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Task Choice Immunizes Against Incidental Affective Influences in Volition

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Abstract

Two experiments tested whether engaging in actions by personal choice vs. external task assignment moderates the effect of incidental affective stimulation on action control (volition). As choice of an action alternative has been found to lead to strong goal commitment, an implemental mindset, and determined task focus, we reasoned that it should shield action control from incidental affective influences. By contrast, external task assignment should lead to weaker action shielding and thus give way to incidental affective influences. Results followed our predictions. When participants were assigned the cognitive task, they persisted less (Study 1) and mobilized lower effort assessed as cardiac pre-ejection period (Study 2) when they were exposed to happy music as compared with sad music. These music effects on volition did not appear among participants who could choose the task. Our results show that working on a task is shielded better from incidental affective influences when the task is chosen rather than assigned.

Keywords: Action shielding, volition, action control, mood, affect, effort, persistence, cardiovascular response

Task Choice Immunizes Against Incidental Affective Influences in Volition

Theorizing and research on volition—the execution, maintenance, and protection of goal-directed action (Kuhl, 1986)—suggest that having formed an intention leads to a phenomenon termed goal shielding (Gollwitzer, 1990; Heckhausen & Gollwitzer, 1987): a mind-set that protects goal pursuit from conflicting temptations and incidental affective influences (e.g., Shah et al., 2002). At the same time, there is ample evidence that affect can systematically influence goal pursuit in terms of both effort intensity (see Gendolla et al., 2012; Gendolla, 2012) and persistence (see Martin, 2001; Martin & Stoner, 1996)—two core aspects and indicators of volition (Ach, 1935; Lewin, 1926). The present research aims at reconciling these phenomena by considering the characteristics of self-chosen vs. assigned actions and specifying when and how affective influences influence action execution.

Affect and Effort

Regarding affective influences on action, Gendolla (2000) posited in his Mood-Behavior-Model that experienced affective states (moods) can influence effort mobilization by their informational impact. Applying an information integration perspective (Abele & Petzold, 1994), the Mood-Behavior-Model posits that people can use their moods as pieces of information and integrate them with all other available information into their behavior-related judgments. Using mood as a piece of information to evaluate task difficulty leads to a mood congruency effect: individuals in a sad mood judge task difficulty as higher than individuals in a happy mood. Effort intensity is then proportional to subjective task demand as long as success is possible and justified (Brehm & Self, 1989).[1] This systematic impact of affective experiences on action execution has been supported by numerous studies that experimentally manipulated mood states (e.g., Gendolla et al., 2001) or assessed individual differences in affectivity (e.g., Brinkmann & Gendolla, 2007), and quantified effort intensity in terms of performance-related changes in the activity of the cardiovascular system (see Gendolla & Brinkmann, 2005; Gendolla et al., 2012, for overviews). However, all of this research has exclusively studied mood effects on effort in assigned but not self-chosen tasks.

Affect and Persistence

Affect has also been found to influence persistence—the maintenance of action execution. According to Martin's Mood-As-Input model (see Martin, 2001; Martin & Stoner, 1996) moods do not have stable motivational implications (cf. Schwarz, 1990). Rather, the impact of mood on task persistence depends on contextual factors like stop rules (e.g., Martin, Ward, Archee, & Wyer, 1993). The basic assumption is that individuals in a happy mood persist longer when they ask themselves questions like "Am I enjoying this task?" or "Do I feel like continuing?" (*enjoy-rule*), putting an emphasis on the task itself, because positive affect signals an enjoyable task that should be continued. By contrast, individuals in a sad mood persist longer when they ask themselves questions like "Have I done enough?" or "Is this a good time to stop?" (*enough-rule*), emphasizing performance outcomes, because negative affect signals insufficient goal progress and the necessity to continue (Carver, 2006). Evidence for these mood effects on persistence has been found in studies with both experimental mood manipulations (e.g., Hirt et al., 1997; Martin et al., 1993) and assessments of individual differences in affectivity (e.g., Brinkmann & Gendolla, 2020). However, as is true for the research on affective influences on effort, the affect-persistence link has only been analyzed regarding assigned tasks rather than studying self-chosen tasks as well.

Task Choice Effects

In the present research we tested whether task choice moderates affective influences on volition in terms of effort mobilization and persistence. There is convincing evidence that humans prefer autonomy and choice (Leotti et al., 2010; Leotti & Delgado, 2011) and react aversively to restrictions of freedom (Brehm, 1966; Rosenberg & Siegel, 2018). Most relevant, giving people the opportunity to choose their goals and actions has positive effects on their interest and performance (Cerasoli et al., 2016; Patall et al., 2008; Ryan & Deci, 2006). Several studies that were conducted in laboratory and ecologic settings with both children and adults have documented the positive effect of choice on performance (e.g., Cordova & Lepper, 1996; Reber et al., 2018; Rosenzweig et al., 2018; Zuckerman et al., 1978).

Besides the effects of action choice on behavior, having formed an intention on one's own has also an effect on individuals' mentality (e.g., Gollwitzer & Kinney, 1989; Gollwitzer et al., 1990; Taylor & Gollwitzer, 1995). According to the mindset theory of action phases (Gollwitzer, 1990, 2012; Heckhausen & Gollwitzer, 1987), having committed to a goal results in an implemental mindset, an activated set of cognitive procedures that facilitates goal striving. This includes action shielding—cognitive processes supporting volition by protecting the individual against disruptions and distractions from inside and outside the person, such as conflicting goals, temptations, or irrelevant information (e.g., Büttner et al., 2014).

When Does Affect Influence Volition?

Drawing on the idea that having formed an intention on one's own fosters action shielding, we posit that task choice should moderate the well documented effects of incidental affective influences on volition (see Gendolla & Brinkmann, 2005; Martin, 2001). Compared with task goals that are externally assigned to a person—which is the default procedure in psychological experiments—self-determined choice of such tasks goes along with strong commitment (e.g., Nenkov & Gollwitzer, 2012). This is not surprising, because (1) people prefer autonomy and self-determination (Ryan & Deci, 2017) and (2) the resolution of an internal conflict during deliberation has been shown to increase commitment to (Brehm, 1956; Brehm & Jones, 1962) and preferences for the chosen alternative (Coppin et al., 2010). Making a decision creates the tendency to enact the decision (Harmon-Jones et al., 2015). That is, having chosen an action alternative on one's own should result in a strong implemental mindset that intensifies action shielding in the service of efficient volition. In other words, acting on a task goal after having chosen this goal should result in a strong task focus (Kuhl, 1986). Consequently, incidental affective influences on acting on one's goal should be minimized. By contrast, externally assigned task goals should be characterized by lower commitment, a weaker implemental mindset, and thus by a weaker task focus and action shielding. Consequently, incidental affective influences on action execution should be stronger in assigned tasks—as shown in the above discussed mood effects on persistence and effort intensity. That is, what underlies people's engagement in a task at hand—personal choice or external assignment—should moderate the influence of incidental affective influences on volition.

The Present Research

We posit that incidental affective influences on action execution should be relatively strong during the pursuit of assigned goals and actions. But they should be weak due to stronger action shielding when self-chosen goals are striven for. In two experiments, half the participants could ostensibly choose between a memory task and an attention task. The other half was assigned to the type of task selected by their yoked participant in the task-choice condition. However, in fact all participants ultimately worked on a Sternberg type short-term memory task (Sternberg, 1966) that comprised both cognitive components—attention and memory. During task performance, participants were then either exposed to sad or happy music. Our first study tested the music effect on persistence—participants could stop working and switch to an alternative task when they felt to have done enough. Our second study focused on effort intensity during performance, objectively assessed as responses in the cardiovascular system. 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:5ioooiesvncubma5fsy2wnof4e

Experiment 1: Persistence

We hypothesized that the sad vs. happy music should influence participants' mood, with an effect on persistence in terms of the time spent on a task and the number of completed trials in the assigned-task condition, but not in the chosen-task condition. Consequently, persistence should be higher in the Sad-Music/Assigned-Task condition than in the Happy-Music/Assigned-Task condition, because participants placed in a sad mood should not think to have done enough and thus stop later as compared to participants in a happy mood (e.g., Hirt et al., 1997; Martin et al., 1993). By contrast, task choice increases task commitment (Pattal et al., 2008) and thus should shield against the music-induced affective influence. That is, task choice should result in relatively high persistence as indicated by longer action maintenance overall irrespective of the influence of music, whether sad or happy.

Participants and Design

We aimed to collect data of 20 participants per condition to meet minimal recommendations for between-person designs (Simmons et al., 2011). At the end of the data collection period we could randomly assign N = 79 first year psychology students (64 women, 15 men, ns = 19 or 20 with 80% to 84% women) to the conditions of a 2 (Task: chosen vs. assigned) x 2 (Music: happy vs. sad) between persons design.[2] According to a sensitivity analysis run with G*power (Faul et al., 2007), this sample size was sufficient to detect significant a priori contrast effects (and ANOVA main and interaction effects) of a medium size with 80% power in our 2 x 2 design. Participants could partially validate practical study-related work with their participation.

Procedure

The present study was conducted in accordance with the ethical guidelines of the University of Geneva and the procedure had been previously approved by the local ethics committee. The protocol was run in individual sessions and the procedure and all measures were computerized (E-prime, Psychology Software Tools, Pittsburgh, PA). We announced the study as an investigation in task performance while listening to music.

Upon arrival at the laboratory, participants were greeted by the experimenter (who was unaware of the experimental condition), seated in front of a computer, and asked to put away any electronic devices and their watches. We did so to prevent awareness of the time spent on the later administered cognitive task. After having obtained signed consent, the experimenter started the experimental software and went to an adjacent room.

Participants learned that the session would take about 30 min in total and that they would work on 1 or 2 cognitive tasks. Next, they rated their affective state to assess mood baseline values with items from the UWIST scale (Matthews et al., 1990) on 7-point scales (2 sadness items: down, sad; 2 happiness items: happy, joyful; 1—*not at all*, 7—*very much*). To prevent suspicion, these affect ratings were introduced as standard measures, because of potentially different feeling states of participants entering the laboratory.

In the *Chosen-Task* condition, the procedure continued with a screen informing that previous research had shown that good performance would be linked to task preferences (we did so to give participants a reason for the task-choice). Therefore, participants could now choose the task of their liking for the next part of the study. The two choice alternatives were a *Memory Task* and an *Attention Task*. In fact, all participants later worked on a Sternberg-type task that entailed both types of cognition—memory and attention. After participants had pressed “enter” to continue, brief descriptions of both types of tasks were provided on the next screen: “Memory task: During the task you should keep presented stimuli in memory” and “Attention task: During the task you should focus your attention on presented stimuli”. 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?” Participants started that period by pressing “enter”. After 1 min, participants were asked to indicate their decision by pressing either a green key for the memory task or a red key for the attention task. When they had entered their choice, they were asked whether they would be sure about their decision to assure their commitment. 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 the *Assigned-Task* condition, participants were asked to take a short 1 min break to match the decision-making time in the Chosen-Task condition. The rest of the procedure was the same as in the Chosen-Task condition. All participants answered the questions “To which degree would you be unhappy with a bad performance on the cognitive task?” to assess commitment, and “To which degree are you capable to show a good performance” to assess self-efficacy—which can positively affect persistence (e.g., Cervone & Peake, 1986). Answers were given on scales ranging from 1 (*not at all*) to 7 (*a lot*). This was followed by performing the task.

Participants read “Now you will work on the cognitive task” and learned that strings of 4 letters would appear on the screen, followed by a mask (a row of the letter “X”) and then a target letter. Participants had to decide whether the target letter was part of the previously presented letter string or not by pressing the respective response keys (green – "yes", red – "no"). This was followed by a screen presenting examples for a "yes" and a "no" response trial. Next, participants learned that they would start with some training trials and were instructed to respond correctly as fast as possible. Each trial started with a fixation cross (500 ms), followed by a string of 4 letters (750 ms), which was masked by a row of the letter "X" with the target letter presented on top of it. Participants had to decide within 3000 ms whether the target letter was part of the previously presented (i.e., the masked) letter string or not. During the training trials, participants received correctness feedback or read in case of no response within 3000 ms "please answer more quickly" (1500 ms). This was followed by a blank screen (2000 ms) before the onset of the next trial. In contrast to the 8 practice trials with correctness feedback, no feedback was given during the main task in order to prevent affective reactions that could interfere with the mood manipulation.

After the training trials, the next slide informed participants that they would now continue working on the cognitive task without correctness feedback, and that they would listen to music during task performance. Moreover, participants read "You can quit the cognitive task when you think that you have done enough by pressing the "p" key instead of entering a "yes" or "no" response. If there remains time after you have decided to stop with the task, you will work on a second cognitive task until the end of the assigned time of 20 min". We did this to prevent shorter persistence in order to terminate the session earlier.

Participants pressed "enter" to start with the main task and the music. In the Happy-Music condition, participants were exposed to Vivaldi's elating "Le quattro stagioni, Op. 1 Allegro"; in the Sad-Music condition, they listened to the depressing piece "The coup" by Hans Zimmer from the movie "The House of Spirits". The music, which has shown its mood inducing effectiveness in previous research (e.g., Gendolla & Krüsken, 2001), was presented in moderate background volume. Each 10th trial, a message appeared on the screen reminding participants how to stop the ongoing task by pressing “p” (instead of the “yes” or “no” response key) if they thought to have done enough.

Once the task was stopped (either by the participants themselves or after 20 min by the experimental software), participants answered the same 4 affect items on 7-point scales as they had done at the procedure’s beginning to assess whether the presented music had changed their mood. For participants who had chosen to stop the first task before its end, the second task started immediately after. Instructions and a trial example for a d2 mental concentration task (Brickenkamp, 1981) were provided: participants should press the green response key if the letter d appeared on the screen with exactly 2 apostrophes, and the red response key for any other presented similar stimuli. However, as the dependent measure of interest was the persistence on the first task, we did neither run training trials nor register or analyze any performance data. At the end of the session, the experimenter asked the participants what they thought the experiment was all about, debriefed them, and thanked them. No participant guessed the purpose of the study.

Results and Discussion

Task Performance

Our main dependent variable was time of persistence (in sec.) on the short-term memory task. To assure that longer persistence did not simply reflect a slow work pace, we also assessed the number of completed trials. As additional measures of performance quality, we also measured response accuracy (% of correct responses) and the reaction times (in ms) for correct responses. We applied contrast analysis to test our theory-based predictions, which is the most powerful and thus appropriate statistical tool to test predictions about complex interactions and predicted patterns of means (Rosenthal &

Rosnow, 1985; Wilkinson & The Task Force on Statistical Inference of APA, 1999). As outlined above, we expected lower persistence in the Happy-Music/Assigned-Task condition (contrast weight -3) than in the other three cells (contrast weights +1).

The persistence and performance measures had skewed distributions and according to K-S tests, and log-transformation only led to normally distributed residuals for the response times (p = .200). However, ANOVAs have been found to be robust against violations of normal distributions (e.g., Schmider et al., 2010). Thus, we report the effects for log-transformed persistence and performance measures but present, for an easier interpretation, the descriptive statistics of the non-transformed data. Additional nonparametric contrast analyses of the rank-transformed scores of persistence, the number of completed trials, and response accuracy (Conover, 2012) did reveal equivalent results, meaning that the following analyses of the persistence and performance measures are indeed robust.[3]

Persistence. In support of our hypothesis, the 3:1 a priori contrast of our main dependent variable was significant, $F(1, 75) = 6.14$, $p = .016$, $\eta^2 = .08$. As depicted in Figure 1 (top panel), the persistence pattern confirmed our hypothesis: background music had an effect when the task was assigned, but less so when the task was self-chosen.

Additional focused cell contrasts revealed that participants in the Assigned-Task/ Happy-Music condition persisted significantly shorter (M = 436.25, SE = 68.07) than those in the Assigned-Task/Sad-Music condition (M = 698.62, SE = 73.49), the Chosen-Task/Sad-Music condition (M = 634.36, SE = 84.35), and the Chosen-Task/Happy-Music condition (M = 577.45, SE = 62.71), ts(75) ≥ 1.67, ps < .05, $\eta^2 \geq .04$.[4] The differences between the latter three conditions were not significant (ps ≥ .371).

Number of trials. In further support of our hypothesis, the 3:1 a priori contrast was again significant, $F(1, 75) = 6.37$, $p = .014$, $\eta^2 = .08$, and the pattern of the number of completed trials corresponded to that of persistence (Figure 1, middle panel). According to additional focused cell contrasts, participants in the Assigned-Task/Happy-Music condition ($M = 78.89$, $SE = 12.53$) completed fewer trials than those in the other three cells, $ts(75) \geq 1.77$, $ps \leq .041$, $\eta^2 \geq .04$, while no significant differences emerged between the other three conditions ($ps \geq .389$; Chosen-Task/Happy-Music $M = 103.35$, $SE = 11.69$; Chosen-Task/Sad-Music $M = 115.75$, $SE = 15.36$; Assigned-Task/Sad-Music $M = 127.10$, $SE = 13.31$).

Response times. The a priori contrast was also significant on this measure, $F(1, 75) = 7.10$, $p = .009$, $\eta^2 = .09$. As depicted in Figure 1 (bottom panel), and further supported by additional cell contrasts, responses in the Assigned-Task/Happy-Music condition ($M = 820.80$, $SE = 39.38$) were significantly slower than in the other three cells, $ts(75) \geq 1.72$, ps $\leq .045$, $\eta^2 \geq .04$, which did not differ significantly from one another ($ps \geq .367$; Chosen-Task/Happy-Music $M = 699.39$, $SE = 26.69$; Chosen-Task/Sad-Music $M = 719.08$, $SE = 31.73$; Assigned-Task/Sad-Music $M = 740.61$, $SE = 33.66$).

Response accuracy. The 3:1 contrast was not significant. Response accuracy was high in general ($p = .258$; Assigned-Task/ Happy-Music $M = 93.70$, $SE = 1.25$; Chosen-Task/Happy-Music $M = 95.70$, $SE = 0.66$; Chosen-Task/Sad-Music $M = 95.33$, $SE = 0.74$; Assigned-Task/Sad-Music $M = 93.94$, $SE = 1.17$).

Verbal Measures

Mood. We created mood sum scores for the affect measures taken before and after the critical task (Cronbach's $\alpha s \geq .86$) after reverse-coding the negative affect items. A 2 (choice) x 2 (music) between-persons ANOVA revealed no significant effects for the mood baseline measure ($ps \geq .321$; total $M = 21.12$, $SE = 0.53$). By contrast, a 2 x 2 ANCOVA of the mood change scores with the mood baseline scores as covariate, $F(1, 74) = 12.89$, $p = .001$,

$\eta^2 = .148$, revealed a significant Music main effect, $F(1, 74) = 4.86$, $p = .031$, $\eta^2 = .062$, in absence of other significant effects (*p*s ≥ .10). Reflecting an effective mood manipulation, mood changes were negative in the Sad-Mood condition (*M* = -0.51, *SE* = 0.43), but positive in the Happy-Music condition (*M* = 0.82, *SE* = 0.43).

Task Ratings. 2 (Task) x 2 (Music) ANOVAs found no significant effects on the commitment rating, $Fs(1, 75) \leq 2.59$, *p*s ≥ .112, (grand *M* = 4.15, *SE* = 0.15), but a Music main effect on rated self-efficacy, $F(1, 75) = 6.41$, $p = .013$, $\eta^2 = .08$, (other *p*s ≥ .096), reflecting higher ratings in the Sad-Music (*M* = 5.13, *SE* = 0.14) than in the Happy-Music condition (*M* = 4.65, *SE* = 0.13). This effect is surprising and hardly interpretable, because Music was not yet manipulated at the time when self-efficacy was assessed. However, additional ANCOVAs of persistence, the number of accomplished trials, and response times with the self-efficacy ratings as covariate revealed no significant associations (*p*s ≥ .161) and the above reported a priori contrasts remained significant after controlling for self-efficacy (*p*s ≤ . 019). This suggests that the present persistence and performance effects can hardly be attributed to self-efficacy.

Conclusions

We found evidence for our prediction that task-choice minimizes incidental affective influences on persistence—a central aspect of volition. Participants who worked on an assigned cognitive task stopped earlier and completed fewer trials when they were exposed to elating music that induced a happy mood than those who were exposed to depressing music that elicited a sad mood. This is in line with the predictions and findings regarding the Mood-As-Input Model (see Martin 2001; Martin & Stoner, 1996). Most relevant, however, this music effect did no longer evince when participants could deliberate and ostensibly chose the type of task they worked on. Under this condition, persistence was strong in general, which was expected because deliberation and choice should result in a strong implemental mindset and a high commitment to performing well (Gollwitzer, 1990; see also Pattall et al., 2008). The pattern of findings observed for persistence was paralleled by the findings regarding the speed of responding.

The effects of our manipulations on the dependent measures were of medium size, meaning that the present sample was big enough for interpreting significant effects as true positives. Thus, we interpret the present findings as first evidence that autonomy in the sense of letting people deliberate and choose immunizes them against incidental affective influences on action execution that are typical for assigned tasks.

Experiment 2: Effort Intensity

The procedures used in this study build on previous research demonstrating that sad and happy moods systematically influence effort intensity during cognitive performance (see Gendolla et al., 2012; Gendolla & Brinkmann, 2005, for reviews). When people work on moderately difficult cognitive challenges, their effort-related responses in the cardiovascular system are stronger in a sad mood than in a happy mood (e.g., de Burgo & Gendolla, 2009; Gendolla & Krüsken, 2002a, 2002b). Apparently, mood has an informative function resulting in mood congruency-effects on demand appraisals. Experienced demand is higher in a sad mood than in a happy mood (e.g., Gendolla et al., 2001), and it influences effort intensity according to the well-supported principles of motivational intensity theory (Brehm & Self, 1989): grounded in a resource conservation principle (Gibson, 1900), effort rises proportionally to subjective demand as long as success is possible, and the necessary amount of effort is justified. Accordingly, people are expected to mobilize (only) the resources that are necessary and justified—and mood informs about what appears to be necessary.

As in previous research (see Gendolla et al., 2012, 2019; Wright & Kirby, 2001; Richter et al., 2016, for overviews) we relied on Wright's (1996) integration of motivational intensity theory (Brehm & Self, 1989) with the active coping approach (Obrist, 1981) to objectively quantify effort intensity. Accordingly, effort is reflected by beta-adrenergic sympathetic nervous system impact on the heart, which becomes especially visible in effects on cardiac contractility force, mirrored by the pre-ejection period (PEP)—the time interval (in ms) between the onset of left ventricular depolarization and the opening of the left aortic valve (Berntson et al., 2004). The shorter this time interval becomes during task performance, the more effort is mobilized (see Kelsey, 2012). However, PEP should always be assessed together with heart rate (HR) and blood pressure to monitor possible preload (ventricular filling) or afterload (arterial pressure) effects on PEP (Sherwood et al., 1990): one should only attribute PEP responses to beta-adrenergic sympathetic impact if decreases in PEP are not accompanied by simultaneous decreases of HR or blood pressure.

In our Study 2, after having been provided (or not) the opportunity to ostensibly choose the to be performed type of task, participants worked on a moderately difficult short-term memory task with background music. We assumed that the music should influence participants' mood and thus influence effort-related cardiovascular reactivity—especially PEP—during task performance in the Assigned-Task condition, but not in the Chosen-Task condition. Consequently, PEP reactivity during the moderately difficult task should be relatively strong in the Assigned-Task/Sad-Music condition, because participants should experience higher task demand than in the assigned-task/happy music condition (e.g., Gendolla et al., 2001). By contrast, task choice should shield against the music-induced mood influence and thus result in relatively weak PEP responses in both mood conditions. This should happen because a moderately difficult task—without being influenced by mood—only necessitates low effort. Consequently, according to the principles of motivational intensity theory (Brehm & Self, 1989), PEP reactivity in the chosen task condition was predicted to be low, even though choice may increase commitment (see Gendolla et al., 2012, 2019; Richter et al., 2016).[5] Together, this results in a 3:1 pattern of effort intensity with relatively strong PEP responses in the Assigned-Task/Sad-Music condition and weaker reactivity in the other three conditions.

Method

Participants and Design

We aimed again to have valid data of at least 20 participants per condition. In order to compensate for eventual data loss due to technical problems with the physiological measures, we randomly assigned 90 university students with different majors (61 women; average age 22 years), recruited with flyers in the university hall, to the experimental conditions of a 2 (Task: chosen vs. assigned) x 2 (Music: happy vs. sad) between-persons design. Participation was voluntary and remunerated with 10 Swiss Francs (about 11 USD). PEP data of 3 participants were lost due to technical problems with their ICG signals and 2 other participants were excluded because of extreme PEP reactivity values (> 3 *SDs* than both the condition and grand mean). This left a final sample of $N = 88$ participants (ns = 22 with 59% to 72% women)[6] and $N = 85$ for the PEP analyses. This sample size was sufficient to detect a significant a priori contrast effect (and significant ANOVA main and interaction effects) of a medium size with 80% power in our 2 x 2 design, as revealed by a sensitivity analysis with G*power (Faul et al., 2007).

Apparatus and Physiological Measures

We noninvasively measured impedance cardiogram (ICG) and electrocardiogram (ECG) signals with a Cardioscreen 1000 system (medis, Ilmenau, Germany) to assess HR and

PEP. Four pairs of electrodes (Ag/AgCl, Medis, Ilmenau, Germany) were placed on the right/left side of the base of participants' neck and on the right/left middle axillary line at the height of the xiphoid. The signals were amplified, transformed into digital data (sampling rate 1000 Hz), and analyzed offline (50 Hz low pass filter) with BlueBox 2.V1.22 software (Richter, 2010). The first derivative of the change in thoracic impedance was calculated, and the resulting dZ/dt signal was ensemble averaged in 1-min intervals. B-point location was estimated based on the RZ interval of valid cardiac cycles (Lozano et al., 2007), visually inspected, and if necessary, manually corrected as recommended (Sherwood et al., 1990). PEP (in ms) was determined as the interval between R-onset and B-point (Berntson et al., 2004). HR was determined on the basis of IBIs assessed with the Cardioscreen system. Additionally, systolic (SBP) and diastolic blood pressure (DBP) were oscillometrically assessed with a Dinamap ProCare monitor (GE Healthcare, Milwaukee, WI). We placed the blood pressure cuff over the brachial artery above the elbow of participant's non-dominant arm. The blood pressure cuff inflated automatically in 1-min intervals and assessed values were stored by the monitor.

Procedure

Except for the task and the main dependent variables, the procedure (which was approved by the local ethics committee) was very similar to that of Experiment 1. The study was announced as an investigation of physiological reactions while listening to music. The experimenter was hired and unaware of both the hypotheses and the experimental conditions. Participants were seated in a comfortable chair, gave signed consent, and were equipped with the physiological sensors. Then the experimenter started the experimental software (E-Prime, Psychology Software Tools, Pittsburgh, PA) and went to an adjacent control room. Participants first rated their affective state with the same items as in

Experiment 1 (down, sad, happy, joyful) on 7-point scales (1—*not at all*, 7—*very much*), which was again introduced as a standard assessment. Next, participants watched a hedonically neutral documentary film about Portugal (8 min) to assess cardiovascular baseline values followed by a short-term memory task (5 min) during which we again assessed cardiovascular activity.

In the *Chosen-Task* condition, participants were provided with the same background information about the possible performance benefits of preferred tasks as in Experiment 1 and learned that they could (ostensibly) select between a memory task and an attention task. In fact, all participants later worked on one and the same short-term memory task, which was adapted from Bijleveld (2018) and comprised two aspects of cognition—memory and attention. Participants had 1 min to deliberate which task they preferred, indicated their choice, were asked whether they were sure about their decision, and then confirmed it. In the *Assigned-Task* condition, participants learned that the type of task would ostensibly have a positive effect on task performance and that they would therefore work on a memory task (or an attention task, respectively). Which alleged type of task participants were assigned to did depend again on their yoked participants' choice in the Chosen-Task condition. This was followed by a 1min break and subsequent commitment ratings. Participants estimated their potential unhappiness with a bad performance, indicated their eagerness to work on the task (1- *not at all*, 7 – *a lot*), and whether they could easily abandon the task (1 – strong disagreement, 7 – strong agreement) on 7-point answer scales.

Next, participants read "Memory Task" (or "Attention Task", respectively) on the computer screen and learned that strings of 7 numbers or letters would appear on the screen during the next 5 min. Trials started with a fixation cross (1000 ms), followed by a first number string (3000 ms), a distractor string consisting of letters (2000 ms), and a second number string (2000 ms). During its presentation, participants had to decide correctly and as fast as possible whether this second number string was identical with the first one (or not) by pressing respective response keys (green – “yes”, red – “no”) with fingers of their choice of their dominant hand. Participants saw examples of the trials and worked on 6 training trials before the main task started. In contrast to the practice trials with correctness feedback, no feedback was given during the main task (30 trials) in order to prevent affective reactions that could interfere with the music manipulation. To assure the same task duration for all participants, the message “response entered”—or the message “please respond faster” in case of no responses within 2000 ms—appeared on the screen for 3500 ms minus participants’ response time. The inter-trial interval randomly varied between 500 and 1000 ms.

After ending the task, participants rated their mood with the same 7-point scales used at the beginning of the procedure and indicated the subjective difficulty of the preceding task (1 – *very easy*, 7 – *very difficult*), answered biographical questions (gender, age, etc.), and indicated eventual medication. Finally, the experimenter asked them what they thought the experiment was about, debriefed and remunerated them, and thanked them for their participation. No participant guessed the aims of the study.

Results and Discussion

We again tested our main hypothesis with contrast analysis. As outlined above, we expected stronger cardiovascular responses (especially PEP) in the Assigned-Task/Sad-Music condition (contrast weight +3) than in the other three conditions (contrast weights -1) of the design. Other measures were analyzed with conventional ANOVAs.

Cardiovascular Baselines

Given that it is typical that cardiovascular baseline values become stable towards the end of habituation periods, we had a priori decided to constitute baselines by averaging cardiovascular values of the last three minutes, which showed high internal consistency (Cronbach's αs ≥ .96). Cell means and standard errors appear in Table 1. Preliminary 2 (Task) x 2 (Music) ANOVAs of the cardiovascular baseline scores revealed no significant differences between the later conditions (*p*s > .065).[7]

Cardiovascular Reactivity

Reactivity scores (Llabre et al., 1991) were created by subtracting the cardiovascular baseline values from the averaged 1 min scores of cardiovascular activity assessed during the task. We ran preliminary 2 (Task) x 2 (Music) ANCOVAs of these reactivity scores with the respective baseline scores as covariates to test for possible associations. These analyses found a significant association between baseline and reactivity scores of DBP, $F(1, 83) = 5.71$, $p = .019$, $\eta^2 = .06$. Therefore, we further analyzed baseline-adjusted reactivity scores of DBP to prevent possible carryover or initial values effects. No other significant associations between baseline and reactivity scores emerged for other cardiovascular indices (*ps* ≥ .101).

PEP Reactivity. In support of our hypothesis, the theory-based a priori contrast for PEP reactivity, our primary effort-related measure, was highly significant, $F(1, 81) = 9.07$, $p = .003$, $\eta^2 = .10$. As depicted in Figure 2, the PEP responses showed the predicted pattern—note that decreases in PEP mean increases in effort intensity.

Additional cell contrasts revealed that PEP reactivity in the Assigned-Task/Sad-Music condition ($M = -6.39$, $SE = 1.24$) was significantly stronger than in the Assigned-Task/Happy-Music ($M = -2.49$, $SE = 0.96$), the Chosen-Task/Happy-Music ($M = -2.38$, $SE = 0.94$), and the Chosen-Task/Sad-Music ($M = -3.14$, $SE = 1.11$) cells, $ts(81) \geq 2.15$, $ps \leq .017$, $\eta^2 > .05$, which in turn did not significantly differ from one another ($ps \geq .619$). This fully confirms our predictions.

HR and Blood Pressure Reactivity. Cell means and standard errors appear in Table 2. The a priori contrasts for HR and SBP $Fs(1, 84) \leq 2.58$, $ps \geq .112$, and baseline-adjusted DBP ($p = .082$) were not significant, although at least the blood pressure responses largely corresponded to the predicted effort pattern.

Task Performance

Response accuracy and reaction times for correct responses were both normally distributed. A 2 (Task) × 2 (Music) ANOVA of response accuracy found no significant effects ($ps \geq .298$). On average, participants made 81% ($SE = 1.17$) correct responses, reflecting that the task was as intended moderately difficult. An ANOVA of the reaction times (in ms) revealed a significant Music main effect, $F(1, 84) = 4.03$, $p = .048$, $\eta^2 = .05$, in absence of other significant effects ($ps \geq .769$), reflecting faster responses in the Happy-Music ($M = 1191$, $SE = 29.54$) than in the Sad-Music condition ($M = 1263$, $SE = 19.72$).

Verbal Measures

Mood. We created mood sum scores for the affect measures taken before and after the task (Cronbach's αs ≥ .73); the negative affect items were reverse coded. A 2 (Task) x 2 (Music) ANOVA of the mood baseline measure revealed no significant effects, $Fs(1, 84) \leq 3.48$, $ps \geq .065$, (grand $M = 22.51$, $SE = 0.36$). The same was true for the ANCOVA of the mood change scores, $Fs(1, 83) \leq 3.74$, $ps \geq .056$, (grand $M = -0.82$, $SE = 0.27$), in which only the covariate effect was significant, $F(1, 83) = 13.13$, $p = .001$, $\eta^2 = .14$.

Task Ratings. A 2 (Task) x 2 (Music) ANOVA of a composite score of the three commitment ratings (the third item was reverse coded) found no significant effects, $Fs(1, 84) \leq 3.05$, $ps \geq .085$, (grand $M = 14.89$, $SE = 0.28$). The same was true for the analyses of the single items, *F*s(1, 84) ≤ 3.61, *p*s ≥ .061, which were run in addition because the correlations between the three ratings were rather low (Cronbach's α = .30). Also the difficulty ratings revealed no significant effects, *F*s(1, 84) ≤ 1.00, *p*s ≥ .431, but suggest that we administered a moderately difficult task (grand *M* = 4.11, *SE* = 0.14).

Conclusions

Our second study found additional evidence for the hypothesis that task-choice minimizes incidental affective influences on volition—this time assessed in terms of effort intensity that was operationalized as cardiac PEP reactivity during task performance (Kelsey, 2012; Wright, 1996). Consistent with previous findings regarding mood effects on effort (e.g., de Burgo & Gendolla, 2009; Gendolla & Krüsken, 2002a, 2002b), participants who worked on an assigned cognitive task mobilized higher effort when they were exposed to sad music than when they were exposed to happy music. Most relevant to our present hypothesis, this effect did not appear when participants could ostensibly choose the type of task they wanted to work on. Under this condition effort was modest in general, which we had expected because the moderately difficult task did not necessitate more effort when participants were immunized against incidental affective influences by being allowed to choose the task by themselves. The effect on our main dependent measure—PEP reactivity—was of medium size, meaning that the present sample was big enough for interpreting the predicted pattern of effort mobilization as reliable. We acknowledge that no significant effects on our verbal manipulation checks were observed, however, and will come back to this point below.

General Discussion

Two studies found evidence for our idea that task choice immunizes against incidental affective influences on persistence and effort intensity—two core aspects of volitional action control. As expected, exposing participants during task performance to background music that had shown its effectiveness on inducing happy and sad moods in past research (e.g., Gendolla & Krüsken, 2001) did influence persistence and effort intensity when participants worked on an assigned task: as compared to participants who were exposed to happy music, participants who were exposed to sad music performed longer and completed more trials in Experiment 1 and mobilized higher effort in Experiment 2. These effects replicate previous research in the context of the Mood-As-Input-Model (Martin, 2001) and the Mood-Behavior-Model (Gendolla, 2000) that also used assigned tasks. Most relevant, these music effects disappeared when participants could ostensibly choose their task. We had predicted this because having chosen a task is known to be associated with an implemental mindset (Gollwitzer, 1990), high commitment (Nenkov & Gollwitzer, 2012), and an action-oriented task-focus (Kuhl, 1986), resulting in strong action shielding. The present studies provide first evidence that the way how people get engaged in action—by personal choice or external task assignment—indeed moderates the effect of incidental affective influences on action execution.

To date, research on goal and action shielding has mostly focused on the effects of conflicting temptations and the role of cognitive processes in the service of goal protection rather than on the effects of mood inducing affective stimulation. Goals one is committed to rest highly accessible in memory (Moskowitz et al., 2004), and one set of studies has found that goal commitment even shields against the mental activation of alternative goals (Shah et al., 2002). Moreover, Plessow et al. (2011) observed that acute stress increases goal shielding thus protecting the execution of a focal goal, but that this increased shielding under acute stress also reduces cognitive flexibility. This suggests that the goal-shielding individual may become rigid—another possible reason why incidental affective influences on action execution are weak when commitment is high. The present research extends the shielding effect from the mental protection against conflicting temptations to the immunization against external affective stimulation that can, otherwise, have strong effects on action execution in assigned cognitive tasks (see Gendolla & Brinkmann, 2005; Martin, 2001, for reviews). These affective influences were also evident in the present two studies—but only when the tasks that participants worked on were externally assigned.

The observed effects on our main dependent measures—persistence in terms of time spent on a task and the number of completed trials in Experiment 1, and effort intensity in terms of cardiac PEP reactivity in Experiment 2—clearly support our hypotheses. However, we were less fortunate with the verbal measures we took. While the verbal mood manipulation check was significant in our first study, it was not so in the second—even though the effort pattern evinced exactly as predicted. This means that the administered music obviously had an effect on our central dependent variable. Moreover, music also influenced response speed—the happy music led to faster reactions. Considering further that the music we had administered in the present experiments has already shown its mood inducting effectiveness in previous research (e.g., Gendolla & Krüsken, 2001), we do not doubt that the music presentation in the present studies was effective.

However, may also be conceivable that the background music in Study 2 led to implicit affective influences rather than eliciting consciously experienced mood states. Research on the Implicit-Affect-Primes-Effort model (Gendolla, 2012) has revealed that the implicitly processed affective stimuli (affect primes) have similar effects on effort intensity as consciously experienced affective states. The underlying mechanism is, however, different. Affect primes that are implicitly processed during task performance activate the performance ease and difficulty concepts, which in turn influence subjective task demand

and thus effort. Among other affect prime effects, it has been shown that sadness primes resulted in stronger effort-related cardiac responses in moderately difficult tasks than happiness primes—without any evidence for elicited conscious feeling states (e.g., Gendolla & Silvestrini, 2011; Lasauskaite et al., 2013). That is, although our background music manipulation in Study 2 aimed at influencing participants' moods, it could be possible that it actually influenced effort intensity implicitly without inducing conscious affective experiences that could be reported in the verbal mood manipulation check. However, even if this would be true, our findings would still provide evidence for shielding effect against external affective stimulation. Conclusive tests of the question whether task-choice can really immunize against implicit affective influences on volition have to be reserved for future research.

We also did not find significant effects on our verbal measures of commitment. Although nonsignificant effects are hardly interpretable, one possible reason for this could be that there are different types of commitment—e.g., commitment based on autonomous task choice vs. externally controlled task assignment—and that our verbal measures were not sensible for capturing post-choice commitment in our experimental paradigm. However, as pointed out by Sigall and Mills (1998), verbal manipulation checks cannot provide evidence against the effectiveness of a manipulation if they do not reflect the intended effect. That is, verbal manipulation checks can only be interpreted if they produce significant effects. If they do not, they do *not* provide evidence that a manipulation failed. Based on this significant limitation and other arguments, Fayant et al. (2017) even advocated for abandoning manipulation checks completely in experimental research—as commonly done in experimental cognitive psychology. In sum, we acknowledge that our verbal manipulation checks did not work well and future research may apply more sensitive commitment measures. But we do not take this as evidence that the manipulations were not effective. They had the expected causal impact on our dependent variables, which were objective and well-established measures of persistence and effort intensity. As predicted, task-choice could immunize against incidental affective stimulation effects on them, which were evident when the same tasks were externally assigned to the participants.

Some readers may wonder why in Experiment 2, which investigated effort intensity, we found the predicted effect on PEP reactivity, our main measure of effort, but not on SBP, DBP, and HR responses—although the cell mean patterns of these measures largely corresponded to the predicted effort effects. However, this is in line with the idea that PEP is the most sensitive noninvasive index of beta-adrenergic sympathetic impact on the heart and thus effort (see Kelsey, 2012). Many studies have found effort effects on SBP (see Gendolla et al., 2012, 2019; Richter et al., 2016; Wright & Kirby, 2001, for overviews). But even though SBP is systematically influenced by cardiac contractility via its effects on cardiac output, blood pressure also depends on peripheral vascular resistance, which does not rely on beta adrenergic impact. Therefore, SBP is a noisier effort index than PEP (e.g., Richter et al., 2008). Most importantly, the present PEP effects were not accompanied by decreases in blood pressure or HR, making it implausible that PEP reactivity may have been caused by cardiac preload or vascular afterload effects instead of beta-adrenergic sympathetic impact on cardiac contractility (see Sherwood et al., 1990).

In contrast to Experiment 1, which found that achievement effects in terms of response speed corresponded to the predicted persistence pattern, there was no such effect in Experiment 2. This is not surprising as effort intensity (behavioral input) and performance (behavioral output) are not conceptually identical and their relationship is quite complex. Performance depends besides effort also (or even more so) on task-related ability and chosen strategies (Locke & Latham, 1990), which makes predictions about a direct link between effort and performance difficult. Consequently, one cannot expect that variations in effort intensity are automatically mirrored by performance. Moreover, the length of each task trial was standardized in Experiment 2 in order to prevent a confound between cardiovascular arousal and mere motoric response speed. In contrast to the trial structure of Experiment 1, in which faster responses led to an earlier start of the next trial, response speed did not bring such a benefit in Experiment 2. Furthermore, participants in Experiment 2 performed 30 trials, while there were on average 105 completed trials in Experiment 1—meaning higher reliability of the response speed scores in the first study. Besides the conceptual differences between effort and performance, these are additional reasons that can explain why effects on response speed, which were however not predicted, were stronger in Experiment 1. On conceptual grounds, the divergence between the two studies could also indicate that persistence’s effect on performance is stronger than that of effort intensity.

Coda and Outlook

The primary goal of this research was advancing theory development—contributing to a better understanding of the conditions under which incidental affective influences on action execution occur, and how goal striving can be shielded against them. The present findings have also clear implications for applications, like the pursuit of personal “real life” goals and action control in educational and organizational settings—i.e., whenever people have to mobilize resources for action execution and goal attainment (see Vohs & Baumeister, 2017, for multiple examples). External affective stimulation is omnipresent in everyday life. To name a few factors, persons’ mood states are influenced by background sounds, odors, the weather, illumination, or the pleasantness of the environment in general (see Gendolla, 2000, for an overview). Better understanding when affective influences on action execution occur and how they could be controlled by self-determination and self-regulation strategies promises better insights in the important question of efficient performance optimization. In this context, the present research adds to the already existing demonstrations of the benefits of autonomy and choice (Leotti et al., 2010; Leotti & Delgado, 2011). Besides the ample evidence that giving people the opportunity to choose their goals and actions has positive effects on their interest and performance (see Cerasoli et al., 2016; Patall et al., 2008; Ryan & Deci, 2006, 2017, for overviews), our findings provide strong evidence for a new benefit of choice: it can shield action execution from external affective stimulation. How people get engaged in action—by a choice vs. external task assignment—moderates the effect of incidental affective influences on volition. In concordance with previous research (see Gendolla & Brinkmann, 2005; Martin, 2001), incidental affect influenced persistence and effort intensity when a task was assigned. However, task choice neutralized this influence, which is evidence for a so far not demonstrated form of action shielding. That is, autonomy can support action control by immunizing against external affective influences on action execution.

Footnotes

[1] In contrast to the Mood-as-Information approach (Schwarz & Clore, 1988), which posits that moods can only be used as information according to an “all-or-nothing” principle in global judgments, the Mood-Behavior-Model relies on the idea that mood is only one piece of information that is integrated with all other available information diagnostic information into any judgment (Abele & Brehm, 1994). The underlying process is information integration (Anderson, 1981) rather than misattribution of one’s feelings to a judgment object in terms of a “how-do-I-feel-about-it” heuristic (e.g., Schwarz & Clore, 1983). Accordingly, the Mood-Behavior-Model posits that subjective task demand is determined by both mood and other diagnostic information like objective task difficulty (e.g., Gendolla & Krüsken, 2001). This is, however, not relevant for the hypotheses tested in the present studies, because objective task difficulty was not manipulated. Moreover, the Mood-Behavior-Model posits, in contrast to Schwarz’ (1990) cognitive tuning hypothesis, that moods have no stable motivational implications.

[2] The gender distributions were balanced in the four conditions with 16 women and 4 men in each cell expect for the happy-music/no-choice condition with 16 women and 3 men. Not surprisingly, a chi-square of these frequency distributions was nowhere near significance (p = .983).

[3] Results of the nonparametric 3:1 contrast analyses of rank-transformed data were equivalent with the analyses of log transformed data repeated in the main text. Persistence: $F(1, 75) = 5.52$, $p = .021$, $\eta^2 = .07$; Number of trials: $F(1, 75) = 5.90$, $p = .017$, $\eta^2 = .07$; Response times: $F(1, 75) = 7.01$, $p = .010$, $\eta^2 = .09$; Response accuracy ($p = .548$). The same was true for analyses of the not log-transformed data. Persistence: $F(1, 75) = 5.56$, $p = .021$,

$\eta^2 =$ 07; Number of trials: $F(1, 75) = 5.45$, p = .022, $\eta^2 = .07$; Response times: $F(1, 75) = 6.85$, p = .011, $\eta^2 = .08$; Response accuracy ($p = .266$).

[4] The *p*-values of focused cell contrasts testing directed predictions are one-tailed.

[5] Note that effort should only be high in the Task-Choice condition when a task is objectively difficult, because high difficulty leads to high effort the latter is justified. By contrast, a moderately difficult task only necessitates low effort—if affective influences are neutralized.

[6] The gender distributions were balanced in the four conditions: Sad-Music/Chosen-Task and Sad-Music/Assigned-Task (16 women/6 men), Happy-Music/Assigned-Task (13 women, 9 men), Happy-Music/Chosen-Task (14 women/8 men). A chi-square test of these frequency distributions was nowhere near significance ($p = .708$). A 2 x 2 ANOVA revealed also no significant age differences between the conditions (*p*s ≥ .601).

[7] The 3:1 contrast that tested our predictions about cardiovascular reactivity was not significant for the PEP baselines ($p = .280$). For readers interested in gender differences in cardiovascular activity, we compared the baseline values of women and men with *t*-tests (including gender in three-factorial ANOVAs did not make sense because there were far more women than men in our sample). These analyses only revealed a significant effect for the SBP baselines, $t(83) = 2.92$, $p = .004$, $\eta^2 = .09$, due to higher SBP for men ($M = 107.68$, $SE = 1.74$) than for women ($M = 101.1$, $SE = 1.33$), which is typical (other *p*s ≥ .272). Gender had no significant main effects on cardiovascular response—only the effect for HR approached significance ($p = .062$; other *p*s ≥ .835).

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Table 1
Means and Standard Errors (in parentheses) of the Cardiovascular Baseline Values.

	Chosen Task		Assigned Task	
	Happy Music	**Sad Music**	**Happy Music**	**Sad Music**
PEP	96.81 (1.93)	97.51 (2.26)	98.76 (1.91)	100.76 (2.53)
SBP	102.12 (2.07)	102.96 (2.25)	101.82 (2.08)	106.20 (2.43)
DBP	55.03 (1.50)	56.48 (1.75)	53.65 (1.34)	57.88 (1.45)
HR	74.80 (1.93)	76.08 (3.02)	74.82 (2.23)	68.72 (2.19)

Notes: PEP = pre-ejection period (in ms), SBP = systolic blood pressure (in mmHg), DBP = diastolic blood pressure (in mmHg), HR = heart rate (in beats/min). *N* = 88 for SBP, DBP, HR with *n* = 22 in all conditions. *N* = 85 for PEP with *n* = 22 in the Assigned-Task/Happy-Music cell and *n*s = 21 in the other conditions.

Table 2
Means and Standard Errors (in parentheses) of the Heart Rate and Blood Pressure Reactivity Scores.

	Chosen Task		Assigned Task	
	Happy Music	**Sad Music**	**Happy Music**	**Sad Music**
SBP	5.38 (1.16)	7.53 (1.05)	5.75 (1.06)	8.50 (1.58)
DBP	4.43 (0.97)	5.61 (0.97)	3.73 (0.98)	6.58 (0.98)
HR	5.14 (0.70)	5.10 (1.06)	3.52 (0.83)	5.26 (1.02)

Notes: SBP = systolic blood pressure (in mmHg), DBP = diastolic blood pressure (in mmHg), HR = heart rate (in beats/min). DBP reactivity is baseline-adjusted. *N* = 88 with *n* = 22 in all conditions.

Figure Captions

Figure 1:

Cell means and ±1 standard errors underlying the combined effects of Task-Choice and Music on persistence (top panel), number of completed trials (middle panel), and reaction times (bottom panel) in the experimental conditions of Experiment 1.

Figure 2:

Cell means and ±1 standard errors underlying the combined effect of Task-Choice and Music on cardiac pre-ejection period (PEP) reactivity (in ms) during task performance in Experiment 2.

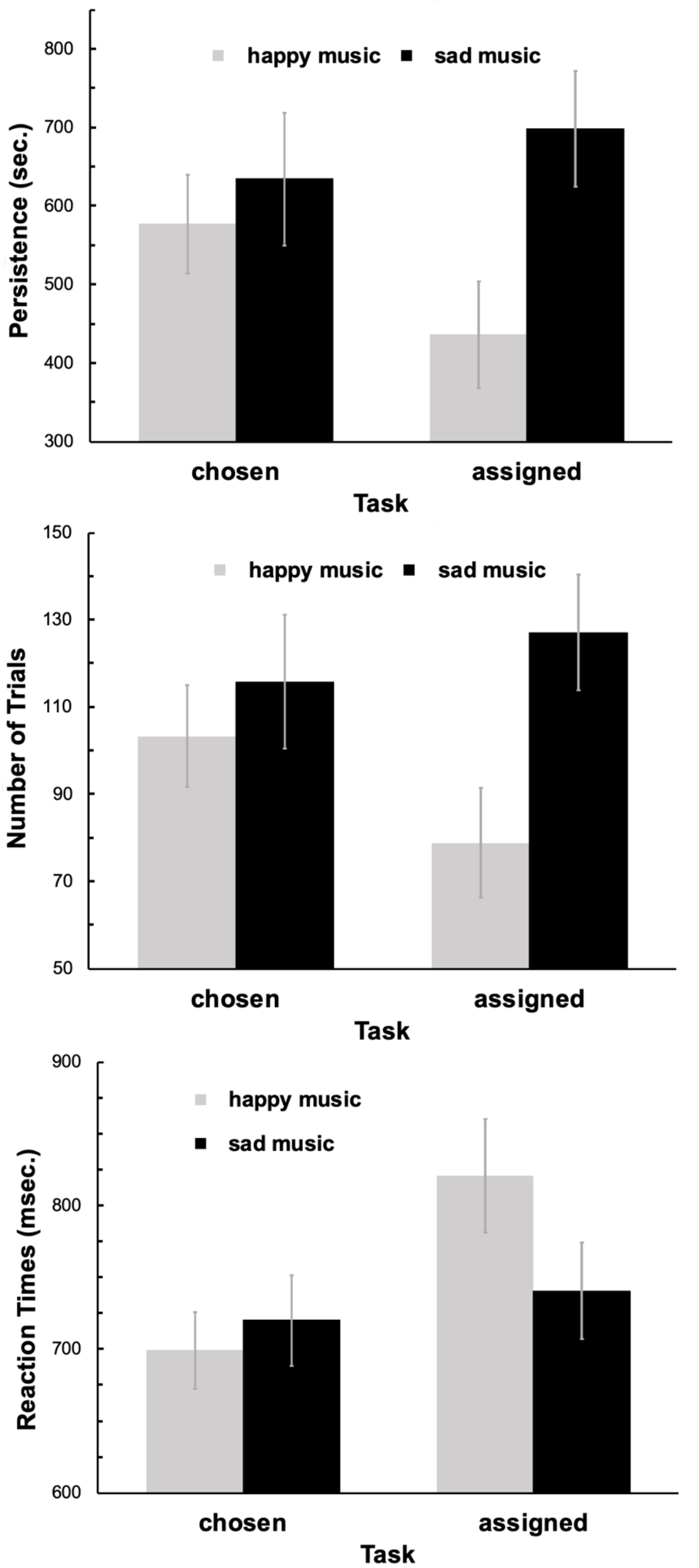
happy music
sad music
Persistence (sec.)
800
700
600
500
400
300
chosen
assigned
Task
happy music
sad music
Number of Trials
150
130
110
90
70
50
chosen
assigned
Task
happy music
sad music
Reaction Times (msec.)
900
800
700
600
chosen
assigned
Task

Figure 1

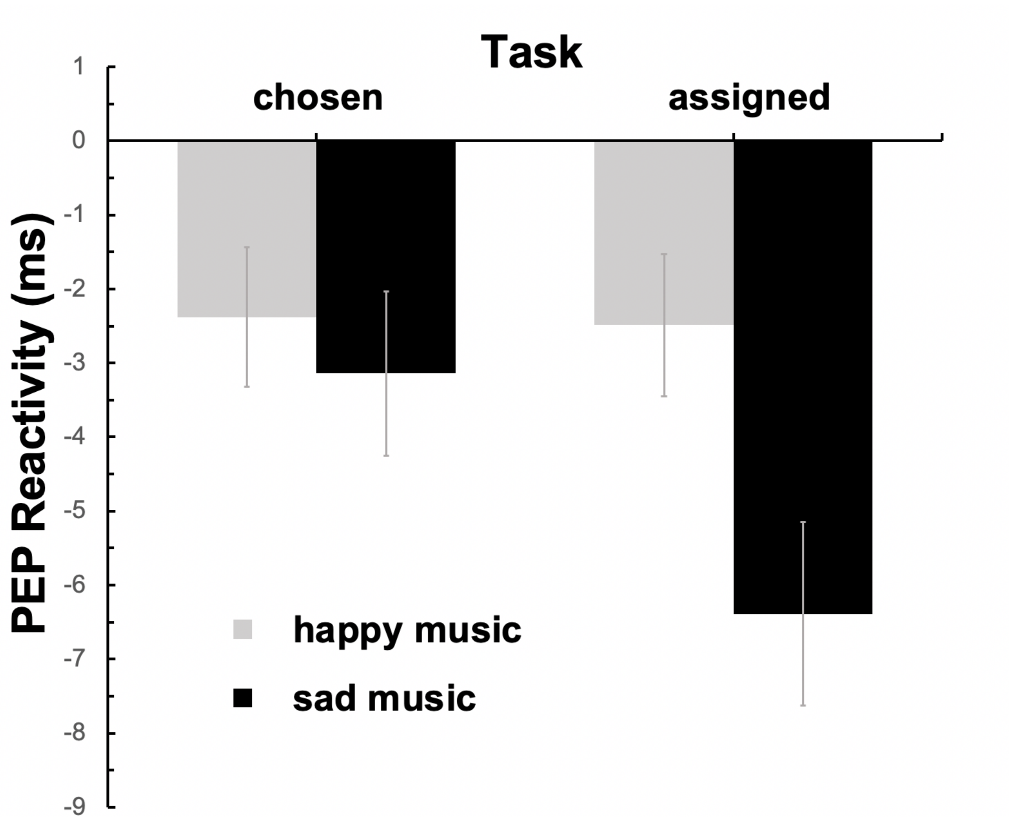
Task
chosen
assigned
PEP Reactivity (ms)
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
happy music
sad music

Figure 2