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Threat rapidly disrupts Reward Reversal Learning

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1 **Abstract**

2 Threat changes cognition to facilitate adaptive coping. However, when threat
3 becomes overwhelming, this may be deleterious for mental health especially in vulnerable
4 individuals. Flexible decision-making was probed with a reward reversal task to
5 investigate, how well healthy participants (N=34) can adapt to changes in reward
6 contingency when they expect adverse events (i.e. electric shocks). Relative to a safe
7 control condition, threat-of-shock significantly impaired reward reversal learning.
8 Moreover, enhanced self-reported threat ratings and elevated skin conductance levels
9 support the successful induction of stressfull and aversive apprehensions. Findings are in
10 line with existing literature showing stress-induced inhibition of goal-directed behavior,
11 at advantage of a reflexive (habitual) response style. Notably, reversal learning was
12 rapidly restored with the omission of threat through several cycles of threat and safety
13 contexts within one experimental session. These results extend the current literature and
14 illuminate the immediate consequence of a sustained threatening stressor (and its
15 removal) on decision-making. Better knowledge of the immediate effects of anticipatory
16 anxiety on behavior can improve understanding of psychopathology and may be
17 informative for the development of effective therapy of anxiety and emotion
18 dysregulation.

1 **1 Introduction**

2 Aversive apprehensions modulate cognition and behavior – a better understanding of this
3 relation promises insights into the emergence and perpetuation of anxiety disorders.
4 Anticipating adverse events effectively primes defensive behaviors in both humans and
5 animals (Bublitzky, Guerra, Pastor, Schupp, & Vila, 2013; Davis, Walker, Miles, &
6 Grillon, 2010), which is also characteristic for anxious psychopathology. As a laboratory
7 approach to examine such anticipatory processes, the threat-of-shock paradigm has
8 revealed insights into the biobehavioral mechanisms underlying anticipatory anxiety
9 (Dillon et al., 2014). Using this paradigm, participants are verbally instructed that an
10 electric shock might occur during one specific condition, but not during another so-called
11 safety condition (e.g. indicated by screen color). Importantly, in contrast to classical
12 conditioning paradigms, the aversive events actually never occur, and the impact of
13 sustained apprehensions or even anticipatory anxiety can be tested.

14 Recent research consistently showed that instructed threat-of-shock (relative to
15 safety) selectively guides attention and activates the autonomic nervous system, primes
16 defensive reflexes and triggers behavioral avoidance (Baas, Kenemans, Böcker, &
17 Verbaten, 2002; Bradley, Moulder, & Lang, 2005; Bublitzky, Flaisch, Stockburger,
18 Schmälzle, & Schupp, 2010). On the neuronal level, instructed threat leads to enhanced
19 limbic brain activation (Cornwell et al., 2007), similar to patterns seen in patients
20 suffering from anxiety disorders and emotion dysregulation (Etkin & Wager, 2007;
21 Schulze, Schulze, Renneberg, Schmahl, & Niedtfeld, 2018). These individuals often
22 report problems to reverse impulsive, rigid behaviors (e.g. frequent body checking or drug
23 consummation) to ones that are more beneficial (e.g. task-oriented coping strategies or
24 social exchange). The symptoms are aggravated under emotional stress (Cackowski et al.,

2014); hence, a pathway to psychopathology might lead through conditional decision-making impairment during stress.

Decisions are based on the hedonic value of the expected outcomes (O’Doherty, Dayan, Friston, Critchley, & Dolan, 2003). Specifically, humans tend to pursue rewarded actions and tend to stop actions leading to loss of reinforcers such as food, social reward or money. Thus, similar to the anticipation of threat, the expectation of reward is a powerful mechanism to drive learning of actions. Such instrumental learning can flexibly adjust behaviors to environmental conditions, and in the best case help resolving response conflicts between opposing goals (e.g. approach despite threat; (Atlas, 2019; Bublatzky, Alpers, & Pittig, 2017; Pittig, Treanor, LeBeau, & Craske, 2018; Schlund et al., 2016)). However, the literature regarding the impact of threat and stress on instrumental learning is mixed. For instance, threat has been shown to reduce risk-taking behavior (Clark et al., 2012) and diminished the advantage of prospective reward in a working memory task (Choi, Padmala, & Pessoa, 2015). Other studies neither found an effect of threat on delay-discounting (Robinson, Bond, & Roiser, 2015b) nor on instrumental learning (Berghorst, Bogdan, Frank, & Pizzagalli, 2013) or decision-making in the Iowa Gambling Task (Robinson, Bond, & Roiser, 2015a). Only few studies so far examined threat-induced impairment of reward learning during threatening versus safe conditions, and investigation of reward extinction and reversal learning under threat is lacking (Bogdan & Pizzagalli, 2006; Bogdan, Santesso, Fagerness, Perlis, & Pizzagalli, 2011).

In the present study, we probed reward reversal learning within contextual settings of instructed threat-of-shock or safety. To this end, the background color of the computer screen was instructed as a signal for receiving up to three shocks (e.g., blue indicated shock threat) while another color indicated a safe control condition (e.g., green signaled safety; see Figure 1a). Within this colored backdrop, participants performed a

1 probabilistic reward reversal task. The task was to choose between two behavioral options
2 which were differently reinforced with monetary wins or losses (Figure 1b), and
3 participants were required to learn the rewarded stimulus. Importantly, stimulus-reward
4 contingency reversed during the experiment so that participants needed to adjust their
5 choice behavior (Figure 1c). One key hypothesis was that the threatening context would
6 impede behavioral adjustment to the new reward-contingency. We expected that threat-
7 of-shock would interfere with reward reversal learning as evidenced by increased choice
8 time. In addition, we planned to explore the effect of threat on error rates, reflecting the
9 flexible updating of stimulus preference. Based on previous findings (Paret, Hoesterey,
10 Kleindienst, & Schmahl, 2016), we further hypothesized a correlation between error rates
11 and negative urgency, which means a tendency to act rashly under negative emotions
12 (Whiteside & Lynam, 2001).

13 As a manipulation check, we expected enhanced emotional arousal and threat
14 ratings, as well as increased activation of the autonomous system (i.e. skin conductance
15 level and heart rate) during threat compared to safety conditions similar to previous
16 research (e.g. (Bradley et al., 2005; Bublatzky et al., 2013)). Furthermore, we expected
17 correlation of these measures with choice time and assumed that participants with more
18 difficulties in emotion regulation would be more prone to threat-induced anxiety.

19 **2 Methods**

20 Preregistration of this study at the OSF platform can be retrieved via <https://osf.io/bxvgm>.

21 Data can be found here:

22 https://osf.io/kw9bc/?view_only=22d90916f236436ea2e8c3d3e1d1b08a.

2.1 Sample description

Data from 35 healthy women were collected. One participant with an extreme depression score (BDI=36) that indicates strong depressive symptoms was excluded from analyses, reducing the sample size to $N=34$ (age: $M \pm SD = 23.74 \pm 4.85$). The Ethics Committee of the Medical Faculty Mannheim of the University of Heidelberg approved the study, and all participants provided written informed consent before participation.

2.2 Reward reversal task and stimulus presentation

Participants were instructed to select one of two images presented on a 17'' computer screen by pressing the left or right button on a computer keyboard. Behavioral options were contingent with either wins or losses (10 cents), which were added or drawn from their money account. They were instructed to choose the image that was most often rewarded and informed that this reward associations may change throughout the experiment. One of the two stimuli was followed by a probabilistic reward (the “correct” stimulus), that is, money was earned in seven out of ten selections and lost in three out of ten selections. In contrast, participants always lost money when they selected the other “wrong” stimulus. After six to ten consecutive selections of the correct stimulus, dubbed the “learning criterion”, stimulus-reward contingency reversed. Notably, variance of the learning criterion did not differ between conditions (standard deviations across subjects: 1.40 ± 0.32 (threat), 1.38 ± 0.29 (safety), $T(33)=0.31$; $p=0.76$, mean across subjects: 8.08 ± 0.43 (threat), 7.86 ± 0.46 (safety), $T(33)=1.71$, $p=0.10$). Hence, the timing of the next reversal was equally (un)predictable in the threat and the safety condition. To prevent frustration, switching from the wrong to the correct stimulus was always rewarded, as was the last correct selection before reversal.

2.3 Procedures

After providing informed consent, participants completed questionnaires (see below). A shock work-up procedure was undertaken to enhance the credibility of threat-of-shock instructions (Bublitzky, Gerdes, & Alpers, 2014). To this end, up to 10 electric shocks were administered with increasing intensity (maximum 10 mA) until participants reported the stimulation as *maximal unpleasant but not yet painful*. Electrical stimulation was done using a Digitimer DS7A stimulator (Digitimer Ltd., Welwyn Garden City, UK) with a surface electrode attached to the dorsal right hand. Importantly, as we were interested in the impact of aversive apprehensions (but not experiences) on reward reversal learning, no further shocks were given throughout the rest of the experiment.

Each run started with 20 trials of the reward-reversal task presented upon a grey background to establish acquisition learning. Then, two threat and two safe blocks were presented in counterbalanced order, each for a duration of 20 trials. In total, 160 trials were administered in each condition to each subject. The experiment was programmed with Presentation software (Neurobehavioral Systems, Berkeley, CA).

Participants were verbally instructed that they might receive up to three electric shocks when a specific background colour is presented (e.g. blue indicates shock threat), but not during the other color (e.g. green indicates safety). In addition, they were informed that the background color would change while they were doing the task. No specific instructions were given with regard to grey background color, which allowed for initial acquisition learning in a non-instructed (neutral) context (these trials were not analyzed). Subjects were told that their performance in the reward reversal task would not affect the likelihood to receive a shock.

2.4 Behavioral and self-report measures

Behavioral data were analyzed according to established procedures (Paret et al., 2016). Choice time for correct stimulus selections was analyzed, unless participants responded faster than 100 ms to the onset of the fruit and face stimuli. In addition to the percentage of incorrect stimulus selections (*%errors*), we quantified the number of incorrect responses made by participants before they reached the learning criterion (*errors-to-criterion*). Moreover, behavioral changes after negative feedback were scored as the sum of trials in which participants shifted from selection of one stimulus to the other (*lose-shift response*). Percentage of lose-shift responses was quantified relative to all valid trials that immediately followed a lost trial (*%lose-shift*).

In addition, questionnaire and rating data were assessed. Questionnaire data from one subject was partly lost. Difficulties of emotion regulation (147.55 ± 18.37 , $N=33$) and negative urgency (36.27 ± 7.23 , $N=33$) were measured with the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) and the UPPS-P Impulsive Behavior Scale (Whiteside & Lynam, 2001). Psychopathology features were quantified for depression with the BDI-ii (Beck, Steer, & Brown, 1996) (3.60 ± 2.70 , $N=33$), borderline symptoms with the Personality Assessment Inventory (Morey, 1991) (18.30 ± 10.52 , $N=33$) and the Borderline Symptom List short version (Wolf et al., 2009) (5.76 ± 6.04 , $N=33$), social anxiety (24.59 ± 7.21 , $N=34$) with Social Phobia Inventory (SPIN; (Connor et al., 2000)) and trait anxiety (32.24 ± 8.66 , $N=34$) with the State-Trait Anxiety Inventory (Laux, Glanzmann, Schaffner, & Spielberger, 1981). After the experiment, participants rated each stimulus and background regarding valence and arousal using the self-assessment manikin (9-level scale; (Bradley & Lang, 1994)). Furthermore, they indicated how threatening they had perceived the threat and safe context (dubbed “appraisal of threat”),

1 and they were asked to report sympathy of the two faces (11-level Likert scale, latter
2 results are not reported).

3 **2.5 Psychophysiological data acquisition**

4 As an indicator for autonomic nervous system activation, electrodermal activity
5 and heart rate were recorded with AcqKnowledge software (BIOPAC Systems; Goleta,
6 CA) using Ag-AgCl electrodes. Skin conductance electrodes were placed at palm and
7 thenar of the non-dominant hand (all participants were right handed) and data were
8 recorded at 20Hz sampling rate. The electrocardiogram was recorded at lead II at a
9 1000Hz sampling rate. Skin conductance level and heart rate of the threat and safety
10 blocks were downsampled to 20 Hz and scored as mean signal change during the block
11 (88 s) relative to a 10-sec-baseline period before condition onset (Bublitzky et al., 2013).

12 In addition, exploratory analyses examined phasic skin conductance response
13 (SCRs) to the different feedback types. For SCRs, noise and slow frequency changes were
14 removed using a 2 Hz FIR low- and a 0.05 Hz high-pass filter using VisionAnalyzer 2.1
15 (Brain Products). SCRs were scored to the onset of feedback stimuli (i.e. ‘You won/lost’)
16 as the maximum increase in skin conductance amplitude in the interval of 1 to 7 s (relative
17 to a 1 s pre-stimulus period). All SCRs < 0.02 mS were scored as zero response and
18 included in the analyses (i.e., SCR magnitude); range and distribution correction was
19 applied (square root [response/maximum response]; see (Bublitzky et al., 2017)).

20 **2.6 Data analyses**

21 We used t-tests to assess hypotheses about differences in behavior and
22 psychophysiology between the threat and the safety context. Pearson correlation was used
23 to test associations between behavior and psychometric measures. Significance was

1 evaluated at $p < 0.05$ -level. Statistical tests were calculated with SPSS (v25, IBM Corp.
2 Armonk, NY).

3 **3 Results**

4 **3.1 More errors under threat**

5 No differences between threat and safety conditions were observed for choice
6 times ($T(33)=0.764$, $p=0.45$, Cohen's $d=0.13$) and total number of incorrect choices
7 (%errors: $T(33)=0.634$, $p=0.53$, $d=0.11$). However, participants made significantly more
8 errors before reaching the learning criterion during threat compared to safety condition
9 (errors-to-criterion: $T(33)=2.057$, $p < 0.05$, $d=0.35$). The overall number of reversals
10 achieved during the experiment correlated significantly with errors-to-criterion ($r=-$
11 0.824 , $p < 0.001$), but not %errors ($r=-0.318$, $p=0.07$). Thus, errors-to-criterion is the better
12 measure for learning accuracy and was further used for hypotheses testing (see Figure 2).

13 **3.2 No significant correlation with psychometric scales**

14 Borderline features and negative urgency (absolute $r_s < 0.28$, $p_s > 0.10$) were not
15 correlated with errors to criterion, taking into account the whole experiment, including
16 both threat and safety blocks (as well as for threat and safety separately). To explore
17 whether results might be different with face stimuli only, correlational analyses were
18 repeated excluding runs with fruit stimuli, but tests still did not turn out significant
19 ($r_s < 0.20$, $p_s > 0.28$).

In a final analysis, we explored whether threat-impaired reversal is associated with anxiety scores. Neither state-, trait-anxiety nor social phobia scores correlated with enhanced errors-to-criterion (i.e. impaired accuracy) nor enhanced choice time during threat vs. safety.

3.3 Psychophysiology and manipulation check

Participants were instructed to expect electric shocks within one context condition (e.g., blue background signaling threat-of-shock), but not during a safety context (e.g. green signaling no shocks). As in previous research, the threat context was rated as more threatening ($T(33)=9.402$, $p<0.001$, Figure 3a), more negative ($T(33)=8.716$, $p<0.001$) and more arousing ($T(33)=9.718$, $p<0.001$) as the safety context. Moreover, successful threat induction was confirmed by elevated skin conductance level during threat compared to safety context ($T(33)=4.065$, $p<0.001$, Figure 3b), indicating enhanced activation of the autonomous nervous system. Interestingly, higher skin conductance level in threat conditions was associated with enhanced threat ratings ($r=0.363$, $p<0.05$). However, neither changes in choice time nor changes in errors-to-criterion correlated with perceived threat nor skin conductance level ($r_s<0.11$, $p_s>0.42$). Other than expected, difficulties in emotion regulation did not predict changes in appraisal of threat and skin conductance level ($r_s<0.11$, $p_s>0.51$).

Exploratory analyses focused on phasic skin conductance responses (SCR) to different feedback types. During threat-of-shock relative to safety condition, reward feedback led to significantly increased SCRs ($T(33)=4.135$, $p<0.001$), however, SCRs to events where participants lost money did not significantly differ ($T(33)=1.855$, $p=0.07$).

Overall, heart rate did not differ between threat and safety condition ($T(33)=0.40$, $p=0.69$, Figure 3c).

1 **4 Discussion**

2 Detecting potential threats in the environment is crucial for preventing harm to an
3 organism. Critically, contextual threat can have detrimental impact on the performance
4 of concurrent tasks. In line with our hypothesis, instructed threat effectively induced
5 aversive apprehensions that interfered with reward reversal learning. Reversal learning
6 requires overriding stimulus preferences when reward contingency changes. Selecting the
7 non-rewarded stimulus more often after reversal (i.e., the stimulus that was previously
8 rewarded but is now associated with loss) indicates failure to update memory and results
9 in later switching to the newly rewarded stimulus. Extending previous findings, which
10 evidenced reduced reward learning with threat-of-shock (Bogdan & Pizzagalli, 2006;
11 Bogdan et al., 2011), our results show impaired overriding of stimulus preferences and
12 delayed switching to the other behavioral option. Thus, the present study demonstrates
13 that contextual threat compromised flexible decision-making, which is crucial to adapt to
14 changes in reward contingency.

15 According to the ‘dual competition model’ (Pessoa, 2009), contextual threat and
16 and ongoing tasks compete for cognitive resources. The present findings of threat-
17 impaired reversal learning reflects such disruption of global performance. Here, threat
18 might tie up executive resources at disadvantage of the reversal-learning task. However,
19 this explanation requires further scrutiny, as two findings seem to contradict: First, if
20 threat captured executive resources at disadvantage of reversal learning, prolonged choice
21 time would be expected (and was hypothesized) for the threat versus safe conditions,
22 because participants would need to actively disengage from the threat context in order to
23 orient towards reward processing. However, choice time was unaffected in the present
24 study. Second, increased SCRs during threat reflect increased sympathetic arousal in

1 response to reward feedback. This finding is difficult to reconcile with a general reduction
2 of resources allocated to the reversal task, which would rather result in a reduction of
3 sympathetic responding to task stimuli.

4 A different line of research indicates that stressful situations involve switching
5 from goal-directed behavior (guided by value expectations) to habitual behavior
6 (Schwabe & Wolf, 2011). Threat has been shown to enhance stimulus-driven attention
7 and reduce flexible cognition (Bublitzky & Schupp, 2012; Cornwell, Mueller, Kaplan,
8 Grillon, & Ernst, 2012). The mechanism can be explained by noradrenaline that is
9 released within seconds after the onset of a stressor (Joëls, Fernandez, & Roozendaal,
10 2011). Noradrenergic binding to amygdala receptors may facilitate the change to a
11 habitual response mode and might reduce flexible learning of reward reversal (Wirz,
12 Bogdanov, & Schwabe, 2018). In line with this notion, a previous study found threat-of-
13 shock to enhance reflexive response inhibition at cost of reward-based goal-directed
14 choice (Mkrtchian, Roiser, & Robinson, 2017). Increased competition between reflexive
15 response systems and goal-directed learning systems under threat suggests rigid choice
16 of conditioned stimuli and less flexible learning of changes in reward contingency; this is
17 exactly what we found.

18 Intriguingly, through several threat–safety cycles, disrupted reversal learning was
19 rapidly restored once the stressor was omitted. Previous studies showed persistent
20 perturbation of decision-making several minutes following stress induction, after removal
21 of the stressor (Otto, Raio, Chiang, Phelps, & Daw, 2013; Raio, Hartley, Orender, Li, &
22 Phelps, 2017). Such effects were ascribed to cortisol which is released on a slower time
23 scale and reaches its peak later than noradrenaline (Joëls et al., 2011). Notably, we show
24 that perturbation of decision-making is readily installed (and removed), in accordance
25 with rapid transition from a stressful to a stress-free context (and back). Our findings

show that aversive apprehensions can immediately disrupt decision-making, possibly due to noradrenergic modulation of the amygdala.

We would like to highlight the different temporal features of threat, reward and reversal learning in this experiment. Whereas recent research demonstrated rather persistent effects of instructed threat on perceptual processing and defensive reflex activity (even across repeated test days; Bublatzky et al., 2014, 2011), these threat/safety-associations can be flexibly reversed (Atlas, 2019; Bublatzky, Guerra, & Alpers, 2018; Bublatzky, Riemer, & Guerra, 2019). Thus, verbal instructions can readily change affective contingencies from threat to safety, as long as simultaneously a new threat-cue is established. For reward learning, however, the present experimental task used instrumental (but not instructed) learning. Participants acquired reward contingencies more slowly driven by feedback (trial-and-error) and the reversal of rewarded/punished choices were not explicitly instructed. Regarding the number of trials needed to initially acquire reward contingencies, Berghorst et al. (2013) did not find differences as a function of threat and safety instruction. For repeated reward reversal learning, in contrast, the present study demonstrates impaired learning under threat. Hence, it is possible that reward reversal in particular and not reward acquisition learning is prone to threat-related perturbation. Future research may focus on combined instructional and experiential learning strategies (as used for cognitive-behavioral treatment) to detail the workings of reward reversal learning under stressful conditions.

Several of our initial hypotheses were not confirmed by the data at hand. First, no correlations were observed between threat-impaired reversal and difficulties in emotion regulation, impulsivity, or borderline features. Because only healthy participants without psychiatric diagnosis were recruited, the current study has limited variance in psychometric scores and psychopathology. Future studies should target samples that are

1 more heterogeneous and need to compare healthy participants with patient samples to
2 overcome this limitation. Second, no general modulation of the heart rate level was found
3 during threat compared to safety blocks. Phasic heart rate responses might have been
4 more informative reflecting orientation towards a stimulus (Bradley et al., 2005;
5 Bublatzky et al., 2017; Clark et al., 2012), however, these analyses are precluded because
6 of the low number of eight block onsets per threat/safety condition. Third, only young
7 female participants were included, similar as in previous studies showing threat effects
8 on reward-based decision-making (Bogdan & Pizzagalli, 2006; Bogdan et al., 2011).
9 Selection of purely female samples was motivated by the higher prevalence of difficulties
10 with emotion regulation and anxiety in females. To gain full understanding of
11 translational mechanisms of adverse apprehensions on mental disorder, differential
12 vulnerability factors (e.g. sex, impulsivity) need to be addressed in future research.

13 **4.1 Conclusion**

14 Disadvantageous decision-making under threat may mediate the emergence and
15 perpetuation of anxiety symptoms. Enhanced stimulus-driven habitual behavior could
16 contribute to rigid behaviors prevalent in those suffering from pathological anxiety and
17 difficulties of emotion regulation. Future research is needed to better understand the
18 behavioral and neural mechanisms involved in threat-impaired reward reversal. This
19 research may eventually improve our understanding of impaired decision-making in
20 mental disorder and could inform therapy.

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1 6 Figures

Figure 1. Reward reversal learning as a function of threat-of-shock. A) Participants were verbally instructed that they might receive unpleasant but non-painful electric shocks during the presentation of one specific background color (e.g., blue), and they will never receive a shock while the other color (e.g., green) is presented. A printout of the assigned colors with threat and safety symbols was fixed under the screen and presented on the screen before each run as a reminder. Assignment of color to condition was counterbalanced. (B) Experimental task was to find out and select the rewarded stimulus (+10 cent). If choosing the wrong stimulus, 10 cents are drawn from their account. (C) Illustration of reward reversal from stimulus A to stimulus B. Trial description: An experimental trial started with a fixation cross (550 ± 300 ms) that was followed by presentation of either apples and oranges (dubbed “fruit“ runs, see Figure) or two female faces (“face“ runs) (2000 ± 300 ms). Two “fruit runs” and two “face runs” were administered in interleaved order and were analyzed together. Presentation of

1 stimuli to right and left side was semi-randomized, so that the same stimulus was never
2 shown on the same side on more than two subsequent trials. Participants were instructed
3 to select one of the stimuli by pressing either the left or right button on the keyboard,
4 using the index and middle finger of the right hand. If no response was made while the
5 stimulus was on the screen, the screen showed the message “no response” and the trial
6 was excluded from analysis. After a blank screen (800 ± 300 ms), the feedback was
7 presented (1050 ± 300 ms) whether they won or lost 10 cents. Trial timing is based on
8 Greening et al. (2011). To enhance the motivation, participants were told that they would
9 receive the money they would earn during the experiment, additionally to course credit
10 or financial reimbursement. Current balance of earned money was always visible on the
11 bottom of the screen.

1

2 Figure 2. A) Under threat, participants made more errors until they learned the
3 new reward contingency after reversal. B) Comparison of the number of reversals and C)
4 choice times between conditions did not reach statistical significance. N=34, error bars:
5 standard deviation, * $p < 0.05$.

Figure 3. Threat-of-shock induced adverse states. A) Self-reported threat was significantly elevated in the threat vs. safe condition, vas=visual analogue scale. B) Skin conductance level was higher within threat-of-shock relative to safety blocks (average across blocks). C) Heart rate level was not increased during threat (bpm=beats per minute. Error bars = standard deviation; N=34). *p<0.05