
<td>Anticipation</td>
<td>134.5 (1.1)</td>
<td>73.6 (0.5)</td>
<td>1.043 (0.018)</td>
<td>71.0 (0.6)</td>
<td>81.8 (1.0)</td>
<td>5.74 (0.08)</td>
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<tr>
<td>Cold Pressor</td>
<td>155.0 (2.4)</td>
<td>86.1 (1.5)</td>
<td>1.812 (0.058)</td>
<td>74.9 (1.4)</td>
<td>78.2 (1.7)</td>
<td>5.89 (0.14)</td>
</tr>
<tr>
<td>Recovery</td>
<td>131.4 (1.5)</td>
<td>73.4 (0.8)</td>
<td>1.077 (0.025)</td>
<td>68.9 (0.6)</td>
<td>80.7 (1.5)</td>
<td>5.48 (0.11)</td>
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<td>Men</td>
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<tr>
<td>Anticipation</td>
<td>134.2 (1.1)</td>
<td>73.4 (0.5)</td>
<td>1.055 (0.018)</td>
<td>70.9 (0.6)</td>
<td>80.7 (1.0)</td>
<td>5.65 (0.08)</td>
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<tr>
<td>Cold Pressor</td>
<td>150.9 (2.3)</td>
<td>83.3 (1.5)</td>
<td>1.724 (0.057)</td>
<td>74.9 (1.3)</td>
<td>80.1 (1.7)</td>
<td>5.91 (0.13)</td>
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<tr>
<td>Recovery</td>
<td>129.2 (1.5)</td>
<td>72.3 (0.8)</td>
<td>1.060 (0.025)</td>
<td>68.9 (0.6)</td>
<td>80.0 (1.5)</td>
<td>5.43 (0.11)</td>
</tr>
</tbody>
</table>

to women, men had higher baseline levels on DBP, SV, and CO \( F(1,145)=10.42-25.15, P^b<.0005 \) to .001, \( \eta^2_p=0.7-0.15 \), whereas women had higher HR levels than men \( F(1,145)=8.44, P=.004, \eta^2_p=0.06 \).

**Postexperiment ratings**

No significant effects of condition, gender, or their interaction were found with regard to effort (mean=4.56, S.D.=1.78), adequate coping (mean=4.32, S.D.=1.65), challenge (mean=3.84, S.D.=1.78), and threat (mean=2.15, S.D.=1.57) during the CPT. The same applied to ratings of belief except that the gender-irrelevant instruction to the CPT was best believed (mean=5.15, S.D.=2.1), followed by the feminine-relevant (mean=3.52, S.D.=2.5) and the masculine-relevant (mean=2.21, S.D.=1.6) \( F(2,132)=21.48, P^b<.0005, \eta^2_p=0.25 \).

**Gender match effects**

A gender match concerned women in the feminine-relevant condition and men in the masculine-relevant condition, whereas a mismatch involved women in the masculine-relevant condition and men in the feminine-relevant condition, and irrelevance concerned women and men in the gender-irrelevant condition (see Table 1 for means and standard errors). The expected Gender×Condition interactions were significant for all cardiovascular variables except for HR \( F(2,144), SBP=3.53, P=0.03, \eta^2_p=0.05; DBP=6.84, P<.001, \eta^2_p=0.09; TRP=8.42, P<.0005, \eta^2_p=0.11; SV=3.67, P=.03, \eta^2_p=0.05; CO=3.55, P=.03, \eta^2_p=0.05 \).

To analyze Gender×Condition interactions further and specifically test the gender match hypothesis, planned contrasts analyses were conducted on SBP, DBP, TRP, SV, and CO responses. As expected, higher responses were shown in case of a match than in case of a mismatch and of irrelevance on SBP, DBP, and TRP (\( P=.0007, \eta^2=0.07; P=.002, \eta^2=0.06; \) and \( P=.03, \eta^2=0.03 \), respectively). Also, as expected, responses in case of a mismatch and of irrelevance did not differ for SBP and DBP, but for TRP, in women only. On TRP, men showed higher responses in case of irrelevance than of mismatch (\( P=.0007, \eta^2=0.05 \)). Contrary to expectations, match responses were not significantly stronger than mismatch and irrelevance responses with regard to SV and CO, whereas responses were stronger in case of mismatch than of irrelevance (\( P=0.01, \eta^2=0.04 \) and \( P=.001, \eta^2=0.07 \), respectively).

Furthermore, results showed neither significant gender differences nor significant Phase×Condition and Phase×Condition×Gender interactions. Response patterns from

**Table 2**

<table>
<thead>
<tr>
<th></th>
<th>SBP (mmHg)</th>
<th>DBP (mmHg)</th>
<th>TPR (MU)</th>
<th>HR (bpm)</th>
<th>SV (ml)</th>
<th>CO (l/min)</th>
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<tbody>
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<td><strong>Feminine</strong></td>
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<tr>
<td>Anticipation</td>
<td>130.9 (1.9)</td>
<td>72.9 (0.9)</td>
<td>1.079 (0.025)</td>
<td>71.1 (1.0)</td>
<td>80.1 (1.4)</td>
<td>5.61 (0.11)</td>
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<tr>
<td>Cold Pressor</td>
<td>156.6 (4.8)</td>
<td>90.8 (2.8)</td>
<td>1.977 (0.110)</td>
<td>77.6 (2.7)</td>
<td>77.2 (3.3)</td>
<td>5.85 (0.25)</td>
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<td>Recovery</td>
<td>132.5 (2.4)</td>
<td>73.7 (1.4)</td>
<td>1.103 (0.052)</td>
<td>67.7 (1.2)</td>
<td>80.2 (2.6)</td>
<td>5.41 (0.19)</td>
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<td><strong>Masculine</strong></td>
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<tr>
<td>Anticipation</td>
<td>131.8 (1.6)</td>
<td>70.9 (0.8)</td>
<td>0.960 (0.021)</td>
<td>73.1 (0.8)</td>
<td>86.0 (1.2)</td>
<td>6.16 (0.09)</td>
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<tr>
<td>Cold Pressor</td>
<td>145.4 (4.1)</td>
<td>77.2 (2.5)</td>
<td>1.432 (0.095)</td>
<td>76.1 (2.2)</td>
<td>87.0 (2.7)</td>
<td>6.44 (0.21)</td>
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<td>Recovery</td>
<td>131.0 (2.1)</td>
<td>71.1 (1.2)</td>
<td>0.892 (0.044)</td>
<td>69.8 (1.0)</td>
<td>92.1 (2.2)</td>
<td>6.31 (0.16)</td>
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<td><strong>Masculine-relevant</strong></td>
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<tr>
<td>Anticipation</td>
<td>136.8 (2.0)</td>
<td>73.4 (1.0)</td>
<td>1.000 (0.027)</td>
<td>73.1 (1.1)</td>
<td>84.4 (1.5)</td>
<td>6.03 (0.12)</td>
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<tr>
<td>Cold Pressor</td>
<td>155.0 (5.1)</td>
<td>86.0 (3.1)</td>
<td>1.711 (0.119)</td>
<td>76.8 (2.9)</td>
<td>79.8 (3.5)</td>
<td>6.17 (0.26)</td>
</tr>
<tr>
<td>Recovery</td>
<td>135.1 (2.6)</td>
<td>73.1 (1.5)</td>
<td>1.000 (0.055)</td>
<td>70.2 (1.3)</td>
<td>87.3 (2.8)</td>
<td>5.91 (0.20)</td>
</tr>
<tr>
<td><strong>Feminine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticipation</td>
<td>131.4 (1.9)</td>
<td>71.8 (0.9)</td>
<td>0.998 (0.025)</td>
<td>71.2 (1.0)</td>
<td>84.4 (1.4)</td>
<td>5.93 (0.11)</td>
</tr>
<tr>
<td>Cold Pressor</td>
<td>148.2 (4.8)</td>
<td>82.7 (2.8)</td>
<td>1.646 (0.110)</td>
<td>77.9 (2.6)</td>
<td>81.7 (3.2)</td>
<td>6.17 (0.24)</td>
</tr>
<tr>
<td>Recovery</td>
<td>130.1 (2.4)</td>
<td>72.1 (1.4)</td>
<td>1.045 (0.051)</td>
<td>68.8 (1.2)</td>
<td>82.3 (2.6)</td>
<td>5.61 (0.19)</td>
</tr>
<tr>
<td><strong>Gender-irrelevant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticipation</td>
<td>130.6 (1.8)</td>
<td>71.2 (0.9)</td>
<td>0.977 (0.023)</td>
<td>72.0 (0.9)</td>
<td>82.7 (1.3)</td>
<td>5.88 (0.10)</td>
</tr>
<tr>
<td>Cold Pressor</td>
<td>146.7 (4.5)</td>
<td>83.7 (2.7)</td>
<td>1.572 (0.104)</td>
<td>76.3 (2.4)</td>
<td>81.0 (3.0)</td>
<td>6.04 (0.23)</td>
</tr>
<tr>
<td>Recovery</td>
<td>130.1 (2.3)</td>
<td>71.4 (1.3)</td>
<td>0.996 (0.049)</td>
<td>69.0 (1.1)</td>
<td>83.5 (2.4)</td>
<td>5.67 (0.18)</td>
</tr>
<tr>
<td><strong>Masculine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticipation</td>
<td>129.0 (1.9)</td>
<td>71.4 (0.9)</td>
<td>1.006 (0.025)</td>
<td>70.7 (1.0)</td>
<td>82.4 (1.4)</td>
<td>5.76 (0.11)</td>
</tr>
<tr>
<td>Cold Pressor</td>
<td>153.5 (4.8)</td>
<td>84.4 (2.9)</td>
<td>1.845 (0.111)</td>
<td>67.0 (2.6)</td>
<td>83.5 (3.2)</td>
<td>5.51 (0.25)</td>
</tr>
<tr>
<td>Recovery</td>
<td>126.9 (2.4)</td>
<td>71.1 (1.4)</td>
<td>1.071 (0.052)</td>
<td>63.3 (1.2)</td>
<td>83.0 (2.6)</td>
<td>5.19 (0.19)</td>
</tr>
<tr>
<td>Baseline</td>
<td>126.9</td>
<td>70.0</td>
<td>0.989</td>
<td>71.6</td>
<td>82.5</td>
<td>5.82</td>
</tr>
</tbody>
</table>
anticipation to CPT to recovery were the same as reported earlier. Differences between conditions were significant for SBP, HR, and CO due to higher responses in the feminine-relevant than in the irrelevant condition (P=.04, P=.03, and P=.01, respectively) and higher SBP responses in the masculine-relevant than in the irrelevant condition (P=.05).

**Gender-role identification match effects**

A gender-role identification match concerned feminine identification+feminine-relevant condition and masculine identification+masculine-relevant condition, whereas a mismatch involved feminine identification+masculine-relevant condition and masculine identification+feminine-relevant condition, and irrelevance concerned the gender-irrelevant condition (see Table 2 for means and standard errors). The expected Gender×Condition interactions were significant for all cardiovascular variables except for SBP (F’s(2,44), DBP=4.82, P=.01, \( \eta^2_g = 0.18 \); TPR=11.24, P<.0005, \( \eta^2_g = 0.34 \); HR=4.88, P=.01, \( \eta^2_g = 0.18 \); SV=4.58, P=.02, \( \eta^2_g = 0.17 \); CO=12.25, P<.0005, \( \eta^2_g = 0.36 \]).

To further analyze these interactions and specifically test the gender-role identification match hypothesis, planned contrasts analyses were conducted. As expected, higher responses were shown in case of a match than in case of a mismatch and irrelevance on DBP and TPR (P=.004, \( \eta^2_g = 0.15 \) and P=.006, \( \eta^2_g = 0.13 \), respectively), and responses in case of a mismatch and of irrelevance did not differ. Contrary to expectations, match responses were not significantly stronger than mismatch and irrelevance responses with regard to HR and CO, whereas responses were stronger in case of mismatch than of irrelevance (P=.006, \( \eta^2_g = 0.16 \) and P=.0003, \( \eta^2_g = 0.26 \), respectively). SV responses were found to be lower in case of match compared to mismatch and irrelevance (P=.04, \( \eta^2_g = 0.07 \)), whereas mismatch and irrelevance did not significantly differ. Overall, gender-role identification effect sizes were consistently higher than gender match effect sizes.

Furthermore, response patterns from anticipation to CPT to recovery were the same as reported earlier and there were no significant Phase×Condition interactions. Results showed no significant differences on gender-role identification except for SV. Participants with masculine gender-role identification showed stronger SV responses than those with feminine identification (P=.01). Differences between conditions were significant for HR and CO due to higher responses in the feminine-relevant condition compared to the gender-irrelevant condition (P’s=.03) and in the masculine-relevant condition compared to the irrelevant condition (P=.02 and P=.04, respectively).

**Discussion**

This study tested the hypotheses that cardiovascular responses across stressor phases would be stronger in case of a gender or gender-role identification match than a gender or identification mismatch and irrelevance, whereas responses in case of mismatch and irrelevance were not expected to differ. Rather than a myocardial pattern of responding, the results showed a vascular pattern across stressor phases, more common for the Cold Pressor Test. In accordance with the gender match hypothesis, higher responses were found in case of a match than in case of a mismatch and of irrelevance on SBP, DBP, and TPR, whereas responses in case of a mismatch and of irrelevance did not differ for SBP, DBP, and TPR, although men showed higher responses on TPR in case of irrelevance than of mismatch. In contrast, HR, SV, and CO responses did not show the predicted pattern. Concerning the gender-role identification match, DBP and TPR data supported the hypothesis (match>mismatch=irrelevant). SBP data tended to show the same pattern, although the Condition×Gender identification interaction was not significant. Again, HR, SV, and CO responses did not show the predicted pattern. As gender-role identification effect sizes were consistently higher than gender match effect sizes, the effects of the gender-role identification match are more pronounced than those with regard to the gender match hypothesis.

These findings are consistent with as well as different from the match results of the studies reviewed earlier. Of the three CPT studies, one is most consistent with our findings by showing match effects on SBP and DBP [11], two found the effect on SBP, but one of them on HR as well [10,16]. Of the six studies using a psychological stressor, two showed the match effect on SBP [12,15], one on HR [17], and three found none [13,14,18]. Differences with our findings may be due to one or more of the variations among these studies, as described in the Introduction. Carefully addressing most of the issues mentioned have probably resulted in the stronger and more extensive support of the match hypotheses, even differentiating gender and identification match by effect sizes. This approach combined with our suggestions below will probably solve the controversies in this field.

Several limitations of this study, as well as their implications for future research are suggested. Although simple instructions without referring to men or women, masculinity or femininity, or hormones have been shown to significantly differentiate between the cardiovascular responses to a strong laboratory stressor as the Cold Pressor Test, the validity of and differences between manipulations deserve consideration in future research. As masculine- and feminine-relevant instructions were less believed than the irrelevant instruction, stronger instructions should be tested. Also, as a Cold Pressor Test without feminine or masculine instruction was considered as relatively gender neutral, more so than stressful math or memory tasks, our neutral instruction, although best believed by both genders, may have been not gender-irrelevant enough. Although limited to TPR results with regard to the gender match data, our findings suggest that
the gender-irrelevant introduction may be more gender-relevant to men than the masculine introduction.

Gender-role identification was determined post hoc, which resulted in small and unbalanced groups. Preferably, participants are randomly assigned to conditions by gender-role identification. Moreover, as the strength of gender-role identification is less strong in Dutch participants as compared to participants in other countries [42], identification levels in our sample may not have differed enough to result in maximum possible effects. Therefore, extreme groups with regard to gender-role identification should be selected in future research. In addition, an even more indirect measure like an implicit association test could be tested in future studies in order to increase the difference with gender by further reducing influences of social desirability.

Finally, direct comparisons with the effects of other (in particular psychological) stressors, taking into account different levels of difficulty, are necessary to increase ecological validity. In addition, previous findings, although not consistent, suggest type of stress differences in myocardial or vascular responsivity [19,20]. Whereas during a psychological stressor BP increases are primarily mediated by an increase in CO (myocardial), BP increases during the CPT are primarily mediated by an increase in TPR (vascular), although instructions added to the CPT requiring effort and engagement may alter the response evoked (e.g., [51]). These possible differences emphasize the importance of measuring more parameters than BP and HR. The more so because it has been also suggested that men are more likely to be vascular reactors and women myocardial reactors, apart from gender differences at rest (i.e., higher HR levels for women and higher BP levels for men) (e.g., [19,20,52]). Heightened cardiovascular responses, most studied in relation to hypertension and cardiovascular disease, can form a health risk. For example, a vascular response pattern has been associated with hypertension [21].

The match–mismatch–irrelevance paradigm, applied to gender in this study, can take research on person–stressor effects a step further than mere statistical interactions. It can be useful in the development and testing of a framework of information processing that specifies which matching of individual differences and stressors can have an impact on stress responses. Ultimately, the model can contribute to the understanding of gender differences in response to stressful situations and related health risks.

References

[23] van Well S, Kolk AM, Oei NYL. Direct and indirect assessment of gender role identification. Sex roles [submitted for publication].


