Aversive imagery causes de novo fear conditioning

by

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Open Data and Open Material (code-book)

Available online: https://zenodo.org
1 Open Data

This dataset includes subjective ratings, as well as skin conductance, heart period, and fear-potentiated startle measurements. We provide SPSS data and syntax files for both studies which are presented in our publication Aversive imagery causes de novo fear conditioning (Psychological Science). All files were created using SPSS 24 (IBM, Armonk, NY, USA).

Data for Study 1 are provided in the file Mueller_et_al_PsychologicalScience_Study1_Data.sav.

Data for Study 2 are provided in the file Mueller_et_al_PsychologicalScience_Study2_Data.sav.

The objective of this code-book is to explain all provided files.

1.1 Sociodemographic Data

Sex (F = “female”; M = “male”), age (in years), and handedness (L = “left-handed”; R = “right-handed”) of all participants are provided in the first columns (columns 2 to 5) of the SPSS data files.

1.2 Ratings

We provide subjective ratings data for both studies (Study 1: columns 6 to 108; Study 2: columns 6 to 60 of the corresponding SPSS data file). Participants rated all CSs and cues several times (T1-7) during the experiment:

| Time of measurement | Experimental phase | Rating of ... |
|---------------------|--------------------|---------------|
| (as named in SPSS data file) | | |
| T1 | Baseline (i.e., before habituation phase) | CSs and Cues |
| T2 | After habituation phase | CSs |
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T3 After acquisition block 1 CSs and Cues
T4 After acquisition block 2 CSs and Cues
T5 After extinction block 1 CSs
T6 (only Study 2) After reinstatement cue CSs
T7 After extinction block 2 CSs and Cues

Example: Rating_Arousal_CSplus_aversive_T3_ACQ1 = Arousal rating of the CS+aversive after acquisition block 1.

CSs are rated on a 5-point Likert scale regarding the associated valence (1 = “very pleasant; 5 = “very unpleasant”) and arousal (1 = “not arousing”; 5 = “very arousing”). In Study 1, participants also reported their subjective experience of fear (1 = “not fearful”; 5 = “very fearful”), anger (1 = “not angry”; 5 = “very angry”), and disgust (1 = “not disgusted”; 5 = “very disgusted”) when looking at the CSs.

Furthermore, participants were shown the three cues and asked to indicate whether they associated an imagery with this cue and to rate on an 11-point Likert scale the unpleasantness of the mental image that they associated with the respective cue (ranging from 0 = “not unpleasant at all” to 10 = “extremely unpleasant”). Participants could also report having no image associated with a cue. These responses were coded as “0” for statistical analyses.

CSs were rated during all times of measurement, while cues were only rated at T1, T3, T4, and T7. Reinstatement of fear (T6) was only investigated in Study 2. In Study 2, one participant had to be excluded from CS analyses, as she reported after the experiment to have misunderstood the questions (blank cells in the SPSS data file).
Syntax: SPSS Syntax files are provided for the most important ANOVA analyses which are described in the manuscript:

Study 1: Mueller_et_al_PsychologicalScience_Study1_Ratings_Syntax.sps.
Study 2: Mueller_et_al_PsychologicalScience_Study2_Ratings_Syntax.sps.

1.3 Electrocardiogram (ECG)

We analyzed heart period changes evoked by CSs and cues (Study 1: columns 109 to 568; Study 2: columns 61 to 400 of the corresponding SPSS data file). We provide ECG data (interbeat intervals, see below) for habituation, acquisition and extinction phases:

| Time of measurement | Experimental phase                                    | IBI changes        |
|---------------------|-------------------------------------------------------|--------------------|
| (as named in SPSS data file) |                                                        |                    |
| T2                  | During habituation                                    | CSs                |
| T3                  | During acquisition block 1                           | CSs and Cues       |
| T4                  | During acquisition block 2                           | CSs and Cues       |
| T5                  | During extinction block 1                            | CSs                |
| T7                  | During extinction block 2                            | CSs                |

The ECG was converted to a time course of interbeat intervals (IBIs) where the value at each time-point reflects the latency between the preceding and the next R spike (i.e., heart period). The IBI time series was then segmented into epochs ranging from -1000 to 7000 ms relative to CS onset (CS-evoked IBI) or from -1000 to 10000 ms relative to cue onset (cue-evoked IBI), baseline-corrected relative to -1000 to 0 ms, downsampled to 2 Hz, and averaged across all trials by block and condition. In Study
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2, only the ECG recording from -1000 to 5000 ms relative to CS and Cue onset was analyzed, due to the shorter CS presentation duration. We provide evoked IBI changes with a frequency of 2 Hz, i.e., two samples per second:

| IBI sample                  | Corresponding time window                              |
|-----------------------------|--------------------------------------------------------|
| (as named in SPSS data file)| (mean CS-evoked or Cue-evoked IBI change)             |
| preCS01 / preCue1          | -1000 to -500 ms relative to stimulus onset (baseline)|
| preCS02 / preCue2          | -500 to 0 ms relative to stimulus onset (baseline)    |
| postCS01 / postCue1        | 0 to 500 ms relative to stimulus onset                |
| postCS02 / postCue2        | 500 to 1000 ms relative to stimulus onset             |
| postCS03 / postCue03       | 1000 to 1500 ms relative to stimulus onset            |
| postCS04 / postCue04       | 1500 to 2000 ms relative to stimulus onset            |
| postCS05 / postCue05       | 2000 to 2500 ms relative to stimulus onset            |
| postCS06 / postCue06       | 2500 to 3000 ms relative to stimulus onset            |
| postCS07 / postCue07       | 3000 to 3500 ms relative to stimulus onset            |
| postCS08 / postCue08       | 3500 to 4000 ms relative to stimulus onset            |
| postCS09 / postCue09       | 4000 to 4500 ms relative to stimulus onset            |
| postCS10 / postCue10       | 4500 to 5000 ms relative to stimulus onset            |
| postCS11 / postCue11       | (only Study 1) 5000 to 5500 ms relative to stimulus onset |
| postCS12 / postCue12       | (only Study 1) 5500 to 6000 ms relative to stimulus onset |
| postCS13 / postCue13       | (only Study 1) 6000 to 6500 ms relative to stimulus onset |
| postCS14 / postCue14       | (only Study 1) 6500 to 7000 ms relative to stimulus onset |
| postCue15                  | (only Study 1) 7000 to 7500 ms relative to stimulus onset |
| postCue16                  | (only Study 1) 7500 to 8000 ms relative to stimulus onset |
Example: $ECG_{IBI\_CSplus\_aversive\_T3\_ACQ1\_postCS01} = \text{Mean IBI change (i.e., baseline-corrected) evoked by the CS+aversive in the first acquisition block, during the first 500 ms after stimulus onset.}$

As described in the manuscript, heart rate responses to a CS during fear acquisition typically show a triphasic response pattern, consisting of an initial deceleration (D1), a transient acceleration (A1), and a second deceleration (D2). For analysis of CS/cue-evoked IBI, the maximum (D1, D2) and minimum (A1) values were extracted for the following time periods:

| Cardiac component | Corresponding time window CS | Corresponding time window Cue |
|-------------------|-----------------------------|------------------------------|
| D1                | Studies 1 and 2: 0 to 2000 ms (max) | Study 1: 0 to 4000 ms (max) |
|                   | Study 2: 0 to 2000 ms (max)       | Study 2: 0 to 2000 ms (max)   |
| A1                | Studies 1 and 2: 2000 to 5000 ms (min) | Study 1: 4000 to 10000 ms (min) |
|                   | Study 2: 2000 to 5000 ms (min)       | Study 2: 2000 to 5000 ms (min)   |
| D2                | Study 1: 5000 to 7000 ms (max) | Study 2: 4000 to 5000 ms (max) |

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postCue17 (only Study 1) 8000 to 8500 ms relative to stimulus onset
postCue18 (only Study 1) 8500 to 9000 ms relative to stimulus onset
postCue19 (only Study 1) 9000 to 9500 ms relative to stimulus onset
postCue20 (only Study 1) 9500 to 10000 ms relative to stimulus onset
Example: *ECG_IBI_CSplus_aversive_T3_ACQ1_D2* = Second cardiac deceleration (D2), i.e., maximum IBI value for the time period from 5000 to 7000 ms (Study 1) or 4000 to 5000 ms (Study 2) after stimulus onset, evoked by the CS+aversive in the first acquisition block.

As described in detail in the manuscript, we calculated peak-to-peak values for CS-evoked IBI:

\[ A_{1\text{corrected}} = A_1 - D_1 \quad \text{and} \quad D_{2\text{corrected}} = D_2 - A_1 \]

Example: *ECG_IBI_CSplus_aversive_T3_ACQ1_D2\text{corrected}* = D2 value referenced to A1, to remove the influence of the preceding component, for the CS+aversive in the first acquisition block.

**Syntax:** All transformations on IBI data (i.e., calculation of D1, A1, D2, A1corrected, and D2corrected) are documented in the following SPSS Syntax files:

- **Study 1:** *Mueller_et_al_PsychologicalScience_Study1_ECG_IBI_calculate_components_Syntax.sps*.
- **Study 2:** *Mueller_et_al_PsychologicalScience_Study2_ECG_IBI_calculate_components_Syntax.sps*.

**Syntax:** SPSS Syntax files are provided for the most important ANOVA analyses which are described in the manuscript:

- **Study 1:** *Mueller_et_al_PsychologicalScience_Study1_ECG_IBI_Syntax.sps*.
- **Study 2:** *Mueller_et_al_PsychologicalScience_Study2_ECG_IBI_Syntax.sps*. 
1.4 Electrodermal Activity (EDA)

We analyzed skin conductance responses (SCRs) evoked by CSs and cues (Study 1: columns 569 to 590; Study 2: columns 401 to 422 of the corresponding SPSS data file). We provide SCR data for habituation, acquisition and extinction phases:

| Time of measurement | Experimental phase | SCRs evoked by ... |
|---------------------|--------------------|--------------------|
| (as named in SPSS data file) |                     |                    |
| T2                  | During habituation  | CSs                |
| T3                  | During acquisition block 1 | CSs and Cues         |
| T4                  | During acquisition block 2 | CSs and Cues         |
| T5                  | During extinction block 1 | CSs                |
| T7                  | During extinction block 2 | CSs                |

Skin conductance responses (SCR) were defined as the sum of SCR-amplitudes of significant SCRs within 1000 and 5000 ms after CS or Cue onset. SCRs smaller than 0.01 µS were considered zero responses. SCRs were logarithmized (ln [µS + 1]) before averaging to obtain a normal distribution. In Study 2, one participant had to be excluded from SCR analyses due to missing data (blank cells in the SPSS data file)

Example: \textit{EDA\textunderscore SCR\textunderscore CSplus\textunderscore aversive\textunderscore T3\textunderscore ACQ1} = Mean SCR evoked by the CS+aversive in the first acquisition block, within 1000 and 5000 ms after stimulus onset.

Syntax: SPSS Syntax files are provided for the most important ANOVA analyses which are described in the manuscript:
Study 1: `Mueller_et_al_PsychologicalScience_Study1_EDA_SCR_Syntax.sps`.

Study 2: `Mueller_et_al_PsychologicalScience_Study2_EDA_SCR_Syntax.sps`.

### 1.5 Electromyography (EMG): Fear-potentiated Startle

Electromyography (EMG) was measured below the left eye over the musculus orbicularis oculi. We analyzed startle responses evoked by CSs (only Study 2: columns 423 to 483 of the corresponding SPSS data file). We provide fear-potentiated startle data for acquisition and extinction phases:

| Time of measurement (as named in SPSS data file) | Experimental phase | Startle responses evoked by … |
|--------------------------------------------------|--------------------|-------------------------------|
| T3                                               | During acquisition block 1 | CSs and Cues                 |
| T4                                               | During acquisition block 2 | CSs and Cues                 |
| T5                                               | During extinction block 1 | CSs                           |
| T7                                               | During extinction block 2 | CSs                           |

Because of the good signal-to-noise ratio of startle responses, data was not aggregated within blocks but instead analyzed at the single-trial level. To this end, the maximum value between 20 and 150 ms was assessed for each trial in which a startle response was observed that did not begin earlier than 20 ms after startle onset.

Single-trial startle magnitudes were T-standardized ($M = 50$, $SD = 10$) within each participant using ITI startle magnitudes as the reference distribution. Afterward, single-trial startle responses were normalized as the percentage of the first startle response during the respective condition.
In case of non-responses, missing values were interpolated based on the value of the preceding available trial of the same category. If there was no preceding trial in that block and category, the value from the succeeding available trial was taken instead. If there was no trial in one acquisition block and category, the participant was excluded (blank cells in the SPSS data file), yielding a final sample for startle analysis of \( n = 29 \) for acquisition and \( n = 26 \) for extinction.

Example: \( EMG_{Startle\_CSplus\_aversive\_T3\_ACQ1\_Trial1} \) = Startle response evoked by the first CS+aversive trial, within 20 and 150 ms after stimulus onset.

Syntax: SPSS Syntax files are provided for the most important ANOVA analyses and single-trial \( t \)-Tests which are described in the manuscript:

Study 1: \( Mueller\_et\_al\_PsychologicalScience\_Study1\_EMG\_Startle\_Syntax.sps \).

Study 2: \( Mueller\_et\_al\_PsychologicalScience\_Study2\_EMG\_Startle\_Syntax.sps \).
2 Open Material

We provide audio files of the original imagery scripts for both studies (in German language) as Open Material. We would like to thank Alexander Petermann (Study 1) and Julia Zachlehner (Study 2) for recording the audio scripts. Furthermore, we provide an audio file of the startle probe (Study 2).

Example: *Mueller_et_al_PsychologicalScience_Sudy1_Audio_Ellipse_Aversive.wav* = Audio file for the Cue$_{aversive}$, blue ellipse served as imagery cue.

The experiment was performed using Presentation® software (Version 18.2, Neurobehavioral Systems, Inc., Berkeley, CA, [www.neurobs.com](http://www.neurobs.com)). All Presentation® scripts are available upon request.