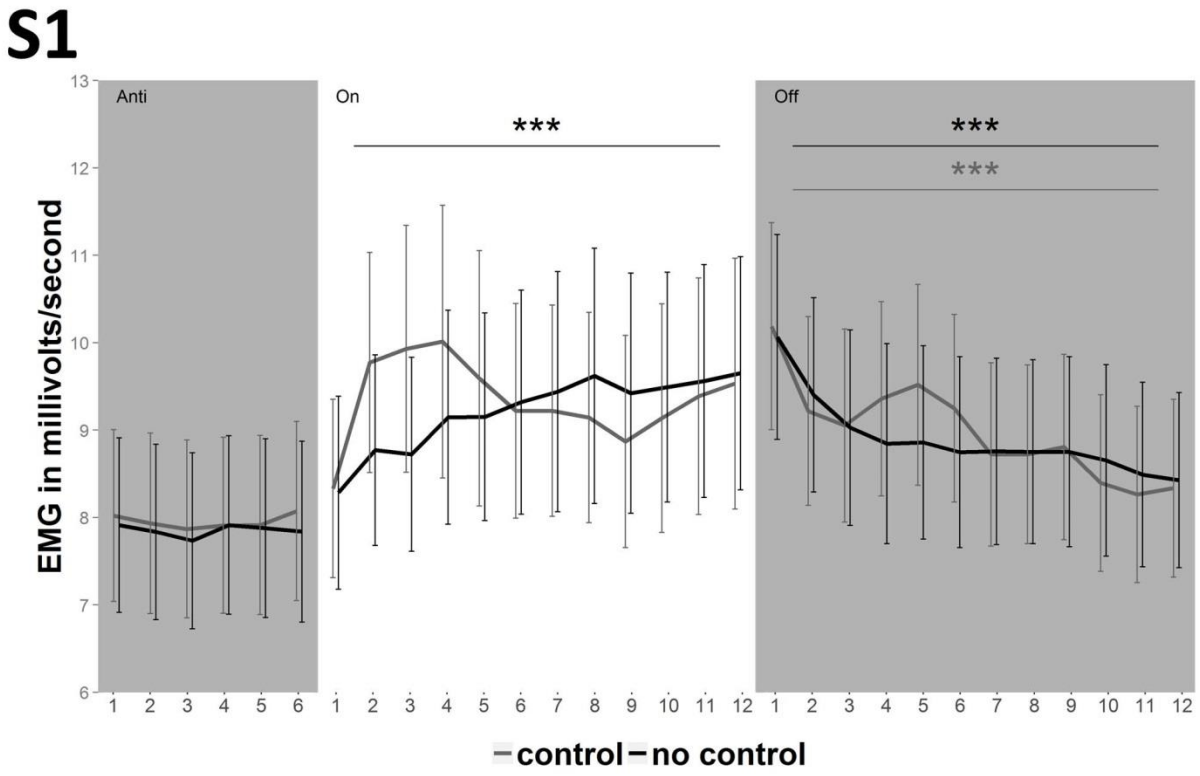
PHYSIOLOGICAL DATA

We recorded physiological responses during an anticipation phase, on-blocks and off-blocks (see Figure 1a). Anticipation of pain triggers similar physiological responses as pain itself [6], and the anticipation of pain may influence the experience of pain itself [4]. To study the effect of pain (on-block) or the anticipation of pain (anticipation phase) we also recorded a phase without any stimulation or the anticipation of the same (off-block) at the end of each trial to have a baseline of physiological responses. Physiological responses have previously been divided into different components, which have also been related to different pain components. For example, HR responses to pain were related to physical pain intensity until 3 seconds of pain onset, while after 6 seconds they were related to the perceived pain experience of the subjects [3]. We therefore checked HR and EMG responses for time effects before the main analysis.

Recordings

Raw EMG signals were filtered with a 20 Hz low cut-off, fullwave rectified and integrated (time constant: 10 ms) using a digital filter. When the EMG was split up into time bins of 1 second, we found a main effect of time for uncontrollable trials in the off-blocks ($F(11,264)=5.62$, $p<.001$, $\eta^2=0.190$ [CI_{90}: 0.094, 0.227]) and the on-blocks ($F(11,264)=1.82$, $p=.049$, $\eta^2=0.070$ [CI_{90}: 0.000, 0.086]), and for the controllable trials in the off-blocks ($F(11,264)=4.46$, $p=.005$, $\eta^2=0.157$ [CI_{90}: 0.065, 0.190]). There was no significant time effect for the anticipation phase (all $F(5,120)<.84$, $p>.52$, $\eta^2<.001$). As can be seen in Figure S1, these time effects can be split up into two phases (0-6 seconds and 6-12 seconds). These phases were therefore considered separately, when analyzing the EMG. Extreme values were excluded from the analyses (cut-off 2 SDs;

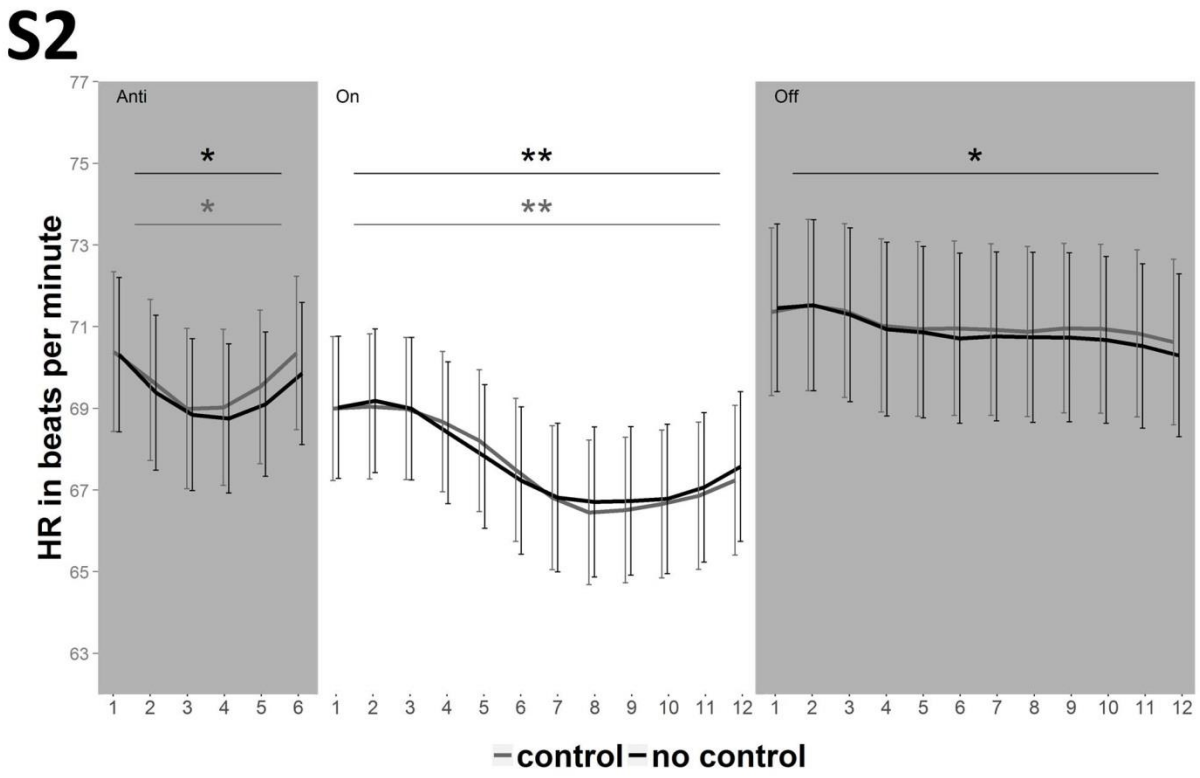
3.6% of the trials). All trials of the anticipation phases, on-blocks and off blocks were averaged per participant.



*<u>Figure S1:</u> Time effect in the electromyogram of the corrugator presented in time-bins of one second within each phase of a trial: lines show mean values, error bars depict the standard error of the mean of the corrugator EMG during anticipation phase (ANTI), On-blocks (ON) and Off-Blocks (OFF). Grey lines depict controllable trials, black lines depict uncontrollable trials. Asterisks show significant main effects within each block (anticipation, on-block, off-block) and condition (controllable, uncontrollable) with ***p<.001. EMG: electromyogram of the corrugator; ANTI: anticipation phase; ON: on-blocks; OFF: off-blocks;*

SCR amplitudes were quantified as the maximum response in the time window of 2–6 s in the anticipation phase, the on-block and the off-block, and were converted to microSiemens (μS). This time window was chosen because it showed the largest

responses during raw data inspection. SCR amplitudes below 0.05 µS were classified as zero responses. The data were transformed using a logarithmic transformation (log_{10}(1+SCR)) and extreme values were excluded from the analyses (cut-off 2 SDs; 4.1% of the trials). To account for habituation effects during the experiment, nonlinear detrending was performed by fitting the data to an $1/e^x$ function using the nonlinear least squares method in R [1]. For each subject an $1/e^x$ function was fitted to the log-transformed original data. All further analyses were performed with the residuals of the original data from this fitted function. All trials of the anticipation phases, on-blocks and off-blocks were averaged per participant.



<u>Figure S2:</u> Time effect in the heart rate presented in time-bins of one second within each phase of a trial: lines show mean values, error bars depict the standard error of the mean heart rate during anticipation phase (ANTI), On-blocks (ON) and Off-Blocks (OFF). Grey lines depict

*controllable trials, black lines depict uncontrollable trials. Asterisks show significant main effects within each block (anticipation, on-block, off-block) and condition (controllable, uncontrollable) with *p<.05 and **p<.01. HR: heart rate; ANTI: anticipation phase; ON: on-blocks; OFF: off-blocks;*

Raw ECG signals were filtered offline with a 20 Hz low cut-off digital filter. Beat detection was visually inspected and interpolated (added, removed or relocated: <1% of R-peaks), if necessary. When the HR was split up into time bins of 1 second, we found a significant main effect of time in the on-blocks (controllable: $F(11,264)=9.40$, $p=.001$, $\eta^2=0.281$ [CI_{90}: 0.180, 0.324]; uncontrollable: $F(11,264)=7.78$, $p=.004$, $\eta^2=0.245$ [CI_{90}: 0.145, 0.286]), in the anticipation phase (controllable: $F(5,120)=4.23$, $p=.03$, $\eta^2=0.150$ [CI_{90}: 0.039, 0.218]; uncontrollable: $F(5,120)=4.01$, $p=.04$, $\eta^2=0.143$ [CI_{90}: 0.034, 0.210]), in the off-blocks only for uncontrollable trials (controllable: $F(11,264)=1.78$, $p=.08$, $\eta^2=0.069$ [CI_{90}: 0.000, 0.084]; uncontrollable: $F(11,264)=4.48$, $p=.01$, $\eta^2=0.157$ [CI_{90}: 0.065, 0.191]), as can be seen in Figure S2, this time effect can be split up into three phases (0-3 seconds, 3-6 seconds, 6-9 seconds), as was previously done by Möltner et al. [3]. These phases were therefore considered separately, when analyzing the heart rate. Heart rate (HR) was calculated as mean HR before the stimulation (anticipation phase, 6 seconds), during the stimulation (on-block, variable duration) and after each stimulation (off-block, 12 seconds). Extreme values were excluded from the analyses (cut-off 2 SDs; 4 % of the trials). All trials of the anticipation phases, on-blocks and off-blocks were averaged per participant.

Statistical analysis

For SCR, EMG and HR we examined the within-subject effects of block (on-block vs. anticipation phase vs. off-block), and controllability (controllable versus uncontrollable).

For HR we additionally included the factor time (0 to 3 sec vs 3 to 6 sec vs. 6 to 9 sec). Effect sizes for the ANOVAs are reported as partial η^2, including 90% confidence intervals (CI) of the effect sizes. CI for partial η^2 was chosen following the recommendations by Steiger et al. [5] for one-sided tests (CI=100(1-2α)%). Lower limits of the CIs are reported as 0 in cases where the F-test is not statistically significant (α=.05). We used pairwise post-hoc t-tests (false discovery rate, FDR [2] corrected) to compare the on-blocks, off-blocks and anticipation phases. Effect sizes for the t-tests are reported as Cohen's d, including 95% confidence intervals of the effect sizes. CI for Cohen's d was chosen following the recommendations by Steiger et al. [5] for two-sided tests (CI=100(1-α)%). Lower limits of the CIs are reported as <0 and upper limits as >0 in cases where the t-test is not statistically significant (α=.05).

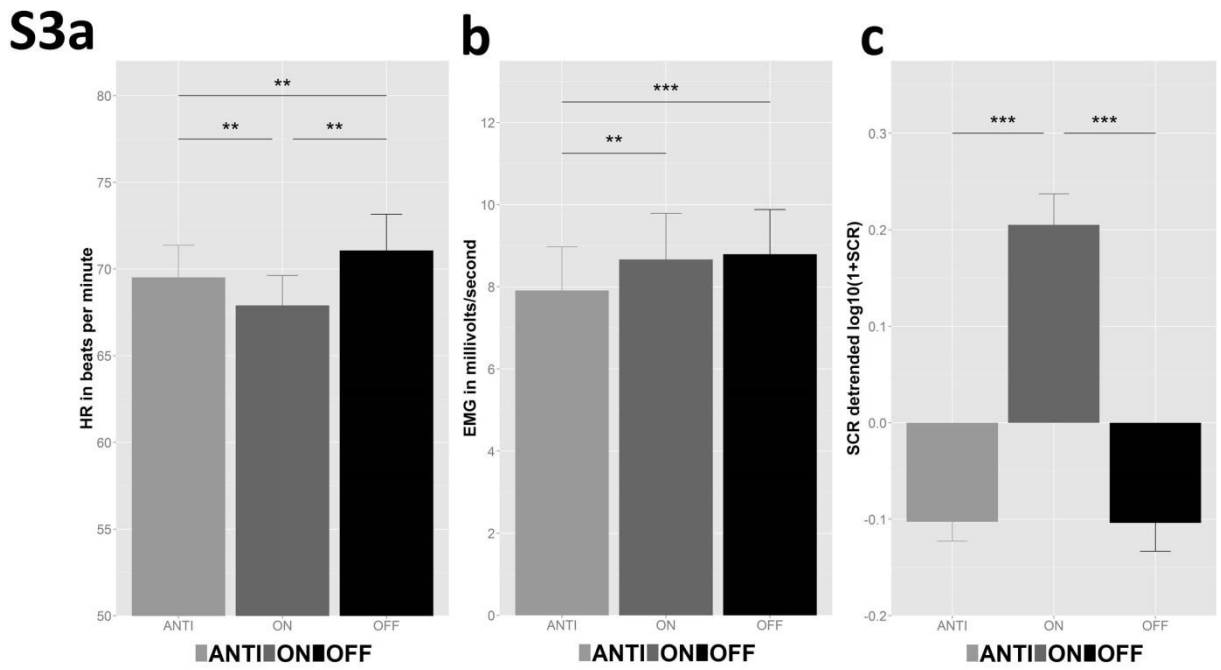
Results

SCR showed a significant effect for block ($F(2,50)=27.5$, $p<.001$, $\eta^2=0.524$ [CI_{90}: 0.343, 0.624]). Post hoc comparisons revealed that the SCRs were significantly higher during on- compared to off-blocks ($t(24)=5.29$, $p<.001$, $d=1.04$, [CI_{95}: 0.55, 1.51]) and the anticipation phase ($t(24)=6.80$, $p<.001$, $d=1.33$, [CI_{95}: 0.80, 1.86]), see Figure S3. The SCRs during the anticipation phase did not significantly differ from the SCRs during the off-blocks ($t(24)=-0.03$, $p=.97$, $d=.006$, [CI_{95}: -0.38, 0.39]). There were no other significant main effects or interactions (all $F<2.9$, all $p>.06$, all $\eta^2<0.002$).

The EMG showed a significant main effect for block ($F(2,50)=9.89$, $p<.001$, $\eta^2=0.283$ [CI_{90}: 0.103, 0.415]) with post-hoc comparisons showing that EMG during anticipation phase was lower than during off- ($t(24)=-4.57$, $p<.001$, $d=.93$, [CI_{95}: 0.46, 1.39]) and on-blocks ($t(24)=-3.46$, $p=.003$, $d=.70$, [CI_{95}: 0.27, 1.13]). EMG during on-blocks did not

differ significantly differ from the EMG during off-blocks ($t(24)=-.55$, $p=.58$, $d=.11$, [CI_{95}: -0.27, 0.50]), see Figure S3. There were no other significant main or interaction effects for the EMG response (all $F<2.38$, $p>.12$, $\eta^2<.001$).

HR showed a significant main effect for block ($F(2,50)=14.01$, $p<.001$, $\eta^2=0.359$ [CI_{90}: 0.169, 0.484]). Post hoc comparisons revealed that HR was significantly lower during on- compared to off-blocks ($t(24)=-3.95$, $p=.002$, $d=.80$, [CI_{95}: 0.34, 1.26]) and the anticipation phase ($t(24)=-3.55$, $p=.002$, $d=.72$, [CI_{95}: 0.27, 1.17]). HR during anticipation was significantly lower than during the off-blocks ($t(24)=-3.21$, $p=.004$, $d=.65$, [CI_{95}: 0.21, 1.09]), see Figure S3. Furthermore, the HR displayed a significant main effect for time ($F(2,50)=7.45$, $p=.008$, $\eta^2=0.230$ [CI_{90}: 0.063, 0.363]). Post-hoc comparisons showed that HR was significantly higher in the first 3 seconds after onset, compared to seconds 3 to 6 ($t(23)=-5.52$, $p<.001$, $d=1.12$, [CI_{95}: 0.61, 1.63]) and decreasing again in seconds 6 to 9 ($t(23)=-2.74$, $p=.01$, $d=.56$, [CI_{95}: 0.12, 1.00]). We furthermore found a significant interaction of time X block ($F(4,100)=5.87$, $p=.01$, $\eta^2=0.190$ [CI_{95}: 0.064, 0.275]), which represents the stronger heart rate deceleration during on- compared to off-blocks, especially 6 to 9 seconds after onset, see Figure S2. There were no other significant main or interaction effects for the HR (all $F<2.04$, $p>.16$, $\eta^2<0.001$).



*<u>Figure S3:</u> Psychophysiology: Bars show mean values, error bars depict the standard error of the mean. Asterisks show significant post-hoc tests (corrected for multiple comparisons with the false discovery rate FDR) with **p<.01 and ***p<.001. (a) heart rate was lowest during on-blocks. During anticipation HR was already decreased. (b) Corrugator electromyogram was decreased during anticipation only. (c) Skin conductance responses increased during painful stimulation (on-blocks). SCR: skin conductance responses; EMG: electromyogram of the corrugator; HR: heart rate; ANTI: anticipation phase; ON: on-blocks; OFF: off-blocks;*

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