Received: 23 November 2023 | Revised: 14 May 2024 | Accepted: 29 May 2024

DOI: 10.1111/psyp.14635

PSYCHOPHYSIOLOGY SPR WILEY

ORIGINAL ARTICLE

Depressive symptoms, task choice, and effort: The moderating effect of personal control on cardiac response

Johanna R. Falk[1,2] | Peter M. Gollwitzer[3,4] | Gabriele Oettingen[3,4] | Kerstin Brinkmann[1,2] | Guido H. E. Gendolla[1,2]

[1]Geneva Motivation Lab, FPSE, Section of Psychology, University of Geneva, Geneva, Switzerland

[2]Swiss Center for Affective Sciences, University of Geneva, Geneva, Switzerland

[3]Department of Psychology, New York University, New York, New York, USA

[4]Department of Political and Social Sciences, Zeppelin University Friedrichshafen, Friedrichshafen, Germany

Correspondence
Johanna R. Falk and Guido H. E. Gendolla, Geneva Motivation Lab, Section of Psychology, University of Geneva, Bd. du Pont d'Arve 40, Geneva CH-1211, Switzerland.
Email: johanna.falk@unige.ch and guido.gendolla@unige.ch

Funding information
Swiss National Science Foundation, Grant/Award Number: 100014_185348

Abstract

Dysphoric individuals perceive mental tasks as more demanding and show increased cardiovascular responses during the performance of easy cognitive tasks. Recent research on action shielding indicates that providing individuals with personal control over their tasks can mitigate the effects of manipulated affective states on cardiovascular responses reflecting effort. We investigated whether the shielding effect of personal choice also applies to the effect of dispositional negative mood on effort. $N = 125$ university students with high (dysphoric) versus low (nondysphoric) depressive symptoms engaged in an easy cognitive task either by personal choice or external assignment. As expected, dysphoric individuals showed significantly stronger cardiac PEP reactivity during task performance when the task was externally assigned. Most importantly, this dysphoria effect disappeared when participants could ostensibly personally choose their task. Our findings show that the previously observed shielding effect of personal action choice against incidental affective stimulation also applies to dispositional negative affect.

KEYWORDS

cardiovascular, depressive symptoms, effort, personal choice, pre-ejection period

1 | INTRODUCTION

Moods are defined as affective states that are experienced without concurrent awareness of their origins (Schwarz & Clore, 2007). They last longer than emotions and can reach from very positive to very negative on a continuous valence dimension. When individuals' mood is negative and stable, it can be referred to as dysphoria—an individual difference variable that can be operationalized as scoring above a certain threshold on a depression scale (Hertel, 2009; Kendall et al., 1987). Therefore, dysphoria can be used to denote subclinical samples with high depressive symptoms.

Grounded in the Mood-Behavior-Model (Gendolla, 2000), a substantial body of research indicates that both a transient negative mood state and dispositional negative mood systematically affect responses in the cardiovascular system that reflect resource mobilization when people cope with cognitive challenges (for overviews, see Brinkmann & Franzen, 2015; Gendolla & Brinkmann, 2005; Gendolla et al., 2012). Specifically, it has been demonstrated that both individuals who

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2024 The Author(s). *Psychophysiology* published by Wiley Periodicals LLC on behalf of Society for Psychophysiological Research.

experience a transient negative mood (e.g., Gendolla et al., 2001; Gendolla & Krüsken, 2001) and those who are dispositionally dysphoric (Brinkmann & Gendolla, 2007, 2008) perceive mental tasks as more demanding, and therefore exhibit greater cardiovascular responses during the performance of easy and moderately difficult cognitive tasks.

Importantly, to date, the effects of naturally occurring negative mood on cardiovascular response during task performance have been studied in the context of *externally assigned* tasks—the usual procedure in psychology experiments. However, recent research has identified the personal choice of tasks (or task characteristics) as an important moderator variable of the link between affective states and resource mobilization. Providing individuals with personal control over an upcoming task can mitigate the effects of incidental affective influences on cardiovascular responses during performance (Falk et al., 2022a, 2022b; Gendolla et al., 2021; see also Bouzidi & Gendolla, 2023a; Framorando et al., 2023a, 2023b, 2024). The present research tested whether this action-shielding effect of personal task choice also applies to dysphoria—a dispositional affective influence. Currently, it remains unclear if the shielding effect is limited to the influence of on the spot created situational affective stimulations or extends to dispositional and thus person-intern origins of affective experiences.

1.1 | Dysphoria and cardiovascular response

The Mood-Behavior-Model (Gendolla, 2000) posits that mood states influence effort—the mobilization of resources for action execution (Gendolla & Wright, 2009)—through their informational value for behavior-related judgments. The model's integration of the informational mood effect with theoretical assumptions about resource mobilization allows for specific and context-dependent predictions about mood effects on effort-related responses in the cardiovascular system.

According to the motivational intensity theory (Brehm & Self, 1989), people are governed by a resource conversation principle and thus avoid investing more effort than necessary. When task difficulty is fixed and clear, effort rises proportionally with experienced task difficulty as long as success is possible and the required effort is justified. Following this principle, effort is low when a task is subjectively easy, moderate when the task feels moderately difficult, and high when the task is experienced as difficult but feasible. However, when task demand (1) is excessive and exceeds the person's ability, or (2) the amount of necessary effort is not justified by the importance of task success, individuals withdraw effort to avoid wasting their resources (for overviews, see Gendolla et al., 2012, 2019; Richter et al., 2016; Wright & Kirby, 2001).

Importantly, the Mood-Behavior-Model posits that mood effects on effort are context-dependent. When people are taking on a task, their mood and information about objective task difficulty are integrated into demand appraisals. For an objectively easy or moderately difficult task, a sad mood increases the perceived difficulty, and consequently leads to higher effort reflected by stronger cardiovascular response. In the context of an objectively difficult task, a sad mood can increase the perceived difficulty in such a way that the experienced task demand becomes excessive. If the subjectively very high necessary effort is then not justified by a high success importance, people disengage and reduce effort (e.g., Gendolla & Krüsken, 2001). Only in the case of high success importance, a sad mood results in very high effort (e.g., Gendolla & Krüsken, 2002; Silvestrini & Gendolla, 2009a, 2009b). In sum, mood can be assumed to moderate the effect of objective task difficulty on cardiovascular activity adjustments reflecting effort.

Importantly, besides experimentally induced mood states, also dispositional negative mood influences individuals' effort during the execution of cognitive tasks. People high in depressive symptoms show stronger sympathetically mediated cardiovascular responses in relatively easy tasks. But when the task is relatively harder, dysphoric individuals show diminished cardiovascular reactivity, consistent with disengagement (Brinkmann & Gendolla, 2007, 2008; Silvia et al., 2016). Moreover, this dispositional mood effect on effort can be reduced by discounting mood's informational impact (Brinkmann et al., 2012). Accordingly, dysphoria does not lead to a general deficit in resource mobilization. Instead, its effects on effort intensity depend on the objective task difficulty context and the extent of mood's informational impact.

1.2 | The role of personal control

Research on volition suggests that the formation of intentions activates cognitive processes that facilitate goal pursuit (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987). After deciding for a goal, individuals enter a mindset that facilitates goal striving by increased commitment (Bandura, 2001; Bouzidi et al., 2022; Nenkov & Gollwitzer, 2012; Ryan & Deci, 2006), heightened task focus (Kuhl, 1986), and an activated implemental mindset (Gollwitzer & Keller, 2016). Strong task focus and action shielding protect goal pursuit against

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

interference from conflicting goals, temptations, or irrelevant information (e.g., Gollwitzer, 1993). This goal shielding effect has been empirically demonstrated in the presence of goal conflict, where goal commitment protects against the mental activation of alternative goals (Shah et al., 2002).

A recent line of research extended this goal shielding effect to action shielding. In accordance with our integrative action shielding model, we found that individuals who could personally choose their type of task or task characteristics were shielded against the effects of both happy vs. sad background music (Falk et al., 2022a, 2022b; Gendolla et al., 2021) and even implicitly processed affect primes (Framorando et al., 2023a, 2023b, 2024, see also Bouzidi & Gendolla, 2023a, 2023b). In contrast to participants to whom the task was externally assigned, their cardiovascular responses were not influenced by the affective stimulation. Going beyond these studies, the present research tested whether the same shielding effect applies to the effects of dispositional negative mood.

1.3 | Effort and cardiovascular response

According to Wright's (1996) integration of motivational intensity theory (Brehm & Self, 1989) with the active coping approach (Obrist, 1981), effort is reflected by beta-adrenergic sympathetic nervous system activity on the heart. The sympathetic innervation of the heart directly affects two cardiac parameters: the contraction pace and the contractile force of the heart muscle (Levick, 2010). The heart's pace depends on both the independent impacts of sympathetic and parasympathetic activity. Consequently, heart rate (HR) is not an ideal indicator of effort. The heart's contractile force, however, depends on beta-adrenergic sympathetic impact (Richter et al., 2016; Wright, 2008). Cardiac pre-ejection period (PEP)—the time interval between the onset of ventricular depolarization and the opening of the aortic valve—is therefore a direct indicator of myocardial contractile force (Berntson et al., 2004). This makes it highly sensitive to manipulations of task demand (e.g., Richter et al., 2008), and thus an ideal index of effort (Kelsey, 2012). Stronger beta-adrenergic sympathetic impact results in a shorter PEP.

Because of its link with cardiac contractile force, many studies have operationalized effort in terms of performance-related changes in systolic blood pressure (SBP; the maximum pressure in the vascular system between two consecutive heart beats; for reviews, see Gendolla et al., 2012, 2019; Richter et al., 2016; Wright & Kirby, 2001). However, besides cardiac contractility, SBP is also influenced by peripheral resistance in the vasculature, which is not systematically linked to beta-adrenergic impact. The influence of vascular resistance on diastolic blood pressure (DBP; the minimal pressure in the vascular system between two consecutive heart beats) is even stronger. However, PEP should always be assessed together with HR and blood pressure to monitor possible effects of ventricular filling and arterial pressure on PEP (Sherwood et al., 1990). In sum, PEP is the purest noninvasive indicator of beta-adrenergic sympathetic impact and thus the most reliable measure of effort among these cardiovascular activity indices (Kelsey, 2012; Richter et al., 2008; Wright, 1996).

1.4 | The present research

We ran a quasi-experimental study to test our conceptual hypothesis that the informational mood impact and thus the effect of depressive symptoms on sympathetically mediated cardiovascular response should be evident in an externally assigned task, but attenuated due to *action shielding* when the task is personally chosen. Participants were pre-selected based on their scores on a depression scale, and then randomly assigned to the task choice or assignment condition of our 2 (dysphoric vs. nondysphoric) × 2 (personal choice vs. task assignment) between-persons design. In a first phase, we assessed depression scores in a large participant pool. In the second phase, we assessed cardiovascular responses of individuals with high (dysphoric) vs. low (nondysphoric) depression scores while performing an easy cognitive task. Importantly, half of the participants could ostensibly choose the type of task, whereas the other half worked on an assigned task (in fact, all participants worked on the same task).

We predicted a moderating effect of personal choice on dysphoria's impact on cardiovascular response (especially PEP) during task performance. In the assigned cognitive task of objectively low difficulty, dysphoric individuals should show stronger sympathetically mediated cardiovascular reactivity than nondysphoric individuals (e.g., Brinkmann & Gendolla, 2008). Most relevant, in the context of a personally chosen easy task, participants should be shielded against dysphoria's impact on effort. Consequently, both dysphoric and nondysphoric individuals should show relatively low cardiovascular reactivity here, because the easy task did only call for the mobilization of few resources (Brehm & Self, 1989). These effects were previously found for different types of external affective stimulation in easy tasks (e.g., Falk et al., 2022b; Framorando et al., 2023a; Gendolla et al., 2021; see also Bouzidi & Gendolla, 2023a). Altogether, we predicted a 3:1 pattern with stronger cardiovascular reactivity (especially cardiac PEP) in the Assigned-Task/Dysphoric condition than in the other three conditions.

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2 | METHOD

2.1 | Participants

In total, 337 university students from an introductory psychology course participated in an online study containing various personality questionnaires. By means of their scores on the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977), we invited students who scored in the lower or upper quartiles of the distribution (i.e., ≤13 or ≥21) via an anonymous code to participate in an ostensibly unrelated experiment in exchange for course credit. It is of note that these scores surpass the conventional cutoff score of 16 (Radloff, 1977), indicating that participants scoring in the upper quartile present high depressive symptomatology, that is, at minimum subclinical symptoms of depression. Following Brinkmann and Gendolla (2008), students with high depressive symptoms are thus referred to as "dysphoric" (see also Kendall et al., 1987). Previous research applying the present task choice manipulation in combination with experimental mood inductions has found significant effects of medium size on effort-related cardiovascular reactivity with samples of 20–30 participants per condition (e.g., Falk et al., 2022a; Gendolla et al., 2021). To have at least the same sample size and to account for possible data loss due to movement or technical problems, we aimed to recruit at least 30 participants per condition. According to a sensitivity analysis with G*power (Faul et al., 2007), this sample size is sufficient to detect a significant a priori contrast and ANOVA main and interaction effects of medium size with 80% power in our 2×2 between-persons design.

A total of 125 participants took part in the main laboratory quasi-experiment and constituted our final sample (106 women, 18 men; average age 21 years). In total, 57 participants (44 women and 13 men) scored in the lower quartile of the CES-D (Time 1 [t1]: $M=7.51$, $SE=0.39$) and are therefore referred to as "nondysphoric". The remaining 68 students (62 women, 6 men) scored in the upper quartile of the CES-D (Time 1 [t1]: $M=35.13$, $SE=0.74$) and are therefore referred to as "dysphoric". As we invited all eligible participants to sign up for the laboratory session using anonymous codes, our control over the gender distributions in the four conditions was constrained: Chosen Task/Nondysphoric (22 women/7 men), Chosen Task/Dysphoric (31 women/3 men), Assigned Task/Nondysphoric (22 women/6 men), and Assigned Task/Dysphoric (31 women/3 men). A chi-square test of these frequencies was not significant ($p=.188$), meaning that there was no evidence for differences in the gender distribution between the conditions. Thus, we decided to report results for the full sample as it was initially intended. Nonetheless, for interested readers, the main results for the female subsample are reported in the Supplementary Online Material. Below, Table 1 presents demographic data of our sample (gender and age), the mean CES-D online questionnaire scores (t1), and the mean momentary mood valence ratings (UWIST Mood Adjective Checklist, Matthews et al., 1990) at the beginning of the laboratory testing session. Due to technical issues at the moment of electrode attachment, electrode detachment during the baseline or task phases, or bad signal quality of their impedance cardiograms (likely due to body movements during the recording period), the PEP data of 6 participants and the HR data of 3 participants could not be analyzed, resulting in final sample sizes of $N=119$ for the PEP analyses and $N=122$ for the HR analyses.

2.2 | Physiological apparatus

We used a Cardioscreen 1000 system (medis; Imenau, Germany) to noninvasively record electrocardiogram (ECG) and thoracic impedance (ICG) signals at a sampling rate of 1000 Hz, from which we derived cardiac PEP (in ms) and HR (beats/min). Therefore, two pairs of single-use electrodes (Ag/AgCI; medis, Imenau, Germany) were attached to the left side of the participants' neck and chest (left middle axillary line at the height of the xiphoid). We used BlueBox 2.V1.22 software (Richter, 2010) for data processing (low-pass filtered at 50 Hz). R-peaks were automatically identified

TABLE 1 Demographic data, preselection CES-D scores, and UWIST average ratings.

	Chosen Task		Assigned Task	
	Dysphoric	**Nondysphoric**	**Dysphoric**	**Nondysphoric**
Age	20.21 (0.32)	24.24 (1.42)	19.97 (0.35)	23.14 (1.26)
Gender (M/W)	3 (8.82%)/31 (91.18%)	7 (24.14%)/22 (75.86%)	3 (8.82%)/31 (91.18%)	6 (21.43%)/22 (78.57%)
CES-D (t1)	33.76 (1.05)	7.10 (0.56)	36.50 (1.00)	7.93 (0.54)
UWIST	18.18 (0.46)	20.31 (0.23)	16.24 (0.44)	18.82 (0.37)

Note: M = men, W = women. $N=125$. Age, CES-D, and UWIST are presented as cell means and standard errors (in parentheses), while gender is shown as the number and percentage (in parentheses) of men and women in each condition.

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

using a threshold peak detection algorithm and visually confirmed, allowing to determine HR. The first derivative of the change in thoracic impedance was calculated, and the resulting dZ/dt signal was ensemble averaged over 1-min periods, based on the detected R-peaks. B-point location was estimated based on the RZ interval of valid heart beat cycles (Lozano et al., 2007), visually checked and manually corrected (Sherwood et al., 1990), allowing to determine PEP (in ms; interval between R-onset and B-point; Berntson et al., 2004). The visual inspection and eventual B-point correction were effectuated blind of conditions on the raw data level and without knowledge of the initial condition means.

Systolic (SBP) and diastolic (DBP; both in mmHg) blood pressure were oscillometrically assessed in 1-min intervals with a Dinamap ProCare monitor (GE Healthcare; Milwaukee, WI). A blood pressure cuff was placed over the brachial artery above the elbow of participants' non-dominant arm. The cuff inflated automatically in 1-min intervals and assessed values were stored by the monitor. For researchers interested in more detailed hemodynamic responses that were unrelated to our hypotheses, analyses of cardiac output and total peripheral resistance are reported in the Supplementary Online Material.

2.3 | Self-report data

Severity of depressive symptoms was assessed with the French version of the CES-D (Fuhrer & Rouillon, 1989), a short self-report scale that has proven its applicability in depression research (Santor et al., 1995). The scale was administered once, about 4–7 weeks prior to the main study, and a second time at the end of the experimental laboratory session. The French version of the CES-D (Fuhrer & Rouillon, 1989) consists of 20 items asking for the frequency of a wide range of depressive symptom experiences on scales from 0 (rarely or none of the time) to 3 (most or all of the time) and has been developed for community samples. Additionally, at the beginning of the experimental session, participants rated two positive (“happy”, “joyful”) and two negative (“sad”, “down”) affect items of the UWIST Mood Adjective Checklist (Matthews et al., 1990) to assess the momentary mood. Participants indicated the extent to which each adjective reflected their momentary feeling state on 7-point Likert scales ranging from 1 (*not at all*) to 7 (*very much*).

2.4 | Procedure

All procedures and measures were approved by the local Ethics Committee. The laboratory session was run with E-Prime 3.0 (Psychology Software Tools; Sharpsburg, PA) and advertised to the students as a 30-min study on cardiovascular activity during a cognitive task. A hired experimenter conducted all laboratory testing sessions over a period of 3 weeks and was unaware of the hypotheses, the participants' depressive symptom scores, and the conditions. Participants were asked to avoid heavy meals 2h prior to the testing session, and not to consume caffeine or nicotine on the testing day.

Upon arrival, participants were welcomed, seated in a comfortable chair in front of a computer, and asked to provide written informed consent, detailing the procedure of the testing session and the automatic attribution of partial course credit for practical work at the end of the laboratory session. The participants were explicitly informed that their participation was voluntary and were assured that they could withdraw from the study at any time. After consent was obtained, the experimenter attached the blood pressure cuff and the electrodes, started the experimental software, left the room, and monitored the procedure from an outside control room (participants were not filmed or acoustically recorded).

First, participants rated the negative and positive affect items of the UWIST mood scale (Matthews et al., 1990) using the computer keyboard. To prevent suspicion, these affect ratings were introduced as standard measures to account for potentially different feeling states of participants entering the laboratory. Next, we assessed cardiovascular baseline activity during the presentation of a hedonically neutral 8-min long documentary film about trees. Participants were instructed to relax during the film.

After the cardiovascular baseline activity measures, we administered the task choice manipulation, following the procedure by Gendolla et al. (2021), Falk et al. (2022a), and Framorando et al. (2023a). Participants in the Chosen Task condition were informed that they could choose one of two tasks based on their preference. To give them a reason for their choice, and making the choice relevant, they read: “Current research results show that the possibility of choosing a task has a positive effect on task performance”. After participants had pressed “enter” to continue, brief descriptions of both types of tasks were provided on the next screen: Memory Task (“during a memory task, you have to remember the presented stimuli”) or Attention Task (“during an attention task, you have to pay attention to the presented stimuli”). Participants started the deliberation period with pressing “enter”: The next screen asked participants to deliberate for 1-min on the question, “Do you want to work on a memory task or an attention task?”. At the end of the deliberation period, participants were asked to indicate their choice by pressing an assigned key for the memory task or an assigned key for the attention task. Next, the chosen task and the question “Are you sure

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

about your choice?" were displayed to assure their commitment to the chosen task. If they pressed the green key for "yes", the procedure continued; if they pressed the red key for "no", they had to indicate their choice again and the procedure continued after entering and confirming their decision. In fact, all participants later worked on the very same task that entailed both types of cognitive processing—memory and attention.

In the Assigned Task condition, participants worked on the ostensible task type chosen by their yoked participant in the task-choice condition. If they previously chose the Memory Task, participants read "Current research results show a positive effect on task performance when the cognitive task is a memory task". When the yoked participant previously chose the Attention Task, the message was "Current research results show a positive effect on task performance when the cognitive task is an attention task". That is, as in the Chosen Task condition, there always was a positive performance framing. To create further matches to the Chosen Task condition, Assigned Task participants were then asked to take a 1-min break before the task instructions were displayed.

The task instructions, which were identical for all participants, were named "Memory Task" or "Attention Task", respectively. The task was an adapted easy version of a Sternberg (1966) task, that comprised both attention and memory components. Instructions explained that participants would work on the task for 5 min. All participants worked on the very same cognitive task requiring both continued attention and memorization. They were presented with 36 different assemblies of 4 letters (e.g., "SBNR"). In 50% of the trials, the single letter that was subsequently presented was part of the four-letter series, and in the other 50% of the trials it was not. Each trial started with a fixation cross (1000 ms), followed by an assembly of 4 letters (1000 ms). The letter series was then followed by a mask and a single letter, and participants had to indicate within 2000 ms whether the target letter was part of the previously presented letter series by pressing a green ("yes") or a red ("no") response key. Participants were instructed to answer correctly and fast in all trials. Their responses were followed by the message "response registered", displayed for 4 s minus their reaction time. When no response was given within the response window, the feedback "please respond faster" was displayed for 2 s. The subsequent inter-trial interval varied between 2000 and 4000 ms. During task performance, participants were presented with a randomized order of the letter series while cardiovascular activity was assessed. Before starting the 5-min task period, participants performed 10 training trials to familiarize themselves with the task and form an impression of task difficulty. During these training trials, participants received feedback at the end of each trial ("correct response"/"incorrect response"/"please respond faster").

After the task, participants rated the task's difficulty on a 7-point Likert scale ("To what extend did you find the task difficult?"), reaching from 1 (*not at all*) to 7 (*very difficult*). Next, participants answered additional questions about their age, first language, French language proficiency, and medication use.

The experimenter then reentered the room to remove the blood pressure cuff and the electrodes. Participants were guided to an adjacent room and seated in front of a computer: Here, they were asked to complete a short questionnaire (CES-D), ostensibly for an unrelated questionnaire validation study. During the completion of the questionnaire, the experimenter waited in the control room. The experiment then ended with a debriefing and the opportunity to discuss one's personal experience of the procedure with the experimenter. Importantly, no participant guessed the purpose of the study or questioned the choice manipulation. Finally, participants were thanked and their partial course credit was electronically attributed.

3 | RESULTS

The data and data coding are available on Yareta—the open access data archiving server of the University of Geneva: https://doi.org/10.26037/yareta:mthubrzvxjchzguu7uhkgszxx4. Our theory-based predictions about task choice and dysphoria effects on sympathetically mediated cardiovascular responses were tested with planned a priori contrast analyses, which are the most powerful and thus appropriate statistical tool to test predicted patterns of means (Rosenthal & Rosnow, 1985; Wilkinson & The Task Force on Statistical Inference of APA, 1999). As explained above, we expected a 3:1 interaction pattern with higher cardiovascular responses (especially PEP) in the Assigned Task/Dysphoric condition (contrast weight +3) and weaker responses in the other three conditions (contrast weights −1). Variables for which we did not specify theory-based predictions were analyzed with conventional exploratory ANOVAs. Because of the low number of male participants and the uneven distribution across conditions, we present findings for the female subsample for the cardiovascular activity measures in the Online Supplementary Material.

3.1 | Cardiovascular baselines

We had a priori decided to constitute participants' cardiovascular baseline scores by averaging cardiovascular values of the last 3 min of the habituation period. We did so to

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 Cell means and standard errors (in parentheses) of cardiovascular baseline scores.

	Chosen Task		Assigned Task	
	Dysphoric	Nondysphoric	Dysphoric	Nondysphoric
PEP	98.60 (1.34)	101.86 (2.17)	100.76 (1.87)	100.73 (2.23)
SBP	104.25 (1.59)	102.06 (1.94)	102.47 (1.42)	104.74 (2.27)
DBP	59.49 (0.84)	59.48 (1.15)	58.61 (0.89)	60.01 (1.18)
HR	81.04 (2.08)	76.07 (2.81)	76.27 (2.29)	78.31 (2.44)

Note: $N=119$ for PEP, $N=122$ HR, $N=125$ for SBP, DBP.
Abbreviations: DBP, diastolic blood pressure (in mmHg); HR, heart rate (in beats/minute); PEP, pre-ejection period (in ms); SBP, systolic blood pressure (in mmHg).

comply with the recommendation to average at least three blood pressure measures and because cardiovascular baseline scores generally become stable toward the end of the habituation periods (Shapiro et al., 1996). The cardiovascular measures showed high internal consistency during that time period (McDonald's ωs ≥ .951). Cell means and standard errors of the baseline scores appear in Table 2. Preliminary 2 (Choice) × 2 (Dysphoria) ANOVAs revealed no significant differences between the later conditions for the entire sample ($ps \geq .147$).[1]

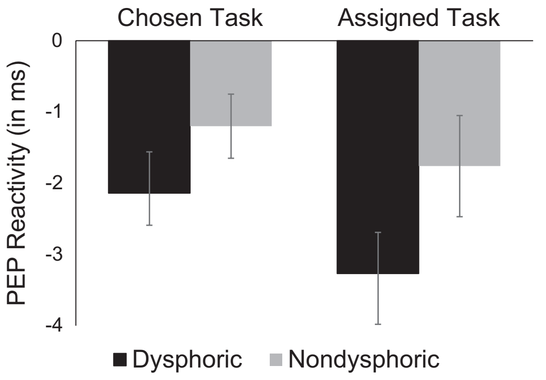

FIGURE 1 Cell means and ±1 standard errors underlying the combined effect of task choice and depressive symptoms on cardiac pre-ejection period (PEP) reactivity during task performance.

3.2 | Cardiovascular reactivity

To obtain reactivity scores (Llabre et al., 1991), we subtracted the baseline scores from the five 1-min scores of PEP, HR, SBP, and DBP that were assessed during task performance. The constituted scores showed high internal consistency (McDonald's ωs ≥ .895) and were averaged to create reactivity scores for the task performance period.

3.2.1 | PEP reactivity

In line with our hypothesis, our theory-based a priori contrast for PEP reactivity—our primary effort-related measure—was significant, $F(1, 115)=5.65$, $p=.019$, $\eta^2=0.05$. As depicted in Figure 1, the PEP responses showed the predicted 3:1 pattern with stronger reactivity in the Assigned Task/Dysphoric condition compared to the other three conditions (decreases in PEP reflecting increased beta-adrenergic sympathetic activity). This supports our main hypothesis.

Additional one-tailed cell contrasts found that PEP reactivity in the Assigned Task/Dysphoric condition ($M=-3.27$, $SE=0.58$) was significantly stronger than PEP reactivity in the Assigned Task/Nondysphoric condition ($M=-1.76$, $SE=0.71$), $t(115)=1.79$, $p=.038$, $\eta^2=0.03$, and the Chosen Task/Nondysphoric condition ($M=-1.20$, $SE=0.45$), $t(115)=2.51$, $p=.007$, $\eta^2=0.04$. The difference to the Chosen Task/Dysphoric condition ($M=-2.14$, $SE=0.58$) fell short of significance, $t(115)=1.43$, $p=.078$, $\eta^2=0.02$. The Chosen Task/Nondysphoric, Assigned Task/Dysphoric, and Assigned Task/Nondysphoric conditions did not significantly differ from each other ($ps \geq .256$).

A critical reader might ask whether the PEP reactivity pattern does in fact not better fit a dysphoria main effect than our predicted 3:1 pattern reflecting the shielding effect. Therefore, we directly compared the probabilities of a dysphoria main effect pattern (1, −1, 1, −1) vs. our theory-based a priori contrast (1, 1, 1, −3) using Bayesian statistics (see Masson, 2011). This resulted in a Bayes Factor of 6.74, which produced a posterior probability of

[1]The 3:1 contrast that tested our predictions about cardiovascular reactivity was not significant for any of the cardiovascular baseline values ($ps \geq .353$). For readers interested in gender differences in cardiovascular activity, we compared baseline values of women and men with *t*-tests (including gender in three-factorial ANOVAs was not warranted because there were far more women than men in our sample). These analyses revealed a significant gender difference for baseline values of SBP, $t(123)=7.58$, $p<.001$, $\eta^2=0.32$, due to higher SBP for men ($M=116.53$, $SE=2.54$) than for women ($M=101.01$, $SE=0.74$). The analyses also revealed a significant gender difference for baseline values of DBP $t(123)=2.24$, $p=.017$, $\eta^2=0.04$, due to higher DBP for men ($M=61.96$, $SE=1.57$) than for women ($M=58.90$, $SE=0.51$). There were no significant gender differences for the PEP and HR baseline values ($ps \geq .076$).

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

0.87 for our initial model. Thus, the results of the Bayesian analysis qualify as positive evidence in favor of our theory-based a priori 3:1 model over the model that assumes only a dysphoria main effect pattern (see Raftery, 1995).

3.2.2 | HR and blood pressure reactivity

Cell means and standard errors are displayed in Table 3. The a priori contrasts for SBP and DBP were not significant, $Fs(1, 121) \leq 2.18$, $ps \geq .080$. The a priori contrast for HR was also not significant, $F(1, 118) = 0.87$, $p = .353$.

3.3 | Task performance

A 2 (Choice) × 2 (Dysphoria) ANOVA of the percentage of correct answers revealed no significant effects ($ps \geq .058$). On average, participants answered correctly in 96% of the trials ($SE = 0.003$). This very high score supports our assumption that the task was easy. Moreover, response accuracy was negatively correlated with PEP reactivity, $r(119) = -.18$, $p = .049$, suggesting that decreases in PEP were associated with increases in response accuracy. This can be interpreted as indicating a positive association between effort and performance.

A 2 (Choice) × 2 (Dysphoria) ANOVA of the reaction times for correct responses revealed no significant effects ($ps \geq .124$). On average, participants took 837.53 ms ($SE = 15.41$) to respond. There was no significant correlation between PEP reactivity and response speed ($p = .128$).

3.4 | Self-report measures

3.4.1 | Mood

We calculated global mood scores by summing the positive and the reverse scored negative adjectives of the UWIST scale (McDonald's $\omega s = .883$). On the global mood score, dysphoric participants ($M = 17.21$, $SE = 0.34$) showed significantly lower scores than nondysphoric participants ($M = 19.58$, $SE = 0.24$), $t(123) = 5.54$, $p < .001$, $\eta^2 = 0.20$. Accordingly, dysphoric individuals were in a more negative mood when arriving at the laboratory.

3.4.2 | Depression scores

The CES-D was first assessed four to seven weeks before the main study (Time 1 [t1] Nondysphoric: $M = 7.51$, $SE = 0.39$, [t1] Dysphoric: $M = 35.13$, $SE = 0.74$), and a second time at the end of the experimental session (Time 2 [t2] Nondysphoric: $M = 8.42$, $SE = 0.75$, [t2] Dysphoric: $M = 26.71$, $SE = 1.24$). At both assessment times, the CES-D showed high internal consistency (McDonald's $\omega s \geq .940$), and the questionnaire scores for t1 and t2 were highly correlated, $r(123) = .803$, $p < .001$. Not surprisingly, the CES-D score difference between the dysphoric and nondysphoric groups was significant and of large size at both times of measure, $ts(123) > 12.07$, $ps < .001$, $\eta^2 s > 0.54$ This indicates that participants' depression scores were relatively stable over time.

3.4.3 | Difficulty

We subjected the task difficulty ratings to a 2 (Choice) × 2 (Dysphoria) ANOVA, which revealed no significant effects ($ps \geq .587$). Generally, the difficulty ratings (grand $M = 1.96$, $SE = 0.11$) were significantly lower than the scale's midpoint (3.5) according to a one-sample t-test, $t(124) = 14.50$, $p < .001$, $\eta^2 = 0.63$. Accordingly, participants perceived the task as intended, that is, as relatively easy.

4 | DISCUSSION

The present study provides first support for our hypothesis that the personal choice of a task can attenuate the effect of depressive symptoms on sympathetically mediated response in the cardiovascular system. We found, as expected, that individuals with high depressive symptoms showed stronger PEP responses during a relatively

TABLE 3 Cell means and standard errors (in parentheses) of cardiovascular reactivity.

	Chosen Task		Assigned Task	
	Dysphoric	Nondysphoric	Dysphoric	Nondysphoric
SBP	3.99 (0.74)	3.83 (0.80)	2.69 (0.57)	3.80 (0.75)
DBP	3.07 (0.68)	3.50 (0.61)	1.77 (0.41)	2.15 (0.54)
HR	−0.75 (1.52)	0.45 (0.48)	−0.47 (1.37)	2.66 (0.78)

Note: $N = 122$ HR, $N = 125$ for SBP and DBP.

Abbreviations: DBP, diastolic blood pressure (in mmHg); HR, diastolic blood pressure (in beats/minute); SBP, systolic blood pressure (in mmHg).

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

easy short-term memory task when the task was externally assigned. This pattern conceptually replicates findings by Brinkmann and Gendolla (2007, 2008) and Silvia et al. (2016). Importantly, the dysphoria effect was no longer evident when participants could ostensibly choose the type of their task by themselves—indicating action shielding by personal choice.

Our main finding extends recent evidence for shielding effects against the impact of different types of external, situation-based affective stimulation to shielding against the effect of dispositional negative affect. More specifically, previous studies investigated the shielding role of personal choice against the following affective influences: happy and sad background music (Falk et al., 2022a, 2022b; Gendolla et al., 2021) and affect primes (Framorando et al., 2023a, 2023b, 2024; see also Bouzidi & Gendolla, 2023a). The present study demonstrates that engaging in a task by personal choice versus external assignment moderates even the effect of dispositional affective influences on sympathetically mediated cardiac response reflecting effort. Thus, the present study adds to the understanding of the moderating role of personal choice in affective influences on effort, extending the findings of previously published studies. The present study further supports the validity of our integrative action shielding model (Gendolla et al., 2021).

Based on the Mood-Behavior-Model's logic, participants with high depressive symptoms should perceive task difficulty as relatively high during the performance of an easy task. In accordance with the principles of motivational intensity theory (Brehm & Self, 1989) and the many studies supporting it (Gendolla et al., 2012, 2019; Richter et al., 2016; Wright & Kirby, 2001 for reviews), this high difficulty perception should result in relatively high effort. Our present effects on PEP reactivity support this prediction—but importantly, only when the easy memory task was externally assigned. When participants could ostensibly choose their preferred task, there was no evidence anymore for a dysphoria effect on PEP. Here, effort was modest in general, again because the objectively low demanding task did not necessitate more effort when dysphoric participants were shielded against mood influences. As also shown previously, this shielding resulted in relatively weak PEP reactivity in an easy task (Bouzidi et al., 2022; Falk et al., 2022b; Framorando et al., 2023a; Gendolla et al., 2021; see also Bouzidi & Gendolla, 2023a).

Importantly, both the performance data and our verbal difficulty manipulation check support the assumption that our task was indeed easy, as intended. Regarding our preselection, participants were selected four to seven weeks prior to the experimental session. Dysphoric and nondysphoric participants differed significantly and largely with respect to their scores on the depression scale (both four to seven weeks before the testing session and at the end of the testing session) and their momentary mood state when entering the laboratory. The mood of dysphoric participants was much more negative than the mood of nondysphoric participants. This pattern of findings supports our assumption that dysphoria is associated with negative mood, and it makes us confident that our sample indeed represents cases of subclinical depression. Nevertheless, it could be valuable for future research to include clinical measurements and clinical samples.

On the physiological level, our predicted reactivity pattern was significant and of medium effect size for PEP reactivity—our main effort-related measure—showing stronger effort in the Assigned Task/Dysphoric condition compared to the other three conditions. By contrast, the responses of SBP, DBP, and HR did not reveal significant effects. This is not surprising, because PEP was our most reliable and valid measure of beta-adrenergic impact. SBP, DBP, and HR are less systematically influenced by the sympathetic nervous system and do not necessarily have to show the same pattern as PEP—although they sometimes do. We note, however, that Brinkmann and Gendolla (2007, 2008) have found significant dysphoria effects on SBP, but PEP was not measured in these studies. Silvia et al. (2016) only assessed PEP and cardiac activity indices other than SBP. Thus, we must leave it for future studies to see if depressive symptoms have effects on both PEP and SBP in easy tasks.

The most important result of the present study was that our predicted reactivity pattern was significant and of medium effect size for our main effort-related measure (i.e., PEP), reflecting higher beta-adrenergic sympathetic impact on the heart in the Assigned Task/Dysphoric condition compared to the other three conditions. We also note that the direct comparison between the Chosen and Assigned Task Dysphoric conditions was in the expected direction but fell short of significance, which is an imperfection. However, as reported in the Online Supplementary Material, the cell difference between the two Dysphoric conditions was significant in the female subsample. Most relevant, the overall contrast modeled according to our theoretical prediction was significant and the Dysphoria effect in the Chosen Task condition was not. In addition, the direct Bayesian comparison of our predicted 3:1 pattern with a simple Dysphoria main effect clearly speaks against the Dysphoria main effect possibility. Taken together, we regard this as supportive evidence for our predictions with a slight imperfection that should be considered in future studies.

There were no significant manipulation effects on task performance quantified as response accuracy and speed. This is not surprising: Previous research on dysphoria effects on effort also did not observe such effects

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

(e.g., Brinkmann & Gendolla, 2008). Further, we did not expect effects in effort intensity to be reflected by performance effects, because the link between effort and performance is difficult to predict. Effort intensity (behavioral input) and performance (behavioral output) are not conceptually identical, and performance depends besides effort also, or even more though, on task-related ability and strategies (Locke & Latham, 1990). Nevertheless, PEP reactivity was significantly correlated with response accuracy. Although the relationship was not of high strength, this finding reflects some association between effort intensity and performance outcome in the present study.

From a broader perspective, our study adds to the existing body of research examining the link between depression and cardiovascular response. In situations where individuals encounter incentives, challenges, and stressors, studies have reported a link between depressive symptoms and reduced cardiovascular reactivity (e.g., de Rooij et al., 2010; Schiweck et al., 2019). As a result, the notion of "depressive blunting" has been introduced (Phillips, 2011; Salomon et al., 2009, 2013; Schwerdtfeger & Rosenkaimer, 2011). On the contrary, other studies have found no respective significant effects (Salomon et al., 2009, 2013) or have reported heightened cardiovascular reactivity (e.g., Light et al., 1998; Matthews et al., 2005; for a meta-analysis see Kibler & Ma, 2004). This variability in research findings has led to the suggestion that there are moderating factors at work. Crucially, as previously demonstrated by Brinkmann and Gendolla (2007, 2008) and Silvia et al. (2016), by adopting the motivational intensity theory framework (Brehm & Self, 1989) alongside the predictions of the Mood-Behavior-Model (Gendolla, 2000), we can gain insights into the circumstances under which depressive symptoms may either reduce or increase cardiovascular response. Accordingly, depressive symptoms do not lead to an overall deficiency in resource mobilization. Instead, depressive symptoms are expected to influence task-difficulty appraisals: Individuals with high depressive symptoms are expected to perceive tasks as subjectively more difficult and thus engage higher effort at objectively easier levels of difficulty, and are also expected to disengage sooner. In line with these predictions, it has been shown that people high in depressive symptoms showed higher effort-related cardiovascular responses in relatively easy tasks. By contrast, when the task was relatively hard, people high in depressive symptoms showed diminished effort-related cardiovascular responses, consistent with disengagement (Brinkmann & Gendolla, 2007, 2008; Silvia et al., 2016). Accordingly, subclinical depression does not lead to an overall deficiency in resource mobilization. Instead, the effects on the intensity of effort and related cardiovascular responses are contingent upon the specific context of the task. The subjective evaluations of individuals with depressive symptoms might originate from maladaptive beliefs and processes that affect individuals' day-to-day functioning. Nevertheless, individuals with depressive symptoms still allocate their effort in a manner that is subjectively rational and systematic when responding to these subjective inputs (see Silvia et al., 2016).

In summary, the present research demonstrates that depressive symptoms affect sympathetically mediated cardiac reactivity during task performance, but in dependence of the participants' control over choosing the upcoming task. Thereby, our present findings add to the existing literature on autonomy and choice. Not only do humans prefer autonomy, self-determination, and choice (Bandura, 2001; Leotti et al., 2010; Ryan & Deci, 2006), the opportunity to personally choose actions can also protect action execution from prolonged negative mood effects on effort, likely through increased task focus and commitment to the chosen option (Gendolla et al., 2021). Apparently, there are instances when dysphoric individuals will rely on their current mood when performing actions—independent of its external or dispositional source—and other instances, where they are highly task focused and committed, and consequently shielded against affective influences on effort-related cardiac response (see also Brinkmann et al., 2012, for the mood discounting effect).

5 | CONCLUSION AND OUTLOOK

The present study helps to integrate two areas of research that have historically made equivocal assumptions about the role of affect in action execution. Theorizing and research on volition suggest that goal striving is shielded against incidental affective influences (e.g., Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987), while research on depressive symptoms and effort has predicted and demonstrated systematic dysphoria effects on effort (e.g., Brinkmann & Gendolla, 2007, 2008; Silvia et al., 2016). The present research demonstrates that the way people engage in an action—by personal choice versus external task assignment—is decisive. Specifically, depressive symptoms influence resource mobilization as reflected by sympathetically mediated cardiac response, but only if a task is externally assigned. By contrast, personal task choice can shield against dysphoria effects on volition. This adds to previously studied benefits of choice (see Leotti et al., 2010), such as facilitating effects of choice on interest and performance (see Cerasoli et al., 2016; Patall et al., 2008; Ryan & Deci, 2006, 2017): Our findings suggest that choice even helps to shield action execution from disposition-based affective influences. Together

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

with previous evidence showing that task choice leads to immunization against external, situation-based affective influences (Falk et al., 2022a, 2022b; Framorando et al., 2023a, 2023b, 2024; Gendolla et al., 2021; see also Bouzidi & Gendolla, 2023a, 2023b), the present study provides first evidence for a corresponding shielding effect against disposition-based affective influences.

AUTHOR CONTRIBUTIONS

Johanna R. Falk: Data curation; formal analysis; investigation; methodology; software; writing – original draft. **Peter M. Gollwitzer:** Conceptualization; methodology; writing – review and editing. **Gabriele Oettingen:** Conceptualization; methodology; writing – review and editing. **Kerstin Brinkmann:** Data curation; writing – review and editing. **Guido H. E. Gendolla:** Conceptualization; funding acquisition; investigation; methodology; project administration; resources; supervision; validation; writing – review and editing.

ACKNOWLEDGMENT

Open access funding provided by Universite de Geneve.

FUNDING INFORMATION

This research was supported by a grant from the Swiss National Science Foundation (SNF 100014_185348/1) awarded to Guido H.E. Gendolla.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to report. We thank Loredana Schifano for her help as a hired experimenter.

DATA AVAILABILITY STATEMENT

The data and data coding for the here reported studies are available on Yareta—the open access data archiving server of the University of Geneva: https://doi.org/10.26037/yareta:mthubrzvxjchzguu7uhkgszxx4.

ORCID

Kerstin Brinkmann https://orcid.org/0000-0002-2075-9677
Guido H. E. Gendolla https://orcid.org/0000-0002-8066-0951

REFERENCES

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, *52*, 1–26. https://doi.org/10.1146/annurev.psych.52.1.1

Berntson, G. G., Lozano, D. L., Chen, Y.-J., & Cacioppo, J. T. (2004). Where to Q in PEP. *Psychophysiology*, *41*, 333–337. https://doi.org/10.1111/j.1469-8986.2004.00156.x

Bouzidi, Y. S., Falk, J. R., Chanal, J., & Gendolla, G. H. E. (2022). Choosing task characteristics oneself justifies effort: A study on cardiac response and the critical role of task difficulty. *Motivation Science*, *8*, 230–238. https://doi.org/10.1037/mot0000269

Bouzidi, Y. S., & Gendolla, G. H. E. (2023a). Is cognitive conflict really effortful? Conflict priming and shielding effects on cardiac response. *Psychophysiology*, *60*(2), e14169. https://doi.org/10.1111/psyp.14169

Bouzidi, Y. S., & Gendolla, G. H. E. (2023b). Action-orientation shields against primed cognitive conflict effects on effort-related cardiac response. *Psychophysiology*, *60*, e14407. https://doi.org/10.1111/psyp.14407

Brehm, J. W., & Self, E. A. (1989). The intensity of motivation. *Annual Review of Psychology*, *40*, 109–131. https://doi.org/10.1146/annurev.ps.40.020189.000545

Brinkmann, K., & Franzen, J. (2015). Depression and self-regulation: A motivational analysis and insights from effort-related cardiovascular reactivity. In G. H. E. Gendolla, M. Tops, & S. L. Koole (Eds.), *Handbook of biobehavioral approaches to self-regulation* (pp. 333–347). Springer New York. https://doi.org/10.1007/978-1-4939-1236-0_22

Brinkmann, K., & Gendolla, G. H. E. (2007). Dysphoria and mobilization of mental effort: Effects on cardiovascular reactivity. *Motivation and Emotion*, *31*(1), 71–82. https://doi.org/10.1007/s11031-007-9054-0

Brinkmann, K., & Gendolla, G. H. E. (2008). Does depression interfere with effort mobilization? Effects of dysphoria and task difficulty on cardiovascular response. *Journal of Personality and Social Psychology*, *94*(1), 147–157. https://doi.org/10.1037/0022-3514.94.1.146

Brinkmann, K., Grept, J., & Gendolla, G. H. E. (2012). Dysphorics can control depressive mood's informational impact on effort mobilization. *Motivation and Emotion*, *36*, 232–241. https://doi.org/10.1007/s11031-011-9236-7

Cerasoli, C. P., Nicklin, J. M., & Nassrelgrgawi, A. S. (2016). Performance, incentives, and needs for autonomy, competence, and relatedness: A meta-analysis. *Motivation and Emotion*, *40*(6), 781–813. https://doi.org/10.1007/s11031-016-9578-2

de Rooij, S. R., Schene, A. H., Phillips, D. I., & Roseboom, T. J. (2010). Depression and anxiety: Associations with biological and perceived stress reactivity to a psychological stress protocol in a middle-aged population. *Psychoneuroendocrinology*, *35*(6), 866–877. https://doi.org/10.1016/j.psyneuen.2009.11.011

Falk, J. R., Gollwitzer, P. M., Oettingen, G., & Gendolla, G. H. E. (2022a). Task choice shields against incidental affective influences on effort-related cardiovascular response. *Psychophysiology*, *59*, e14022. https://doi.org/10.1111/psyp.14022

Falk, J. R., Gollwitzer, P. M., Oettingen, G., & Gendolla, G. H. E. (2022b). Incidental affective influences on effort-related cardiac response: The critical role of choosing task characteristics. *International Journal of Psychophysiology*, *177*, 76–82. https://doi.org/10.1016/j.ijpsycho.2022.04.010

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/bf03193146

Framorando, D., Falk, J. R., Gollwitzer, P. M., Oettingen, G., & Gendolla, G. H. E. (2023a). Can personal task choice shield against fear and anger prime effects on effort? A study on cardiac response. *Biological Psychology*, *181*, 108616. https://doi.org/10.1016/j.biopsycho.2023.108616

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Framorando, D., Falk, J. R., Gollwitzer, P. M., Oettingen, G., & Gendolla, G. H. E. (2023b). The power of personal control: Task choice attenuates the effect of implicit sadness on sympathetically mediated cardiac response. *Psychophysiology*, *61*, e14495. https://doi.org/10.1111/psyp.14495

Framorando, D., Falk, J. R., Gollwitzer, P. M., Oettingen, G., & Gendolla, G. H. E. (2024). Personal task choice attenuates implicit happiness effects on effort: A study on cardiovascular response. *International Journal of Psychophysiology*, *196*, 112282. https://doi.org/10.1016/j.ijpsycho.2023.112282

Fuhrer, R., & Rouillon, F. (1989). La version française de l'échelle CES-D (Center for Epidemiologic Studies–Depression Scale): Description et traduction de l'échelle d'autoévaluation. *European Psychiatry*, *4*, 163–166.

Gendolla, G. H. E. (2000). On the impact of mood on behavior: An integrative theory and a review. *Review of General Psychology*, *4*(4), 378–408. https://doi.org/10.1037/1089-2680.4.4.378

Gendolla, G. H. E., Abele, A. E., & Krüsken, J. (2001). The informational impact of mood on effort mobilization: A study of cardiovascular and electrodermal responses. *Emotion*, *1*(1), 12–24. https://doi.org/10.1037//1528-3542.1.1.1

Gendolla, G. H. E., Bouzidi, Y. S., Arvaniti, S., Gollwitzer, P. M., & Oettingen, G. (2021). Task choice immunizes against incidental affective influences in volition. *Motivation Science*, *7*(3), 229–241. https://doi.org/10.1037/mot0000225

Gendolla, G. H. E., & Brinkmann, K. (2005). The role of mood states in self-regulation: Effects on action preferences and resource mobilization. *European Psychologist*, *10*(3), 187–198. https://doi.org/10.1027/1016-9040.10.3.187

Gendolla, G. H. E., & Krüsken, J. (2001). The joint impact of mood state and task difficulty on cardiovascular and electrodermal reactivity in active coping. *Psychophysiology*, *38*(3), 548–556. https://doi.org/10.1017/S0048577201000622

Gendolla, G. H. E., & Krüsken, J. (2002). Mood state, task demand, and effort-related cardiovascular response. *Cognition and Emotion*, *16*(5), 577–603. https://doi.org/10.1080/02699930143000446

Gendolla, G. H. E., & Wright, R. A. (2009). Effort. In D. Sander & K. R. Scherer (Eds.), *The Oxford companion to emotion and the affective sciences* (pp. 134–135). Oxford University Press.

Gendolla, G. H. E., Wright, R. A., & Richter, M. (2012). Effort intensity: Some insights from the cardiovascular system. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 420–439). Oxford.

Gendolla, G. H. E., Wright, R. A., & Richter, M. (2019). Advancing issues in motivation. Intensity research: Updated insights from the cardiovascular system. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (2nd ed., pp. 373–392). Oxford University Press.

Gollwitzer, P. M. (1990). Action phases and mind-sets. In E. T. Higgins & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 53–92). Guilford.

Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology*, *4*(1), 141–185. https://doi.org/10.1080/14792779343000059

Gollwitzer, P. M., & Keller, L. (2016). Mindset theory. In V. Zeigler-Hill, & T. Shackelford (Eds.), *Encyclopedia of personality and individual differences* (pp. 1–8). Cham: Springer. https://doi.org/10.1007/978-3-319-28099-8_1141-1

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational versus volitional states of mind. *Motivation and Emotion*, *11*(2), 101–120. https://doi.org/10.1007/BF00992338

Hertel, P. T. (2009). Dysphoria. In D. Sander & K. R. Scherer (Eds.), *The Oxford companion to emotion and the affective sciences* (192). Oxford University Press.

Kelsey, R. M. (2012). Beta-adrenergic cardiovascular reactivity and adaptation to stress: The cardiac pre-ejection period as an index of effort. In R. A. Wright & G. H. E. Gendolla (Eds.), *How motivation affects cardiovascular response: Mechanisms and applications* (pp. 43–60). American Psychological Association.

Kendall, P. C., Hollon, S. D., Beck, A. T., Hammen, C. L., & Ingram, R. E. (1987). Issues and recommendations regarding use of the Beck depression inventory. *Cognitive Therapy and Research*, *11*(3), 289–299. https://doi.org/10.1007/BF01186280

Kibler, J. L., & Ma, M. (2004). Depressive symptoms and cardiovascular reactivity to laboratory behavioral stress. *International Journal of Behavioral Medicine*, *11*(2), 81–87. https://doi.org/10.1207/s15327558ijbm1102_3

Kuhl, J. (1986). Motivation and information processing: A new look at decision making, dynamic change, and action control. In E. T. Higgins, & R. M. Sorrentino (Eds.), *Handbook of motivation and cognition: Foundations of social behavior* (pp. 404–434). New York, NY: Guilford.

Leotti, L. A., Iyengar, S. S., & Ochsner, K. N. (2010). Born to choose: The origins and value of the need for control. *Trends in Cognitive Sciences*, *14*(10), 457–463. https://doi.org/10.1016/j.tics.2010.08.001

Levick, J. R. (2010). *Introduction to cardiovascular physiology* (4th ed.). Oxford University Press.

Light, K. C., Kothandapani, R. V., & Allen, M. J. (1998). Enhanced cardiovascular and catecholamine responses in women with depressive symptoms. *International Journal of Psychophysiology*, *28*(2), 157–166. https://doi.org/10.1016/s0167-8760(97)00093-7

Llabre, M. M., Spitzer, S. B., Saab, P. G., Ironson, G. H., & Schneiderman, N. (1991). The reliability and specificity of delta versus residualized change as measures of cardiovascular reactivity to behavioral challenges. *Psychophysiology*, *28*(6), 701–711. https://doi.org/10.1111/j.1469-8986.1991.tb01017.x

Locke, E. A., & Latham, G. P. (1990). *A theory of goal setting & task performance*. Prentice-Hall, Inc.

Lozano, D. L., Norman, G., Knox, D., Wood, B. L., Miller, D., Emery, C. F., & Berntson, G. G. (2007). Where to B in dZ/dt. *Psychophysiology*, *44*, 113–119. https://doi.org/10.1111/j.1469-8986.2006.00468.x

Masson, M. E. (2011). A tutorial on a practical Bayesian alternative to null-hypothesis significance testing. *Behavior Research Methods*, *43*, 679–690. https://doi.org/10.3758/s13428-010-0049-5

Matthews, G., Jones, D. M., & Chamberlain, A. G. (1990). Refining the measurement of mood: The UWIST mood adjective checklist. *British Journal of Psychology*, *81*(1), 17–42. https://doi.org/10.1111/j.2044-8295.1990.tb02343.x

Matthews, S. C., Nelesen, R. A., & Dimsdale, J. E. (2005). Depressive symptoms are associated with increased systemic vascular resistance to stress. *Psychosomatic Medicine*, *67*(4), 509–513. https://doi.org/10.1097/01.psy.0000160467.78373.d8

Nenkov, G. Y., & Gollwitzer, P. M. (2012). Pre-versus postdecisional deliberation and goal commitment: The positive effects of defensiveness. *Journal of Experimental Social Psychology*, *48*(1), 106–121. https://doi.org/10.1016/j.jesp.2011.08.002

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Obrist, P. A. (1981). *Cardiovascular psychophysiology: A perspective*. Plenum Press. https://doi.org/10.1007/978-1-4684-8491-5

Patall, E. A., Cooper, H., & Robinson, J. C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin*, *134*(2), 270–300. https://doi.org/10.1037/0033-2909.134.2.270

Phillips, A. C. (2011). Blunted cardiovascular reactivity relates to depression, obesity, and self-reported health. *Biological Psychology*, *86*(2), 106–113. https://doi.org/10.1016/j.biopsycho.2010.03.016

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Raftery, A. E. (1995). Bayesian model selection in social research. In P. V. Marsden (Ed.), *Sociological methodology* (pp. 111–196). Blackwell.

Richter, M. (2010). *BlueBox 2 v1.22*. University of Geneva.

Richter, M., Friedrich, A., & Gendolla, G. H. E. (2008). Task difficulty effects on cardiac activity. *Psychophysiology*, *45*, 869–875. https://doi.org/10.1111/j.1469-8986.2008.00688.x

Richter, M., Gendolla, G. H. E., & Wright, R. A. (2016). Three decades of research on motivational intensity theory: What we have learned about effort and what we still don't know. *Advances in Motivation Science*, *3*, 149–186. https://doi.org/10.1016/bs.adms.2016.02.001

Rosenthal, R., & Rosnow, R. L. (1985). *Contrast analysis*. Cambridge University Press.

Ryan, R. M., & Deci, E. L. (2006). Self-regulation and the problem of human autonomy: Does psychology need choice, self-determination, and will? *Journal of Personality*, *74*(6), 1557–1586. https://doi.org/10.1111/j.1467-6494.2006.00420.x

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory*. Guilford.

Salomon, K., Bylsma, L. M., White, K. E., Panaite, V., & Rottenberg, J. (2013). Is blunted cardiovascular reactivity in depression mood-state dependent? A comparison of major depressive disorder remitted depression and healthy controls. *International Journal of Psychophysiology*, *90*(1), 50–57. https://doi.org/10.1016/j.ijpsycho.2013.05.018

Salomon, K., Clift, A. D., Karlsdóttir, M., & Rottenberg, J. (2009). Major depressive disorder is associated with attenuated cardiovascular reactivity and impaired recovery among those free of cardiovascular disease. *Health Psychology*, *28*(2), 157–165. https://doi.org/10.1037/a0013001

Santor, D. A., Zuroff, D. C., Ramsay, J. O., Cervantes, P., & Palacios, J. (1995). Examining scale discriminability in the BDI and the CESD as a function of depressive severity. *Psychological Assessment*, *7*, 131–139. https://doi.org/10.1037/1040-3590.7.2.131

Schiweck, C., Piette, D., Berckmans, D., Claes, S., & Vrieze, E. (2019). Heart rate and high. Frequency heart rate variability during stress as biomarker for clinical depression. A systematic review. *Psychological Medicine*, *49*(2), 200–211. https://doi.org/10.1017/S0033291718001988

Schwarz, N., & Clore, G. L. (2007). Feelings and phenomenal experiences. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (pp. 385–407). Guilford.

Schwerdtfeger, A., & Rosenkaimer, A. K. (2011). Depressive symptoms and attenuated physiological reactivity to laboratory stressors. *Biological Psychology*, *87*(3), 430–438. https://doi.org/10.1016/j.biopsycho.2011.05.009

Shah, J. Y., Friedman, R., & Kruglanski, A. W. (2002). Forgetting all else: On the antecedents and consequences of goal shielding. *Journal of Personality and Social Psychology*, *83*(6), 1261–1280. https://doi.org/10.1037/0022-3514.83.6.1261

Shapiro, D., Jamner, L. D., Lane, J. D., Light, K. C., Myrtek, M., Sawada, Y., & Steptoe, A. (1996). Blood pressure publication guidelines. *Psychophysiology*, *33*, 1–12. https://doi.org/10.1111/j.1469-8986.1996.tb02103

Sherwood, A., Allen, M. T., Fahrenberg, J., Kelsey, R. M., Lovallo, W. R., & Doornen, L. J. P. (1990). Methodological guidelines for impedance cardiography. *Psychophysiology*, *27*, 1–23. https://doi.org/10.1111/j.1469-8986.1990.tb02171.x

Silvestrini, N., & Gendolla, G. H. E. (2009a). Mood-regulative hedonic incentive interacts with mood and task difficulty to determine effort-related cardiovascular response and facial EMG. *Biological Psychology*, *82*(1), 54–63. https://doi.org/10.1016/j.biopsycho.2009.05.005

Silvestrini, N., & Gendolla, G. H. E. (2009b). The joint effect of mood, task valence, and task difficulty on effort-related cardiovascular response and facial EMG. *International Journal of Psychophysiology*, *73*(3), 226–234. https://doi.org/10.1016/j.ijpsycho.2009.03.004

Silvia, P. J., Mironovová, Z., McHone, A. N., Sperry, S. H., Harper, K. L., Kwapil, T. R., & Eddington, K. M. (2016). Do depressive symptoms "blunt" effort? An analysis of cardiac engagement and withdrawal for an increasingly difficult task. *Biological Psychology*, *118*, 52–60. https://doi.org/10.1016/j.biopsycho.2016.04.068

Sternberg, S. (1966). High-speed scanning in human memory. *Science*, *153*(3736), 652–654. https://doi.org/10.1126/science.153.3736.652

Wilkinson, L. A., & The Task Force on Statistical Inference of APA. (1999). Statistical methods in psychology journals. *American Psychologist*, *54*(8), 594–604. https://doi.org/10.1037/0003-066X.54.8.594

Wright, R. A. (1996). Brehm's theory of motivation as a model of effort and cardiovascular response. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 424–453). Guilford.

Wright, R. A. (2008). Refining the prediction of effort: Brehm's distinction between potential motivation and motivation intensity. *Social and Personality Psychology Compass*, *2*(2), 682–701. https://doi.org/10.1111/j.1751-9004.2008.00093.x

Wright, R. A., & Kirby, L. D. (2001). Effort determination of cardiovascular response: An integrative analysis with applications in social psychology. *Advances in Experimental Social Psychology*, *33*, 255–307. https://doi.org/10.1016/S0065-2601(01)80007-1

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Data S1. Supporting Information.

How to cite this article: Falk, J. R., Gollwitzer, P. M., Oettingen, G., Brinkmann, K., & Gendolla, G. H. E. (2024). Depressive symptoms, task choice, and effort: The moderating effect of personal control on cardiac response. *Psychophysiology*, *00*, e14635. https://doi.org/10.1111/psyp.14635

14698986, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/psyp.14635, Wiley Online Library on [27/06/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License