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Chapter 5

Cardiovascular reactivity and resistance to opposing viewpoints during intragroup conflict

This study examined how the outcomes of joint decision-making relate to cardiovascular reactions when group members disagree about the decision to be taken. A conflict was experimentally induced during a joint decision-making task, while cardiovascular markers of challenge/threat motivational states were assessed following the biopsychosocial model of challenge and threat (BPSM; J. Blascovich, 2008). Results show that individuals were less likely to adjust their initially preferred decision alternative the more they exhibited a cardiovascular pattern indicative of threat (i.e., relatively high Total Peripheral Resistance and low Cardiac Output) compared to challenge. This finding extends the BPSM by showing a link between threat and rigidity, and emphasizes the importance of psychophysiological processes for studying intragroup conflict and decision making.

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In situations of joint decision-making, people often experience disagreements in which they need to choose between their own standpoint and the standpoint of another group member (e.g., Amason, 1996; Jehn, 1995). Jury members, for example, may disagree about whether the accused is guilty or innocent, cabinet members may disagree about the best decision to tackle a crisis, and members of top management teams may disagree about investments that sometimes affect thousands of employees. These disagreements often become fierce, thereby eliciting physiological reactions such as an elevated heart rate or blood pressure (e.g., Newton & Sanford, 2003). Although it is likely that the *type* of cardiovascular response is intimately related to how people manage and cope with disagreements, so far psychophysiological processes have received little attention in research on intragroup conflict. To fill this void, in this chapter we examine how the outcomes of joint decision-making are affected by physiological reactions during group conflict. Integrating principles from the conflict literature and the biopsychosocial model of challenge and threat (BPSM; Blascovich, 2008), we propose that the more group members respond to the conflict with a cardiovascular pattern indicative of threat, the more they are likely to act rigidly, and stick to their initially preferred opinion.

In general, for joint decision-making to be effective, it is important that group members dare to defend their own preferred decision alternative and do not adopt one of the opinions of the other group members too easily (e.g., Janis, 1972). At the same time, group members should be willing to consider other standpoints and, in case of a conflict, refrain from trying to "win" the conflict at all costs (e.g., Fisher & Ury, 1981). Especially the latter seems sometimes difficult: People quickly develop a strong feeling of ownership over their initial standpoint and often in turn perceive criticism on this standpoint as a personal attack (e.g., De Dreu & Van Knippenberg, 2005; Swann, Polzer, Seyle, & Ko, 2004). Group members therefore tend to respond defensively to criticism; they rigidly hold on to their initial decision alternative and argue for it as a goal in itself, rather than trying to develop an accurate and deeper understanding of the decision at hand (e.g., Brodbeck, Kerschreiter, Mojzisch, & Schulz-Hardt, 2007; Greitemeyer & Schulz-Hardt, 2003).This rigidity in holding on to initially preferred decision alternatives is likely to be closely related to a state of threat during the conflict. That is, when individuals are threatened, they tend to become more biased towards information that supports their dominant viewpoint and become more reluctant to make adjustments to initial anchors (e.g., Fischer et al., 2011; Kamphuis, Gaillard, & Vogelaar, 2011; Kassam, Koslov, & Mendes, 2009; Staw, Sandelands, & Dutton, 1981). Individuals who are relatively threatened by a disagreement may therefore show a relatively strong resistance to opposing standpoints, as well as a tendency to rigidly hold on to initially preferred decision alternatives.

To examine whether rigidity and resistance to opposing standpoints during a conflict is indeed linked to threat, in this chapter we apply the biopsychosocial model of challenge and threat (BPSM; e.g., Blascovich & Mendes, 2010; Blascovich & Tomaka, 1996) to intragroup conflict and joint decision-making. The BPSM applies to situations that are goal relevant and require individuals to actively cope with stressors. According to the BPSM, threat and challenge are the outcome of an evaluation of the demands of the situation (i.e., required effort, uncertainty, and danger) and the person's resources to deal with these demands (i.e., the available skills, knowledge, support, and dispositions). The BPSM predicts that individuals are *threatened* when they evaluate the demands of a situation as exceeding their personal resources while individuals are *challenged* when they evaluate resources as matching or exceeding demands (e.g., Blascovich & Mendes, 2010; Blascovich & Tomaka, 1996; Tomaka, Blascovich, Kelsey, & Leitten, 1993). Within the BPSM, threat and challenge are conceptualized as always relative to each other and can be seen as the end points of a continuum. That is, the BPSM does not see challenge and threat as discrete motivational states, but as motivational states along a continuum. Importantly, the BPSM also describes how threat and challenge are associated with distinct patterns of cardiovascular reactivity.

According to the BPSM, the differentiation between threat and challenge relies on a combination of four cardiovascular measures: heart rate (HR); pre-ejection period (PEP; an index of left ventricular contractile force); cardiac output (CO; the amount of blood pumped by the heart, in liters per minute); and total peripheral resistance (TPR; an index of net constriction vs. dilation in the arterial system). Task engagement, a prerequisite for both challenge and threat, is indicated by increased HR and decreased PEP. Challenge is marked by increased activation of the sympathetic-adrenomedullary (SAM) axis, which—through the release of epinephrine—leads to vasodilatation in the large skeletal muscle beds and bronchi resulting in an overall decline in systemic vascular resistance (i.e., a decrease in TPR) and, in turn, to an increase in CO. Threat is marked by activation of both the SAM axis and the hypothalamic pituitary adrenal (HPA) cortical axis; the latter leading to reduced vasodilatation, or even vasoconstriction (i.e., increase in TPR), and relatively small increases in CO. In the context of motivated performance, changes in TPR and CO apply to both threat and challenge motivational states; that is, challenge is marked by relatively higher CO and lower TPR compared to threat (e.g., Seery, Weisbuch, Hetenyi, & Blascovich, 2010). In the past 15 years, dozens of studies validated the BPSM in a variety of contexts (from athletic performance to intergroup interactions) as an indirect measure of psychological threat and challenge states by showing relationships with demand/resource appraisals as well as with performance outcomes (see Blascovich & Mendes, 2010; Blascovich & Tomaka, 1996).

In the current study, we apply the BPSM to conflict and joint decision-making and examine whether cardiovascular markers of threat/challenge are associated with individuals' tendency to hold on to initially preferred decision alternatives. Although the level of threat or challenge during a conflict can be measured using self-report measures of demands and resources appraisals (e.g., Blascovich & Tomaka, 1996; Lazarus & Folkman, 1991), the use of cardiovascular measures presents several advantages over such conventional methods. For example, when it comes to task conflicts, self-report measures of threat may lead to defensive responding (leading those who are the most threatened to indicate this to the least extent; e.g., Blascovich, 2000). Likewise, because of the richness of stimuli and the dynamic nature of conflicts during group decision-making, people may often not be aware of the specific motivational state they are in, while at the same time these states might change and develop, making cardiovascular measures of challenge and threat (which can be measured continuously and unobtrusively), particularly useful in this context (e.g., Blascovich, 2008).

To examine threat and challenge during intragroup conflict, we experimentally induced a task conflict between two individuals working on a joint decision-making task. We developed and extensively piloted (see below) a paradigm in which two group members (a participant and a confederate) had diverging task-related opinions leading to disagreement about the decision to be taken. The interaction took place via a computer and webcam interface, and the confederate's reaction was held constant, to cancel out differences in, for example, the level of acquaintanceship between the two persons and differences in the emotionality and duration of the conflict. Before the interaction took place, participants were asked to present their initial personal decision in front of a webcam and to provide a clear motivation as to why they came to this decision.

We examined cardiovascular reactivity during the speech in which the participants presented their initial decision, as well as during the task conflict later on. In this way, we could verify that any relationship between participants' physiological reactivity to the conflict and their final decision was explained by the arousal elicited by the conflict rather than arousal elicited by task difficulty or communicating through a webcam per se. Furthermore, we examined whether CV profiles indicative of threat (vs. challenge) motivational states are predictive of rigidity in group decision-making beyond two key factors predicting rigidity in group decision-making that are often (and also currently) assessed using self-report questionnaires: The trustworthiness of a decision-making partner (e.g., Sniezek & Van Swol, 2001) and the confidence in one's ability to derive a correct decision (e.g., See, Morrison, Rothman, & Soll, 2011). That is, ample research shows that individuals' tendency to modify an opinion in deference of another individual depends on the specific characteristics of the other individual. For example, when the other individual is considered reliable (e.g., due to greater experience) or sincere, people are more likely to adjust their opinion and use the advice of others (e.g., Sniezek & Van Swol, 2001). Likewise, individuals are more likely to use advice when they think the task is difficult (Gino & Moore, 2007) and when they feel insecure about their own ability to perform well or to make a certain decision (see Bonaccio & Dalal, 2006, for a review). In the current research, we expected that the cardiovascular reactivity during the task conflict (and not the individual decision-making speech) would predict individuals' tendency to hold on to initial decision alternatives, and that adjustment would be negatively related to the extent to which individuals exhibit threat, compared to challenge, above and beyond the influence of the perceived trustworthiness of the other decision maker and the perceived self-efficacy in making a decision[14].

Method

Participants and Design

Fifty-four participants (24 women, 30 men) took part in this study in return for a monetary award (6 Euros) or partial course requirement. For all participants, we induced a task conflict during a joint decision-making task, and as independent variable we measured cardiovascular reactions to the task conflict[15].

Physiological Measurements

Physiological recording equipment. Electrocardiographic (EKG) signals were recorded using an ECG100C amplifier (Biopac Systems Inc., Goleta, CA), and a Standard Lead I electrode configuration. Impedance-cardiographic (ICG) signals were recorded using a NICO100C amplifier (Biopac Systems Inc.), and a four-spot electrode array as described by Sherwood et al. (1990) in which the two outer electrodes injected a small (400μA) alternating current while the two inner electrodes measure the voltage developed through the thorax volume. As output, the NICO100C provides measures of baseline impedance (Z0) and the rate of change in impedance (dZ/dt). We applied a low-pass filter of 10 Hz to remove high-frequency noise. Participants' mean arterial blood pressure (MAP) was measured using a Nexfin HD system (Bmeye B.V., Amsterdam, The Netherlands). The Nexfin HD comprises an inflatable finger cuff that is attached around the middle phalanx of the ring finger of the participant's non dominant hand. Blood pressure is determined using a volume clamp method, in which the pulsating finger artery is clamped to a

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[14] Note that given the conceptualization within the BPSM of challenge and threat as relative states, the current hypotheses (relative threat leads to rigidity) is identical to that stating that relative challenge leads to less rigidity.

[15] In addition to the 54 participants of which we report the data, six other individuals participated but were excluded from the analyses because of their physiological recordings: five because they yielded cardiovascular data that were impossible to score reliably due to poor ICG or BP signal quality, and one because her reactivity during the conflict presented an extreme outlier (i.e., her HR reactivity was greater than 3 SDs (and, in fact, greater than 4 SDs) above the mean). In addition, five participants were excluded because of technical problems with the computer and webcam interface, two participants because they failed to follow the instructions and two participants because there was no task conflict between them and their decision making partner.

constant volume by applying a fluctuating counter pressure comparable with the arterial pressure, and resulting in a beat-to-beat pressure waveform. Subjects were instructed to limit the movement of their non-dominant arm to minimize movement artifact in the blood pressure (BP) recordings. All physiological signals were recorded continuously and digitized at 250 Hz through a Biopac MP150 data system.

Quantification of physiological data. We used Acqknowledge software (Biopac Systems) to record and store the physiological data. Before scoring the data, we first "upsampled" the signals from 250 Hz to 1000 HZ. Upsampling is a method for increasing the sampling rate by means of a precise reconstruction of an original signal without introducing new frequency components. We performed the upsampling using Matlab software (MATLAB, Mathworks Inc., Natick, MA), following the procedures of the Digital Signal Processing Committee (1979). Next, the EKG and ensemble-averaged ICG recordings were scored with Matlab software using an interface comparable to the AMSIMP program, a component of the Vrije Universiteit-Ambulatory Monitoring System software suite (VU-AMS, Vrije Universiteit, Department of Psychophysiology, Amsterdam, The Netherlands). We first visually inspected the ICG recordings. ICG measurements that could not be scored due to movement artifacts were rejected in accordance with standard guidelines (Sherwood et al., 1990) and the VU-AMS scoring principles (http://www.vu-ams.nl/support/manuals/amsimp/impedance-scoring/). We next analyzed the ICG and EKG recordings to determine the upstroke (B-point), dZ/dtmin, and incisura (X-point). In accordance with standard guidelines (Sherwood et al., 1990), the first author scored the B-point as the first or second order zero-crossing in the dZ/dt signal, near to the dZ/dt isoelectric line, and the origin of the longest uphill slope before the dZ/dt_{min} point.[16] We scored the dZ/dtmin as the highest point of the ICG complex between the B- and the X-point. We scored the X-point or incisura as the local minimum after the dZ/dt_{min}. Scoring was conducted blind to other participant data. Finally, the BP recordings were visually inspected using Matlab and BP measurements that could not be

[16] We obtained virtually identical results to the currently-reported results, when we, instead of using the manually-scored upstroke (B-point) used upstroke-scores derived using the "Lozano formula" (Lozano et al., 2007; Psychophysiology) which identifies the upstroke based on the relationship between the R to B interval and the interval between the R-wave and the peak of the dZ/dt function.

scored due to movement artifacts were rejected. We determined beat-to-beat systolic (SBP) and diastolic blood pressure (DBP), and combined it to calculate beat-to-beat mean arterial blood pressure: (MAP = 1/3 * [SBP-DBP] + DBP).

We used the ECG recordings to determine HR (i.e., the number of heart beats per minute). We determined PEP, which represents the interval between the start of the electromechanical systole and the opening of the aorta valve, by calculating the time in milliseconds between the Q-point in the ECG and the B-point in the ICG. Left ventricular ejection time (LVET) was determined as the time in milliseconds between the B- and X-points in the ICG. We calculated stroke volume (SV: the amount of blood that is pumped by the heart at a given heartbeat) using the Kubicek formula (Kubicek et al., 1966)[17] and calculated CO by multiplying SV by HR, which we derived from the EKG. Finally, following the guidelines of Sherwood et al. (1990), we used CO in combination with the blood pressure recordings to determine TPR using the following formula: MAP × 80 / CO.

Joint Decision-making Task and Induction of Conflict

Participants worked on the NASA dilemma (see Cammalleri, Hendrick, Pittman, Blout, & Prather, 1973), a joint decision-making task in which participants are presented with a moon landing scenario and a set of 14 objects. It is the participant's task to order these items in terms of their usefulness to survive on the moon. The instructions, the complete set of 14 items, and their correct place in the hierarchical ordering can be found in Appendix C. There is good evidence that people readily develop ownership of their standpoint in this kind of experimental task, and in turn feel threatened when others disagree (De Dreu & Van Knippenberg, 2005).To induce a task conflict, we had to ensure that the group members had a different solution in mind and openly disagreed about their different solutions for the task (e.g., Jehn, 1995). We expected that most of the participants would place the "20 liters of water" (see Appendix C) among

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[17] We used a value of 135 for blood resistance (ϱ), and for each participant we measured the distance between the inner two ICG electrodes. The Kubicek formula is:

$$SV = \rho \times \frac{L^2}{Z_0^2} \times \frac{\mathrm{dZ}}{\mathrm{dtmin}} \times \mathrm{LVET}$$

the top items of their hierarchical ordering. To induce a task conflict, the confederate therefore stated in response to the participants' initial solution that she did not agree with the solution regarding the water, and provided several reasons for why she believed the water should be ranked at place 13 in the hierarchy.

Pilot. A pilot test (N = 45) was conducted to confirm the effectiveness of this procedure to induce a task conflict, and in turn the potential to elicit threat. The results showed that, as expected, most of participants initially placed the conflict item (i.e., the 20 liters of water) at one of the top positions of their hierarchy (M = 2.87, SD = 1.65, Mdn = 2). Moreover, the manipulation of task conflict was also successful; the average level of reported task conflict was high (M = 5.33, SD = .82 on a 7-point scale, adapted from Jehn, 1995) and significantly higher than the midpoint on the scale (i.e., 4), $t(44) = 10.87$, $p < .001$. The pilot study also showed that after the conflict, thus when making their final decision, participants placed the conflict item significantly lower in their preferred ranking than before the conflict, M = 7.62, SD = 3.63, Mdn = 7, $F(1,44) = 88.44$, $p < .001$, suggesting that the arguments of the confederate were convincing enough for participants to adjust their initial viewpoint.

In addition, the pilot test also confirmed that the conflict did indeed have the potential to elicit threat. More specifically, to examine whether some participants really felt they had too little resources to deal with the issue and hence could be classified as "threatened", in the pilot study we also examined the participants' demands (e.g., "It was stressful that we disagreed"; 3 items) and resources (e.g., "During the debate about our different solutions I felt in control"; 2 items) appraisals regarding the task conflict. A difference score between the mean resources and demands appraisals indicated that substantial individual variation (M = -1.15, SD = 1.86) existed in the extent to which the situation was appraised as a threat or a challenge, and that for roughly 27% (12 out of 45) of the participants, the height of the demands appraisals outweighed the height of the resources appraisals, and could therefore be labeled as threatened.

Thus, in summary, the pilot not only confirmed the successfulness of the current procedure in inducing intragroup conflict, but also showed that substantial variation existed across people in how they appraised their level of resources and demands regarding the conflict. This is important because it shows that the procedure has the potential to elicit a threat state for some individuals (when their demands appraisals outweigh their resources appraisals) while eliciting a challenge state for others (when their resources appraisals outweigh their demands appraisals). Given that the current procedure has the potential to elicit responses throughout the threat/challenge continuum, it enables us to examine how the extent to which someone exhibits a threat or challenge state during a conflict relates to their decision making, which was the aim with the main study.

Procedure

Upon arrival in the lab, participants were seated in separate cubicles in front of a PC and were told that they would work on a decision-making task with another participant via the computer system. After we attached the sensors for the physiological recordings, we closed the door and all further instructions, tasks, and measures were provided to the participant by means of the computer. After some general information, participants were instructed to sit quietly for 5 min during which we took baseline recordings of the cardiovascular measures. Next, the participants were instructed to study the NASA dilemma individually, to decide on their personally preferred hierarchical ordering of the items, and to present it in front of the webcam by providing a clear motivation for the ranking of each of the 14 items.

After both decision makers had (ostensibly) provided their initial solution, we told the participants that the discussion would commence and that the computer had randomly decided that their decision-making partner (i.e., a female confederate) would start the discussion. This meant that their partner had a minute to study the participant's initial solution and another minute to give her opinion via the webcam. The participants were told that they would have in turn 1 min to respond to the reaction of their partner. This set-up (as opposed to a real discussion) was used to control the task situation and to standardize it across participants (see Greitemeyer & Schulz-Hardt, 2003, for a similar procedure). We induced the task conflict by means of pre-recorded videos. The video recording showed the decision-making partner who stated her disagreement with the participant's solution and provided the participant with an alternative solution. Directly after they had watched, and had reacted to, the reaction of their partner, we checked whether participants perceived the interaction as a task conflict by asking participants to rate their agreement with two statements adapted from Jehn (1995): "The decision of the partner differed from my own decision" and "We disagree on the location of some objects in the hierarchy ordering." After this, participants were asked to provide their final decision and to fill in a short questionnaire including our control variables (see below for more details). Participants gave their responses to all questions on 7-point Likert scales with strongly disagree (1) and strongly agree (7) as end points. Finally, participants were debriefed, paid, and thanked for their participation.

Dependent measures

The dependent variable is the "adjustment of the initial viewpoint" (AIV), a continuous measure expressing the extent to which participants chose to stick to their initial decision or change it in the direction of the decision suggested by their decision-making partner (see Harvey & Fischer, 1997). The AIV ratio is equal to 0 when participants are rigid and do not adjust their initial decision regarding the conflict item and equal to 1 when they adjust their final decision such that it is identical to the decision suggested by their decision-making partner:

$$AIV = \frac{\textit{final decision} - \textit{initial decision}}{\textit{decision suggested by partner} - \textit{initial decision}}$$

Control variables

We measured perceived trustworthiness using six questions (e.g., "Do you think your decision-making partner is a reliable person?" and "Do you think your decision-making partner is a sincere person?"). The answers on the six items were averaged to create a perceived trustworthiness scale (α = .76). We measured task self-efficacy using 4 items (e.g., "I was able to solve the dilemma", and "I found it easy to solve the dilemma", α = .79). Finally, we controlled for gender because we anticipated that male and female participants might react differently to the reaction of the female confederate (e.g., Carli, Lafleur, & Loeber, 1995).

Results

Checks

Induction of task conflict. As expected, and in line with our pilot study, most participants initially placed the 20 liters of water at one of the top positions of their hierarchy (*M* = 2.91, *SD* = 1.53, *Mode* = 2, *Mdn* = 2.5). Results also show that the manipulation of task conflict was successful; the average level of reported task conflict was high and significantly higher than the midpoint on the scale (i.e., 4; *M* = 5.55, *SD* = .93, $t(54) = 12.22$, $p < .001$).

Cardiovascular measures. Average levels of HR, PEP, CO, and TPR were calculated for the last 3 min of the baseline, the first 2 min of the individual decision-making speech, and the 2-min task-conflict period. In line with the general procedure regarding data analyses in research on the BPSM, for each person we focused on a similar time period regarding the physiological data during the tasks (i.e., the first 2 min), because the challenge motivational state typically habituates more quickly than the threat motivational state (Mendes, Reis, Seery, & Blascovich, 2003). Descriptive statistics for each of the indices can be found in Table 5.1[18]. In line with standard practice (e.g., Seery et al., 2010), reactivity scores were created by subtracting baseline scores from the mean scores during the decision-making speech and the task conflict.[19] Descriptive statistics for each of the reactivity scores can be found in Table 5.2. We then first confirmed task engagement (a prerequisite of motivated performance, the domain of the BPSM), by testing HR and PEP reactivity against zero (i.e., baseline levels). During the decision-making speech, HR increased significantly from baseline levels, $t(53) = 8.10$, $p < .001$, while PEP decreased significantly from baseline levels, $t(53) = -4.24$, $p < .001$). The same was true for the conflict period HR: $t(53) = 9.37$, $p < .001$, and PEP: $t(53) = -13.59$, $p < .001$. In concert, these results indicate task engagement during both the decision-making speech and the task conflict, which paved the way for a further examination of CO and TPR during these tasks in terms of challenge and threat motivational states (Seery et al., 2010).

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[18] As can be seen in the Table, the absolute levels of CO are lower than the levels typically found when band electrodes are used for impedance cardiography. While for reliably scoring PEP it does not matter whether one uses spot or band-electrodes, spot-electrodes are only acceptable when the primary interest is looking at relative, rather than absolute values of CO (Sherwood et al., 1990). In the current work the primary focus is on relative CO-differences with baseline values, justifying the use of spot-electrodes which have led, however, to relatively lower estimates of CO.

[19] Apart from the participant mentioned in Footnote 1, outlier analyses showed that for one participant, the TPR reactivity during the conflict presented an outlier (i.e., more than 3.3 standard deviations above the mean). Analyses using a transformed score of the raw score to a value one unit larger than the next most extreme score, provided virtually identical results to those currently reported, and therefore we left the raw score of the TPR reactivity unchanged.

Table 5.1. *Descriptive Statistics (N = 54)*

	Baseline		Decision-making speech		Task Conflict	
	Mean	SD	Mean	SD	Mean	SD
HR	79.44	10.92	87.47	14.16	91.37	14.78
PEP	119.59	14.75	112.59	18.74	103.19	16.25
CO	2.06	0.79	2.21	0.81	2.39	0.89
TPR	3821.37	1523.19	3973.22	1420.83	4031.20	1485.97
Threat Challenge Index	0.00	1.89	0.00	1.90	0.00	1.91

Main analyses

Table 5.2 shows the correlations and descriptive statistics for the variables that were included in the analyses. To simplify the analyses and because changes in CO and TPR can be seen as two related measures of the same underlying SAM versus PAC activation, we also derived a single threat challenge index (TCI), in addition to examining CO and TPR separately (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004). The TCI was calculated by first converting each participant's TPR and CO values into z scores, then assigning the CO scores a weight of +1 and TPR a weight of -1, and finally summing them so that larger values indicate reactivity indicative of greater challenge (e.g., Seery et al., 2010). Larger values on the threat challenge index corresponded to reactivity consistent with relatively greater challenge (and lower threat), while lower values correspond to reactivity consistent with relatively greater threat (and lower challenge). Using this index increases the reliability of the cardiovascular measures and simplifies analyses by carrying out a single test of challenge/threat reactivity.

The cardiovascular markers of challenge/threat during the conflict were significantly related to the adjustment of the initial viewpoint (see Table 5.2). As expected, an increase in TPR during the task conflict—consistent with threat compared to challenge reactivity—was associated with relatively little adjustment of the initial viewpoint (r = -.32, p = .02). Likewise, decreases in CO and TCI during the task conflict—also consistent with threat compared to challenge reactivity—were associated with relatively little adjustment of the initial viewpoint (r = .29, p = .04; and r = .33, p = .01, respectively). Importantly, cardiovascular reactivity during the decision-making speech was not significantly related to AIV (TPR: r = -.10, p = .47; CO: r = .07, p = .62; TCI: r = .09, p = .50).

Table 5.2 *Means, standard deviations, and correlation matrix (N = 54)*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Adjustment of initial viewpoint (AIV)	–													
2. Gender (male = 0, female = 1)	-.08	–												
3. Trustworthiness of partner	.32*	-.02	–											
4. Task self-efficacy	-.03	-.36**	-.10	–										
Reactivity to decision-making speech														
5. HR	.02	.12	.04	-.03	–									
6. PEP	-.26†	-.08	-.06	.12	-.31*	–								
7. CO	.07	.20	.14	-.05	.63***	-.59***	–							
8. TPR	-.10	-.06	-.23†	.20	-.33*	.43**	-.65***	–						
9. Threat Challenge Index	.09	.14	.21	-.13	.53***	-.56***	.91***	-.91***	–					
Reactivity to task-conflict														
10. HR	.20	-.18	.06	.15	.73***	-.19	.54***	-.31*	.47***	–				
11. PEP	-.25†	.31*	-.16	-.16	-.08	.40**	-.37**	.19	-.31*	-.41**	–			
12. CO	.29*	-.06	.14	-.02	.42**	-.27*	.65***	-.43***	.59***	.67***	-.51***	–		
13. TPR	-.32*	.05	-.13	.25†	-.28*	.37**	-.51***	.74***	-.69***	-.39**	.35*	-.65***	–	
14. Threat Challenge Index	.33*	-.06	.15	-.15	.38**	-.36**	.64***	-.64***	.71***	.58***	-47***	.91***	-.91***	–
Mean	0.40	1.44	5.10	4.60	8.02	-7.00	.16	151.85	0	11.93	-16.40	.34	209.83	0.00
SD	0.39	0.50	0.79	0.86	7.28	12.12	.23	477.24	1.82	9.36	8.87	.30	622.83	1.81

† *p* <.10 * *p* <.05, ** *p* <.01, *** *p* <.001

To determine the contribution of the cardiovascular markers of threat/challenge above and beyond the control variables, we entered them simultaneously in single regression analyses. In line with Seery et al. (2010) and Blascovich et al. (2004), we first examined the relationship between AIV, the control variables, and participants' reactivity during the task conflict. All predictor variables were centered to reduce possible problems due to multicollinearity. As can be seen in Model 1 in Table 5.3, the findings show that participants' TCI reactivity during the task conflict was positively related to AIV (TCI: ß = .29, *SE* = .07, *p* = . 033) even when controlling for the perceived trustworthiness of the other group member, gender, and task self-efficacy; of these control variables only the former was positively related to participants' AIV (ß = .28, *SE* = .13, *p* = .039). Together, the model accounted for 19% of the variance in AIV. In line with the bivariate correlations, Model 2 in Table 5.3 shows that, in contrast to cardiovascular reactivity during the task conflict, the cardiovascular reactivity during the individual decision-making speech was unrelated to AIV, also when controlling for the three control variables[20].

Table 5.3 *Regression results predicting adjustment of initial viewpoints using reactivity scores (N = 54)*

	Adjustment of initial viewpoint (AIV)					
	Model 1			Model 2		
	B	*SE*	*ß*	*B*	*SE*	*ß*
Constant	1.55*	.77		1.82*	.80	
Gender (male = 0, female = 1)	-.10	.28	-.05	-.19	.29	-.09
Trustworthiness of partner	.28	.13	.28*	.30	.14	.31*
Task self-efficacy	.03	.16	.02	-.03	.17	-.03
TCI - Task Conflict	.16	.07	.29*			
TCI - decision-making speech				.02	.08	.04
F	2.84*			1.52		
R^2	0.19			0.11		

* $p \leq .05$

[20] We also performed a regression analysis including both TCI-scores, as is common in analyses of cardiovascular markers of threat/challenge (e.g., Blascovich et al., 2004; Seery et al., 2010). The effect of task conflict-related reactivity remained significant (TCI - task conflict: *ß* = .54, *SE* = .10, *p* < .01), while the decision speech-related reactivity approached significance in the opposite direction (TCI – decision speech: *ß* = -.35, *SE* = .10, *p* =.06), suggesting that individuals whose cardiovascular reactivity indicated threat during the initial decision-making speech were more likely to adjust their opinion after the conflict. This is line with previous work on confidence and using advice from others (e.g., See et al., in press; Sniezek & Van Swol, 2001). Yet, due to potential problems with multicollinearity in our relative small sample size (TCI– decision speech: VIF = 2.205, Tolerance =.453), we decided to report as main analyses the analyses in which we analyzed the reactivity scores independently.

Table 5.4 *Regression results predicting adjustment of initial viewpoints using absolute scores (N = 54)*

	Adjustment of initial viewpoint (AIV)								
	Model 3			Model 4			Model 5		
	B	*S.E.*	*ß*	*B*	*S.E.*	*ß*	*B*	*S.E.*	*ß*
Gender (male = 0, female = 1)	-.01	.28	.00	-.02	.30	-.01	.03	.28	.01
Trustworthiness of partner	.32	.13	.32*	.28	.13	.28*	.30	.13	.30*
Task self-efficacy	.07	.17	.06	-.02	.17	-.02	.04	.16	.03
Total Peripheral Resistance									
TPR – Baseline [a]	.13	.28	.19						
TPR – Decision-making speech	.72	.42	1.02†						
TPR – Task Conflict	-.91	.31	-1.36**						
Cardiac Output				-.21	.60	-.17			
CO – Baseline				-.84	.78	-.69			
CO – Decision-making speech				1.18	.59	1.04*			
CO – Task Conflict									
Threat Challenge Index									
TCI – Baseline							-.10	.24	-.18
TCI – Decision-making speech							-.58	.34	-1.10†
TCI – Task Conflict							.77	.27	1.46**
F	2.74*			1.94†			2.65*		
R^2	.26			20			.25		

† $p \leq .10$, * $p \leq .05$, ** $p \leq .01$, [a] *Note.* TPR values are reported in 10^{-3} resistance units

Finally, in addition to analyses on reactivity scores, we also examined the relationship between AIV, the control variables, and participants' absolute levels of TPR, CO, and TCI during the baseline, the speech task, and the task conflict. In line with the prior analyses, as well as our hypothesis, Models 3 and 4 in Table 5.4 show that CO and the TCI during the task conflict are positively related to changes of initial viewpoints, while Model 5 shows that TPR levels during the task conflict are negatively related to changes of initial viewpoints, when controlling for baseline values and speech-task values (which are both not significantly related to the dependent variable). These results again support the conclusion that the adjustment of initial viewpoints is negatively related to the extent to which individuals exhibit cardiovascular patterns indicative of relative threat, as opposed to challenge, during the conflict (i.e., relatively high TPR values, and low CO and TCI values). Important to note is that the strength as well as the direction of these results were unaffected by the inclusion of the control variables.

Discussion

The results of this study support the prediction that the outcomes of joint decision-making are related to people's cardiovascular reactions when they and another group member disagree about the decision to be taken. More specifically, the more individuals' cardiovascular pattern during a task conflict was indicative of relative threat rather than relative challenge (lower levels of CO; higher levels of TPR), the less likely they were to change their initial opinion. Illustrative of the robustness and strength of this relationship, the cardiovascular markers of challenge/threat predicted the adjustment of the initial viewpoint, even when controlling for other well-known predictors of rigidity during group decision-making, such as the perceived trustworthiness of the opponent and task self-efficacy.

The current research addresses two important limitations of past conflict research. First, in the vast literature on intragroup conflict, relatively little attention has been paid to the influence of stress responses (see Dijkstra, Van Dierendonck, & Evers, 2005, for an exception). Secondly, conflict researchers have often assumed a uniform positive or negative relation between conflict and decision-making –neglecting that the way people respond physiologically to the conflict (i.e., as a challenge or a threat) can be an important indication of how conflicts affect group performance (c.f., Jehn, Rispens, & Thatcher, 2010). The current research shows that there are important differences among individuals in cardiovascular reactivity to task conflict, and that this can be intimately related to the decisions that are made.

These findings also provide important insights into the behavioral correlates of threat and challenge states. In line with Kassam et al. (2009), the current findings show that the extent to which individuals exhibit a threat state, rather than a challenge state, is negatively associated with adjustments to initial anchors. Given that in the current study the initial anchor was correct, the extent to which individuals exhibited a threat state was therefore positively related to decision-making quality. Thus far, only a few studies have investigated the behavioral correlates of threat versus challenge patterns, and most of these studies reported a positive correlation between challenge states on cognitive and physical performance (e.g., Blascovich et al., 2004; Chalabaev, Major, Cury, & Sarrazin, 2009; Schneider, 2004; Seery et al., 2010; Tomaka et al., 1993). The current study, therefore, is one of the first studies to show a positive relationship between cognitive task performance and the extent to which individuals exhibited a threat, instead of a challenge state (cf. Hunter, 2001). Future research may examine whether a threat state is also related to superior performance on other tasks requiring cognitive *in*flexibility.

The current findings also extend research on the threat-rigidity hypothesis, which predicts that groups and individuals react to threat with rigidity, for example, in the form of restricted information processing and reliance on prior expectations (e.g., Staw et al., 1981). Support for the threat-rigidity hypothesis has mainly come from studies that focused on group level processes and responses to threat (e.g., Gladstein & Reilly, 1985; Kamphuis et al., 2011). Specifically, under threat, groups tend not only to utilize less information to make a decision, they also show more biased information processing, and more inflexibility in their manner of decision making (e.g., Harrington, Lemak, & Kendall, 2002). The current study extends these studies in two ways. First, it shows that in addition to threats external to the group, *internal* threats (i.e., conflict) are also related to group decision-making, restricted information processing and rigidity in particular. Secondly, the current study moves beyond group-level responses and processes and supports Staw et al.'s (1981) proposition that also at the individual level, threat, compared to challenge, is linked with a reluctance to change prior and dominant viewpoints.

One of the limitations of the current study is that to induce a task conflict, the discussion between the group members was experimentally controlled. Future research should investigate whether in real group discussions the same processes take place and can account for the effects of threat/challenge on the decisions that are made. We want to emphasize that the controlled, as opposed to a real, interaction had the important advantages that all participants were confronted with exactly the same task conflict. In this way, we could cancel out intra- and interconflict differences such as the emotionality of the conflict, acquaintanceship, or duration of the debate.

Another limitation of the chosen design was that during the task-related disagreement, "rigidity" was always functional for decision-making quality. Hence, the design could not address what would have happened if the initial opinion was incorrect. It is likely that in many day-to-day situations, threat-rigidity will lead to inferior rather than superior decision-making. Specifically, when group members rigidly hold on to their initial decision and show a bias towards preference-consistent information, they may fail to develop an accurate and deeper understanding of the decision problem and, in the end, may make an uninformed and incorrect decision. Indeed, recent work by De Wit, Jehn, and Scheepers (2012) shows that when an initial opinion is incorrect, conflict-related threat (and rigidity, for that matter) tends to be negatively related to information processing and decision-making quality.

To conclude, the results of this study show that individuals are less likely to adjust their initially preferred decision alternative when they exhibit a cardiovascular pattern indicative of threat compared to challenge in response to a disagreement with a fellow decision maker. The present research underlines the importance of adopting a psychophysiological approach, and of taking into consideration individual-level characteristics such as cardiovascular reactivity, to better understand how people manage disagreements during joint decision-making.