



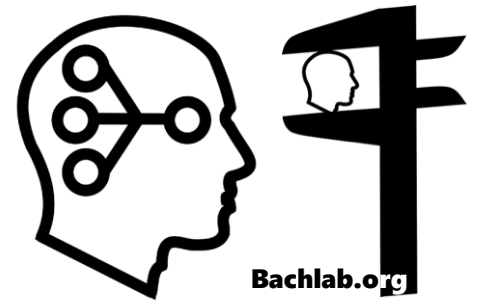
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FEAR CONDITIONING

Comparison of Models in PsPM & New Methods



Bachlab.org

Yanfang Xia

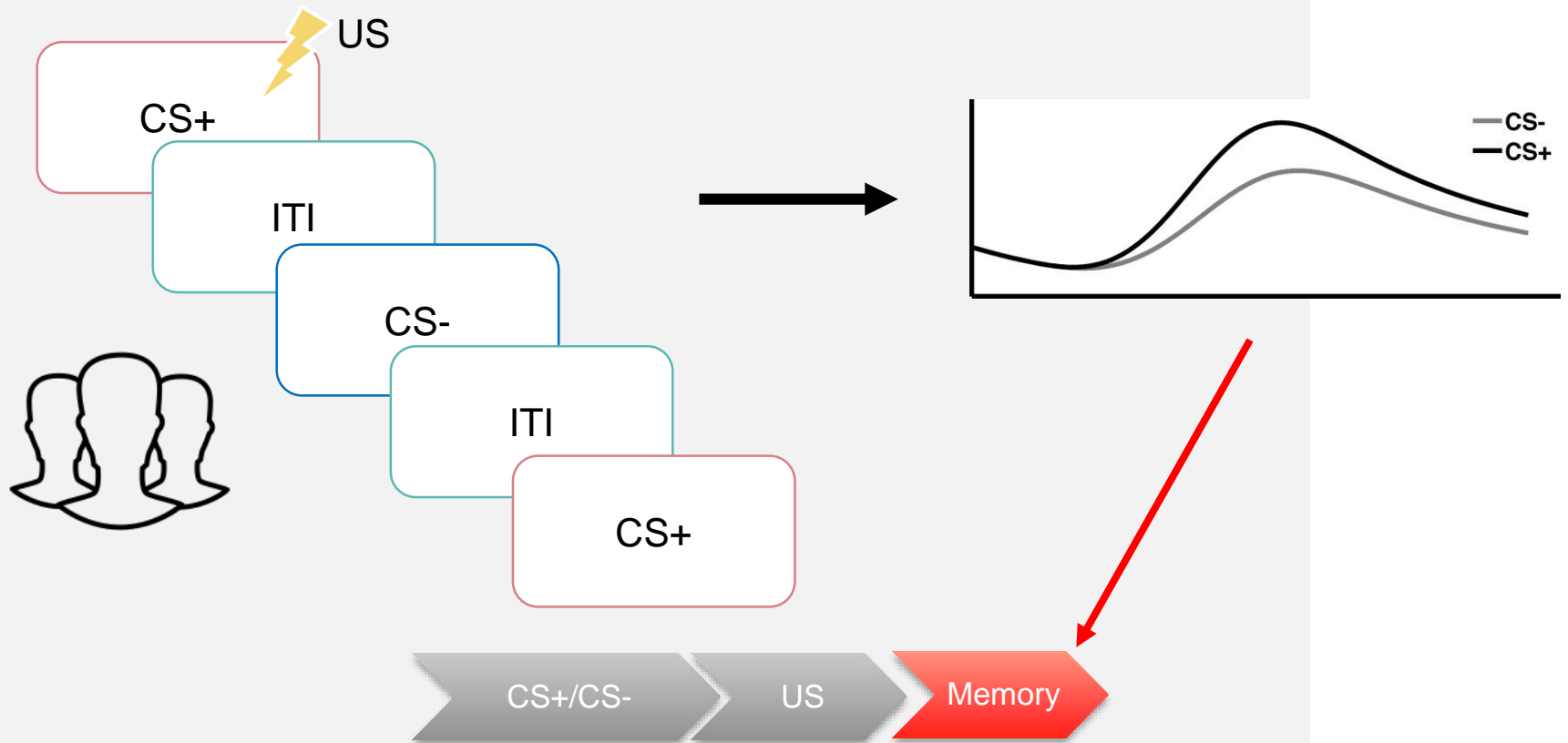
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14.05.2020

INTRODUCTION

Fear Conditioning

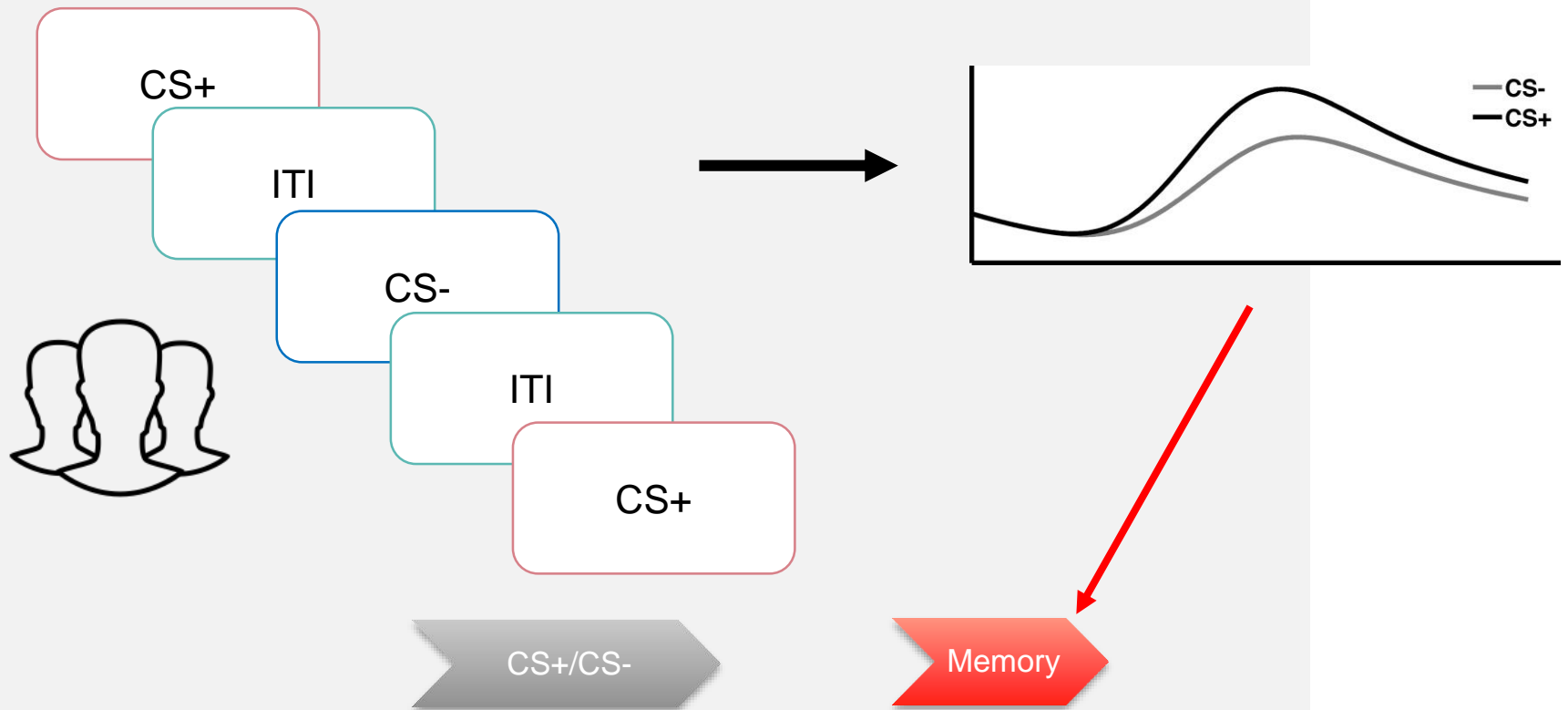
- Fear conditioning
 - contribute to survival
 - CS – US association



INTRODUCTION

Fear Conditioning

- Fear conditioning
 - contribute to survival
 - CS – US association



INTRODUCTION

Fear Conditioning measures

- Skin Conductance Responses
- Pupil Size Responses
- Heart Period Responses
- Respiration Amplitude Responses

- Fear-Potentiated Startle Responses
- Limb Withdrawal Responses
- Gaze Direction Responses

- Reaction Time
- Pavlovian-to-Instrumental Transfer

- Explicit Report

[Ojala & Bach 2020]



INTRODUCTION

Fear Conditioning measures in PsPM

- Skin Conductance Responses
- Pupil Size Responses
- Heart Period Responses
- Respiration Amplitude Responses

- Fear-Potentiated Startle Responses
- Limb Withdrawal Responses
- Gaze Direction Responses

- Reaction Time
- Pavlovian-to-Instrumental Transfer

- Explicit Report

[Ojala & Bach 2020]



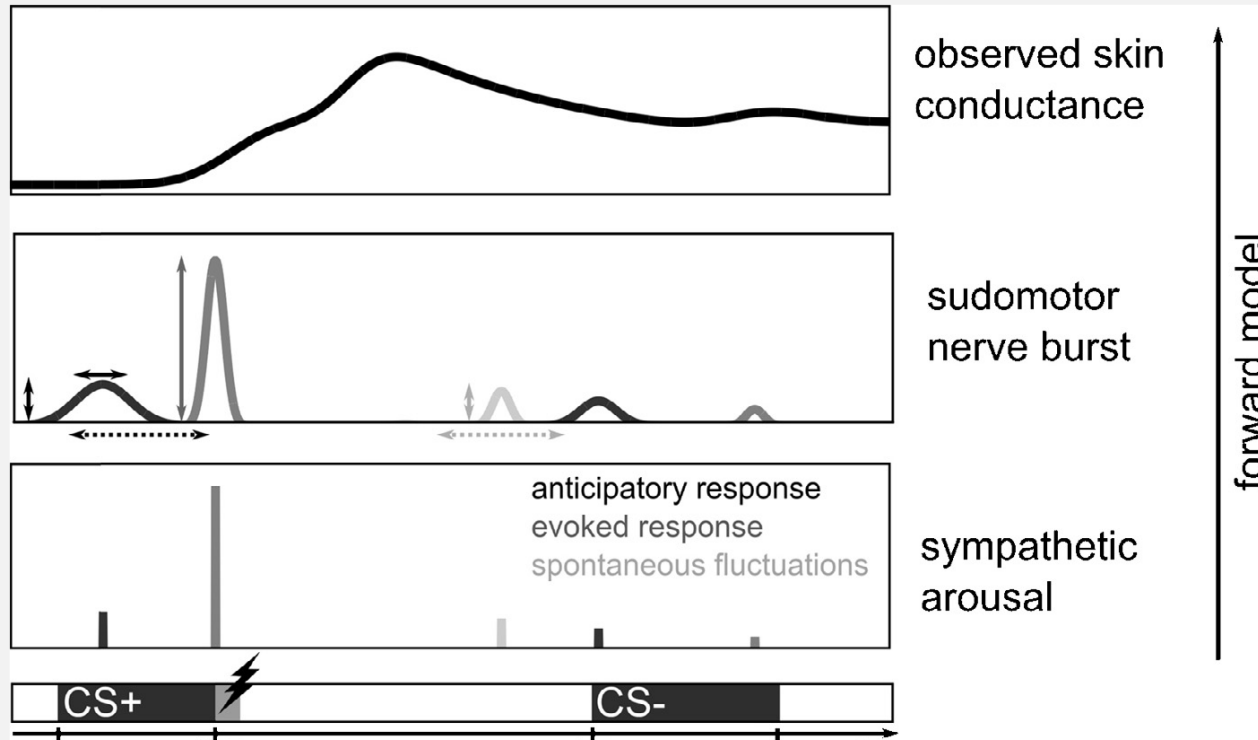
CONTENTS

- **Comparison of Models in PsPM**
 - Skin Conductance Response
 - Pupil Size Response
 - Fear-Conditioned Bradycardia
 - Respiration Amplitude Responses
 - Fear-Potentiated Startle

- **New Methods**
 - Pavlovian-to-Instrumental Transfer
 - Scanpath Length / Speed

MODEL COMPARISON

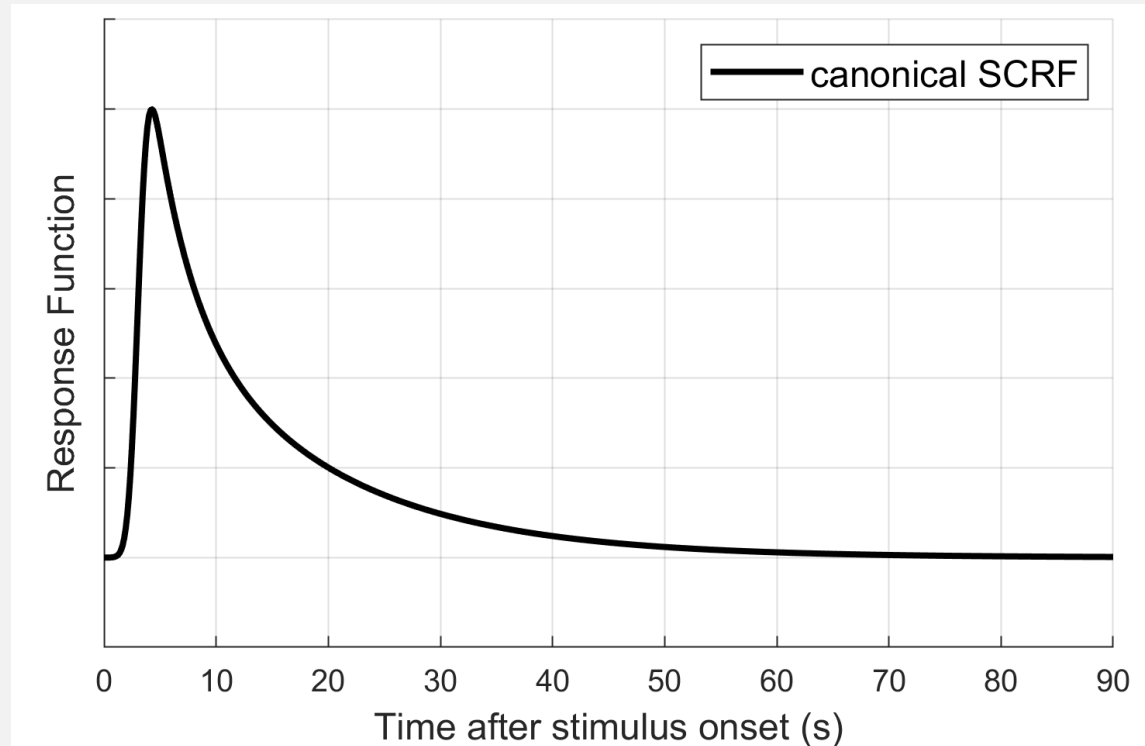
Fear Conditioning measures in PsPM – Skin Conductance Responses



Conditioned stimuli (CS) → SA → SCR

MODEL COMPARISON

Fear Conditioning measures in PsPM – Skin Conductance Responses



- Canonical response function in a non-linear model (“DCM”);
- Trial-by-trial
- Flexible latency after CS onset
- Experiments with short (up to 4 s) CS-US interval

MODEL COMPARISON

Fear Conditioning measures in PsPM – Skin Conductance Responses

Exp 1:

20 participants;
 CSs: blue or orange filled circles; 3.5 s SOA;
 50% reinforcement

Exp 2:

30 participants;
 CSs: sine sounds of different frequencies; 3.5 s SOA;
 50% reinforcement

	Experiment 1			Experiment 2		
	CS+ > CS-		Comparison with default DCM: LBF (smaller is better)	CS+ > CS-		Comparison with default DCM: LBF (smaller is better)
	t(19)	p		t(29)	p	
Default DCM	3.88	0.001		3.55	0.001	
Peak	1.99	0.062	18	2.32	0.027	11
CDA ('AmpSum')	2.39	0.027	15	2.77	0.010	08
CDA ('SCR')	2.56	0.019	13	2.64	0.013	09
DCM (z-standard)	4.31	<0.001	-2	3.64	0.001	-1
Peak (z-standard)	2.12	0.047	17	2.64	0.013	09
CDA ('AmpSum') (z-standard)	2.59	0.018	13	2.95	0.006	06
CDA ('SCR') (z-standard)	2.92	0.009	10	2.94	0.006	06

MODEL COMPARISON

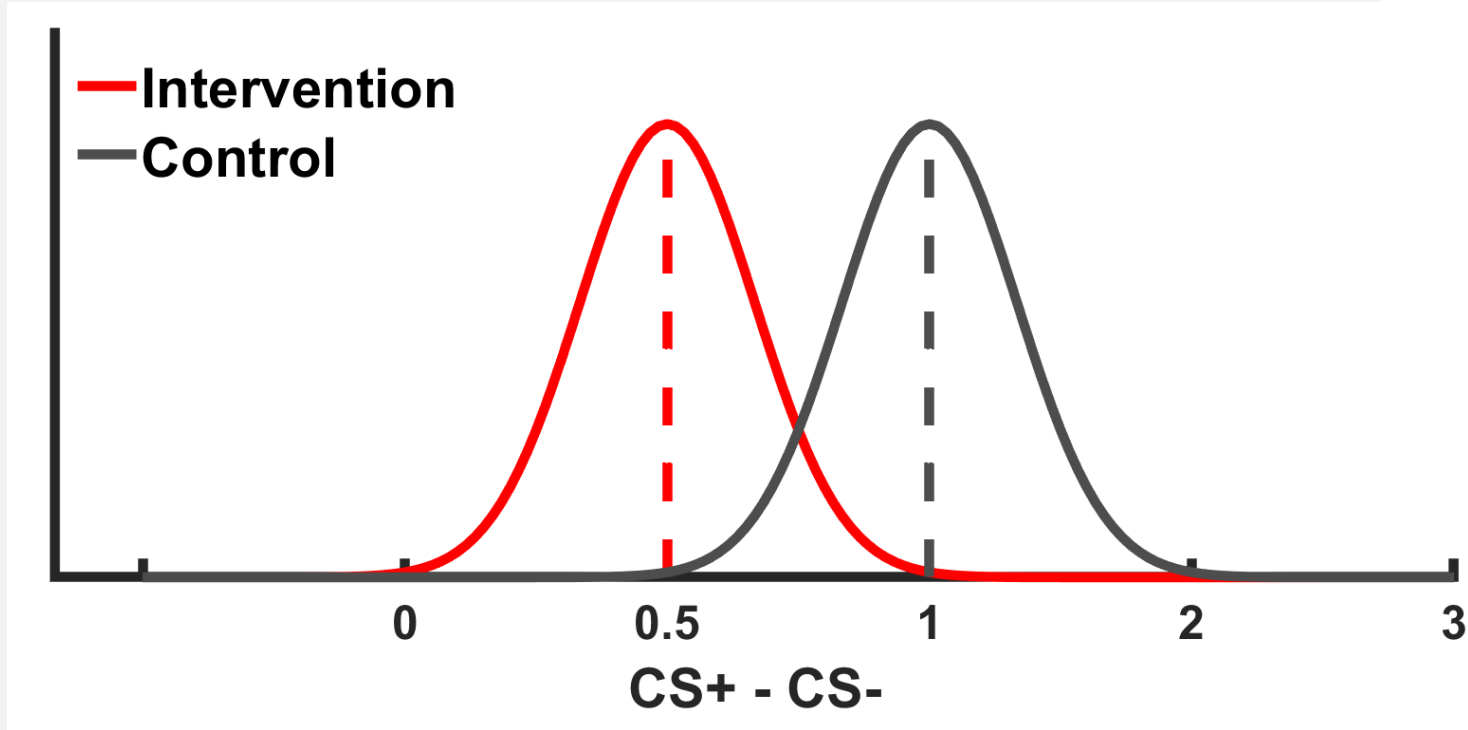
Fear Conditioning measures in PsPM – Skin Conductance Responses

	Experiment 1			Experiment 2		
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CDA ('SCR') (z-standard)	2.92	0.009	10	2.94	0.006	06

Weighted average effect size (Cohen's d)	
Peak scoring	0.44
PsPM	0.75

MODEL COMPARISON

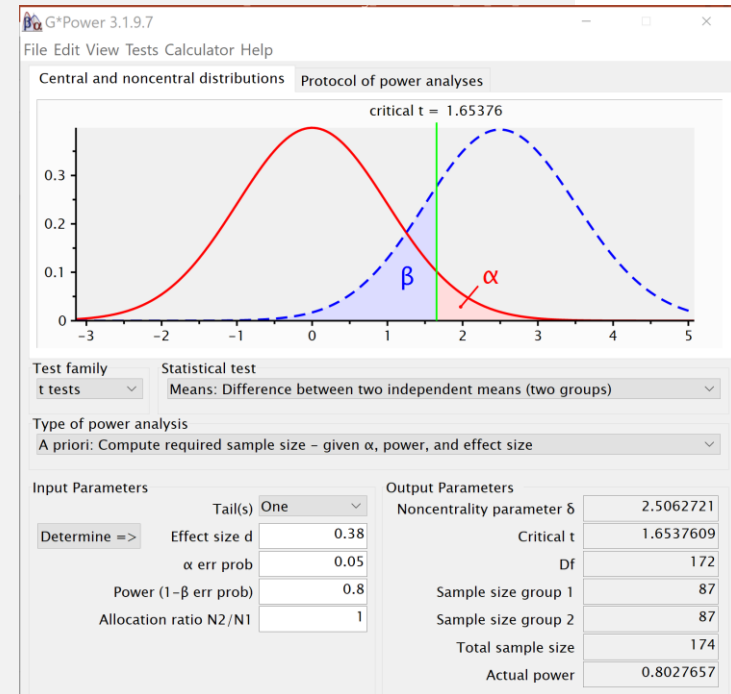
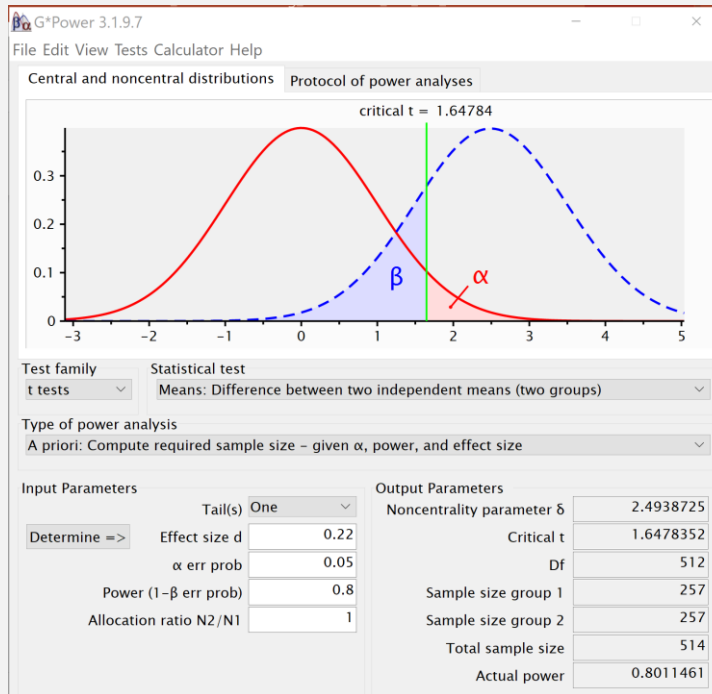
Fear Conditioning measures in PsPM – Skin Conductance Responses



To investigate a placebo-controlled fear memory intervention with at least 80% power at $\alpha = .05$ in a one-tailed test, under the assumption of equal variance in control and intervention groups (best-case scenario) with a fear memory reduction of at least 50%

MODEL COMPARISON

Fear Conditioning measures in PsPM – Skin Conductance Responses



	Cohen's d	Sample size
Peak scoring	0.44	514
PsPM	0.75	174

MODEL COMPARISON

Fear Conditioning measures in PsPM – Skin Conductance Responses

Batch Editor
File Edit View PsPM BasicIO

Module List

- Import
- Trim
- Non-Linear Model**
- Pupil preprocessing
- Find valid fixations
- Pupil foreshortening error correction
- Preprocess heart data
- Preprocess respiration data
- Find startle sound onsets
- Preprocess startle eyeblink EMG
- GLM for SEBR
- GLM for PS (fear-conditioning)
- GLM for HP (fear-conditioning)
- GLM for RA (fear-conditioning)

Current Module: Non-Linear Model

Help on: Non-Linear Model

Model Filename DEP Import: Output File

Output Directory DEP Trim: Output File

SCR channel

. Default

Data & design

- . Session
- . Data File DEP Trim: Output File
- . Design
- . . . Timing File <-X
- . . . Condition names
- . . . Condition <-X
- . . . Name <-X
- . . . Index <-X
- . . . Missing Epochs
- . . . No Missing Epochs

Data Options

- . Normalization No
- . Filter Settings
- . Default

Subsession threshold

Current Item: Model Filename

Reference from

Import: Output File

Specify... Dependency

Model Filename

Specify file name for the resulting model.
A string is entered.
The character array may have arbitrary size.

Batch Editor
File Edit View PsPM BasicIO

Module List

- Import
- Trim
- Non-Linear Model**
- Pupil preprocessing
- Find valid fixations
- Pupil foreshortening error correction
- Preprocess heart data
- Preprocess respiration data
- Find startle sound onsets
- Preprocess startle eyeblink EMG
- GLM for SEBR
- GLM for PS (fear-conditioning)
- GLM for HP (fear-conditioning)
- GLM for RA (fear-conditioning)

Current Module: Non-Linear Model

. . . No missing epochs

Data Options

- . Normalization No
- . Filter Settings
- . . Default
- . Subsession threshold 2
- . Constrained model 0

Response Function Options

- . Estimate the Response Function from The Data No
- . Only Estimate RF (Do Not Do Trial-Wise DCM) No
- . Use External File to Provide Response Function No

Inversion Options

- . Number of Trials to Invert at The Same Time 2
- . SF-Free Window Before First Event [s] 2
- . SF-Free Window After Last Event [s] 5
- . Maximum Frequency of SF in ITIs [Hz] 0.5
- . SCL-Change-Free Window Before First Event [s] 2
- . SCL-Change-Free Window After Last Event [s] 5

Display Options

- . Display Progress Window Yes
- . Display Intermediate Windows No

Current Item: Model Filename

Reference from

Import: Output File

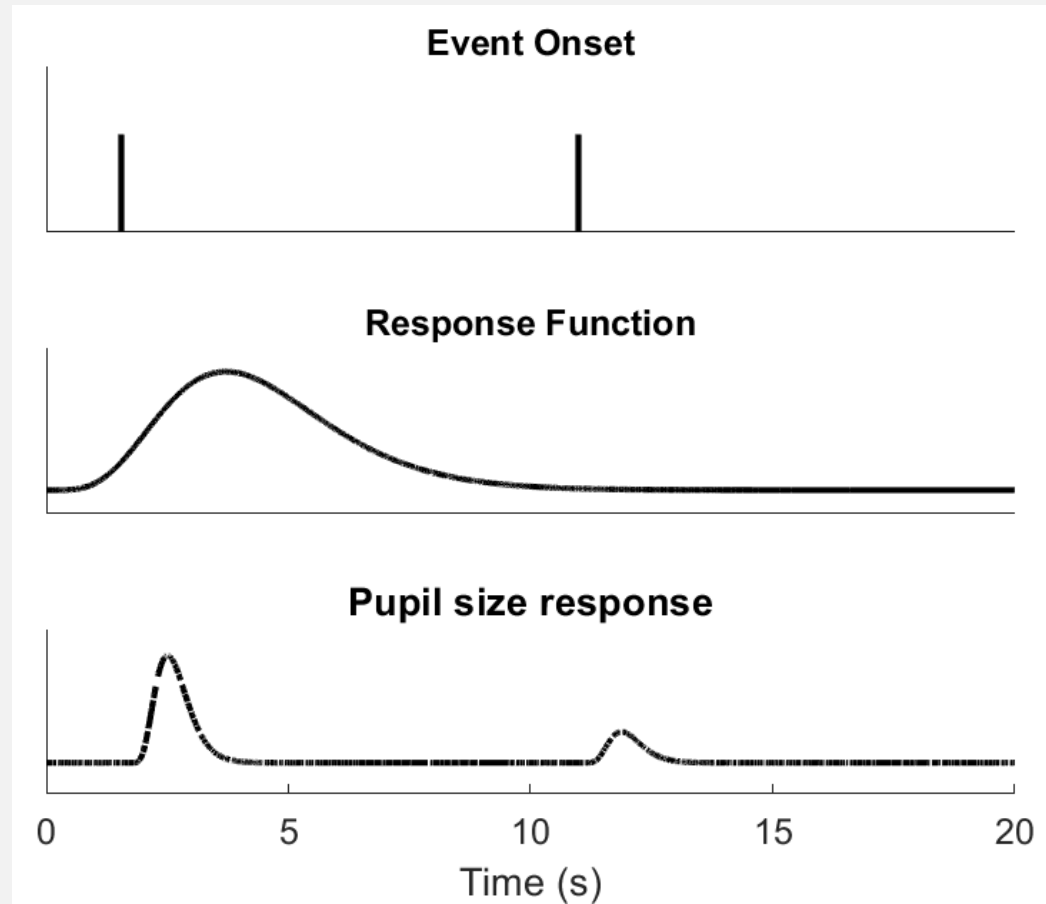
Specify... Dependency

Model Filename

Specify file name for the resulting model.
A string is entered.
The character array may have arbitrary size.

MODEL COMPARISON

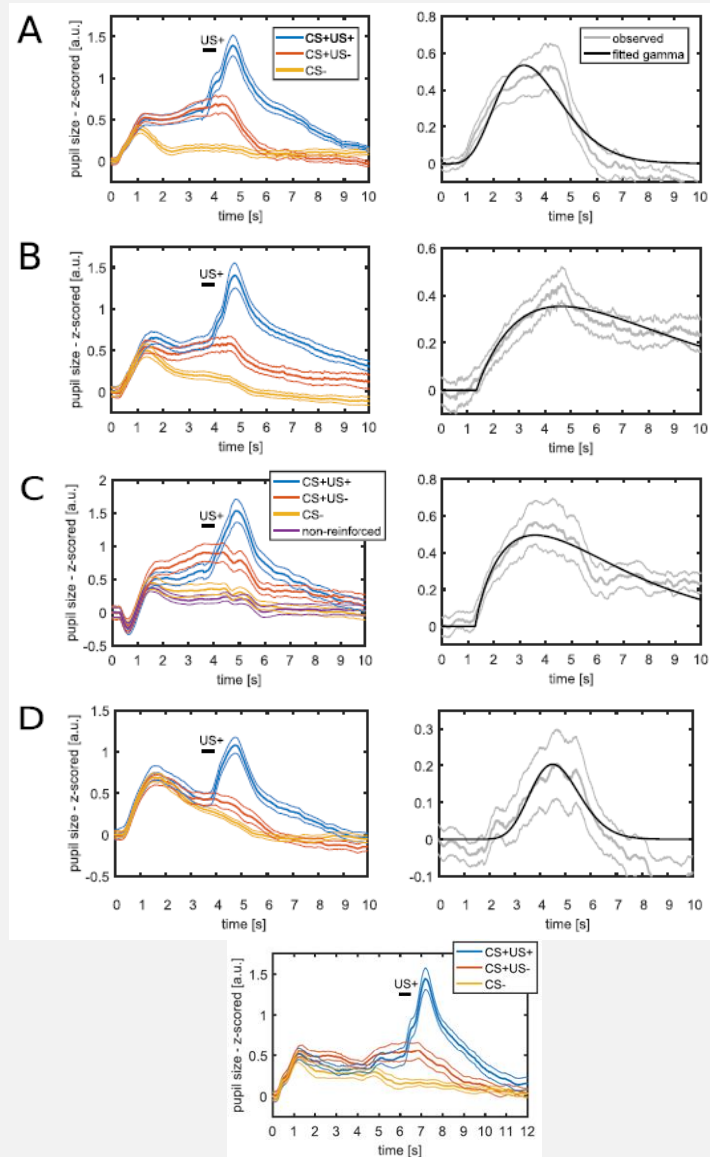
Fear Conditioning measures in PsPM – Pupil Size Responses



Conditioned stimuli (CS) → cognitive inputs → PSR

MODEL COMPARISON

Fear Conditioning measures in PsPM – Pupil Size Responses



Exp 1: 19 participants;
Auditory CSs;
3.5 s SOA; 50% reinforcement

Exp 2: 12 participants;
Auditory CSs;
3.5 s SOA; 50% reinforcement

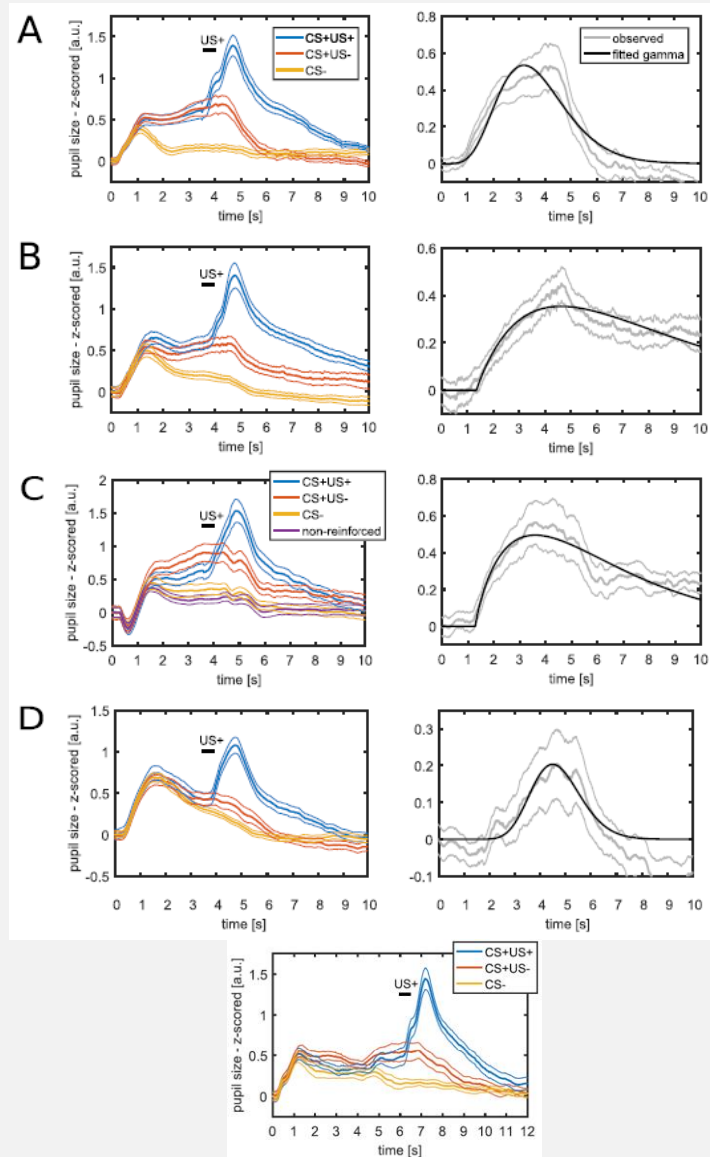
Exp 3: 17 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement

Exp 4: 18 participants;
Somatosensory CSs;
3.5 s SOA; 50% reinforcement

Exp 5: 15 participants;
Long auditory CSs;
6 s SOA; 50% reinforcement

MODEL COMPARISON

Fear Conditioning measures in PsPM – Pupil Size Responses



- A gamma probability density function in a General linear model (GLM)
- Trial-by-trial
- CS-locked
- Experiments with different CS types, and luminance changes

MODEL COMPARISON

Fear Conditioning measures in PsPM – Pupil Size Responses

Table 3. Model Comparison

Experiment	<i>t</i> , <i>p</i> , and <i>d</i> values			
	Peak amplitude	AUC	GLM with response function from Experiment 1	GLM with response function from Experiment 1 plus derivative
Experiment 1: Auditory CS (<i>n</i> = 19)	<i>t</i> (18) = 4.41; <i>p</i> = .0003; <i>d</i> = 1.01	<i>t</i> (18) = 3.97; <i>p</i> = .0009; <i>d</i> = 0.91	<i>t</i> (18) = 5.05; <i>p</i> < 10 ⁻⁴ ; <i>d</i> = 1.16	<i>t</i> (18) = 5.89; <i>p</i> < 10 ⁻⁴ ; <i>d</i> = 1.35
Experiment 2: Auditory CS (<i>n</i> = 12)	<i>t</i> (11) = 2.63; <i>p</i> = .0234; <i>d</i> = 0.76	<i>t</i> (11) = 3.29; <i>p</i> = .0073; <i>d</i> = 0.95	<i>t</i> (11) = 3.09; <i>p</i> = .0104; <i>d</i> = 0.89	<i>t</i> (11) = 2.10; <i>p</i> = .0593; <i>d</i> = 0.61
Experiment 3: Visual CS (<i>n</i> = 17)	<i>t</i> (16) = 2.71; <i>p</i> = .0155; <i>d</i> = 0.66	<i>t</i> (16) = 2.20; <i>p</i> = .0432; <i>d</i> = 0.53	<i>t</i> (16) = 2.96; <i>p</i> = .0093; <i>d</i> = 0.72	<i>t</i> (16) = 2.91; <i>p</i> = .0103; <i>d</i> = 0.71
Experiment 4: Somatosensory CS (<i>n</i> = 18)	<i>t</i> (17) = 2.46; <i>p</i> = .0248; <i>d</i> = 0.58	<i>t</i> (17) = 2.53; <i>p</i> = .0216; <i>d</i> = 0.60	<i>t</i> (17) = 3.16; <i>p</i> = .0058; <i>d</i> = 0.74	<i>t</i> (17) = 2.87; <i>p</i> = .0107; <i>d</i> = 0.68
Experiment 5: Long auditory CS (<i>n</i> = 15)	<i>t</i> (14) = 1.62; <i>p</i> = .1271; <i>d</i> = 0.42	<i>t</i> (14) = 2.43; <i>p</i> = .0289; <i>d</i> = 0.63	<i>t</i> (14) = 3.76; <i>p</i> = .0021; <i>d</i> = 0.97	<i>t</i> (14) = 3.78; <i>p</i> = .0020; <i>d</i> = 0.98

Weighted average effect size (Cohen's *d*)

Peak scoring

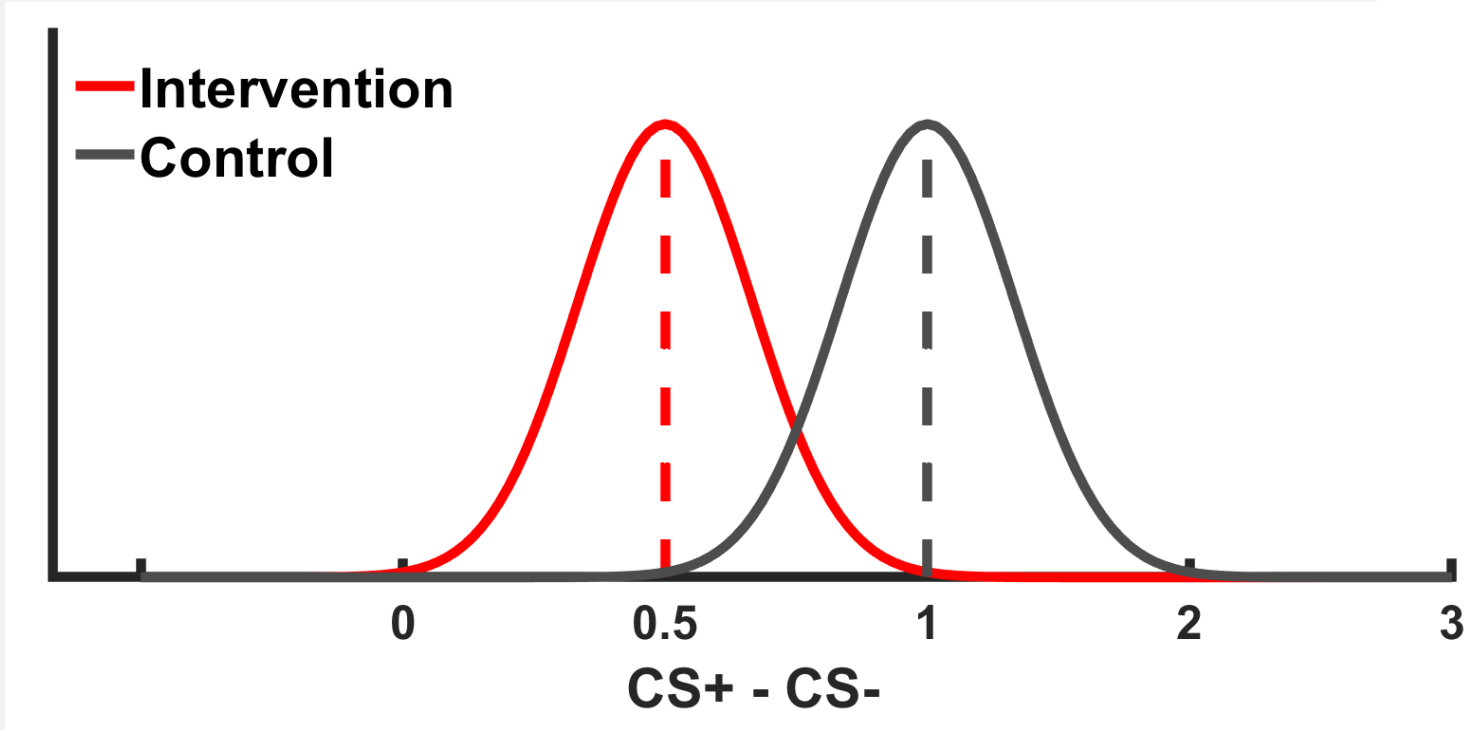
0.60

PsPM

0.82

MODEL COMPARISON

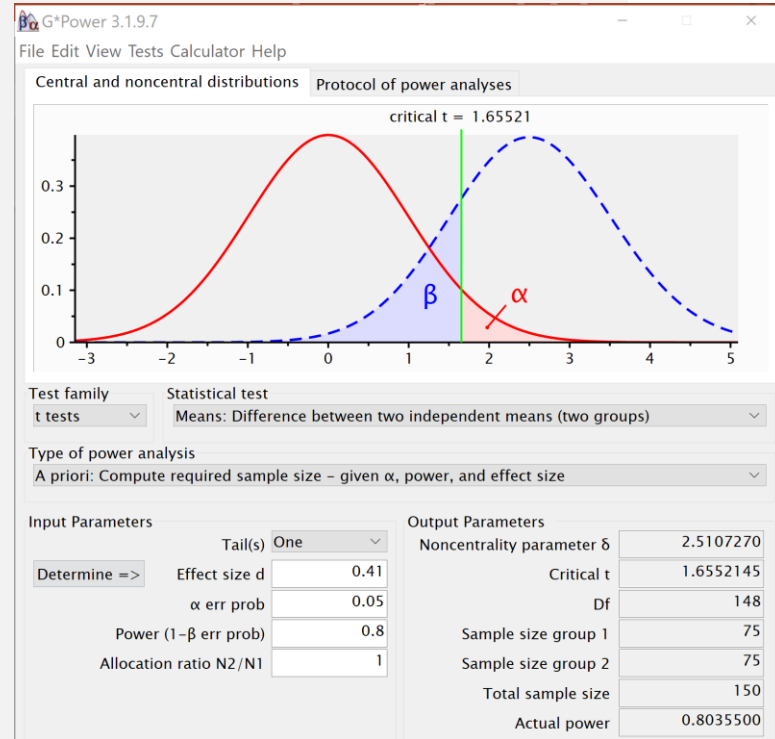
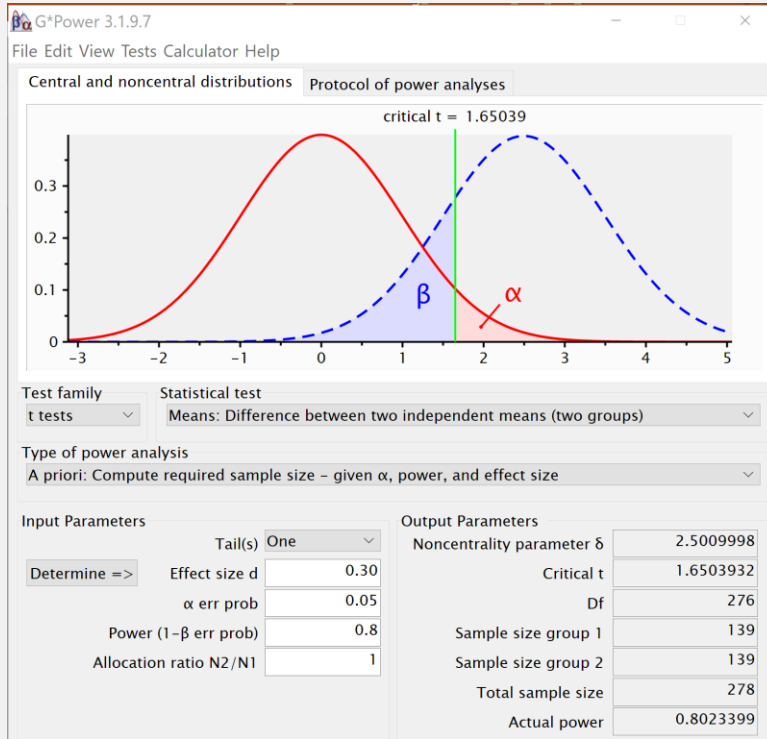
Fear Conditioning measures in PsPM – Pupil Size Responses



To investigate a placebo-controlled fear memory intervention with at least 80% power at $\alpha = .05$ in a one-tailed test, under the assumption of equal variance in control and intervention groups (best-case scenario) with a fear memory reduction of at least 50%

MODEL COMPARISON

Fear Conditioning measures in PsPM – Pupil Size Responses



	Cohen's d	Sample size
Peak scoring	0.60	278
PsPM	0.82	150

MODEL COMPARISON

Fear Conditioning measures in PsPM – Pupil Size Responses

The image displays three screenshots of the PsPM Batch Editor interface, illustrating the configuration of different modules for fear conditioning measures.

Left Screenshot: Pupil preprocessing

- Module List:** Pupil preprocessing
- Current Module:** Pupil preprocessing
- Data File:** ...spm_DA121030.mat
- Channel definition:** Best pupil
- Secondary channel to preprocess and combine:** No combining
- Channel action:** Add
- Settings:** Default settings
- Segments:** False
- Plot data:** False

Right Screenshot: Find valid fixations

- Module List:** Find valid fixations
- Current Module:** Find valid fixations
- Data File:** ...pl preprocessing; Output File
- Eyes:** All eyes
- Validation method:** Validation settings
- Secondary channel to preprocess and combine:** [1280 1024]
- Channel:** pupil
- Missing:** Enabled
- Output settings:** File output, Overwrite original file, Channel action: Add, Plot gaze coords and fixation point(s): No

Bottom Screenshot: Pupil foreshortening error correction

- Module List:** Pupil foreshortening error correction
- Current Module:** Pupil foreshortening error correction
- Data File:** ...id fixations; Output File
- Screen resolution:** [NaN NaN]
- Screen size:** [NaN NaN]
- Correction mode:** Manual mode
- Channel to correct:** Best pupil
- Channel definition:** Add
- Channel action:** Add

Right Screenshot: GLM for PS (fear-conditioning)

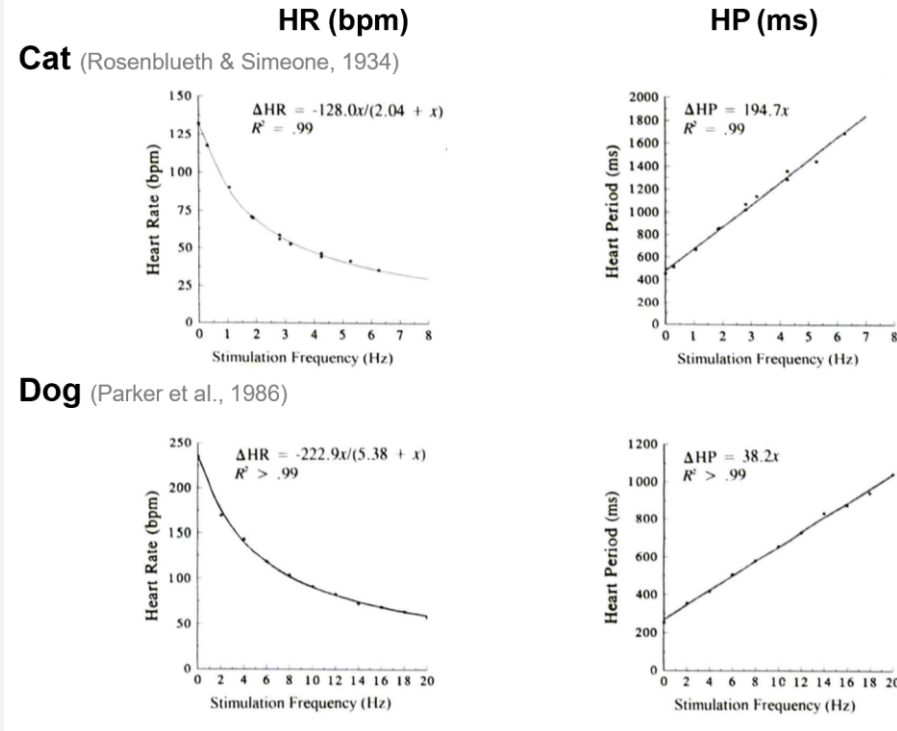
- Module List:** GLM for PS (fear-conditioning)
- Current Module:** GLM for PS (fear-conditioning)
- Help on:** GLM for PS (fear-conditioning)
- Model Filename:** mdl_ps_xxxx
- Output Directory:** ... project\PsPM_workshop
- PSR Channel:** Default
- Time Units:** Best eye
- Markers:** 0
- Data & Design:** Marker Channel
- Session:** ...ror correction: Output File
- Data File:** ...
- Missing Epochs:** <-X
- No Missing Epochs:** <-X
- Design:** <-X
- Nuisance File:** No
- Basis Function:** PSRF_FC 1
- Normalize:** No
- Filter Settings:** Default
- Current Item:** Model Filename
- Model Filename:** mdl_ps_xxxx

Model Filename: Specify file name for the resulting model. A string is entered. The character array may have arbitrary size.

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia

Heart rate vs. heart period (see Berntson et al., 1995)

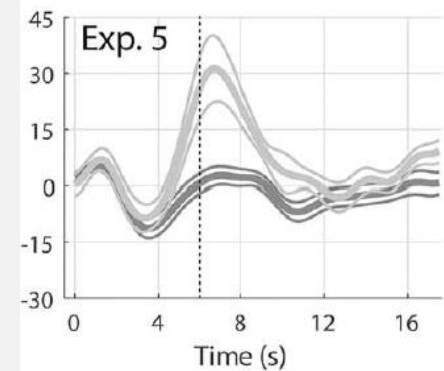
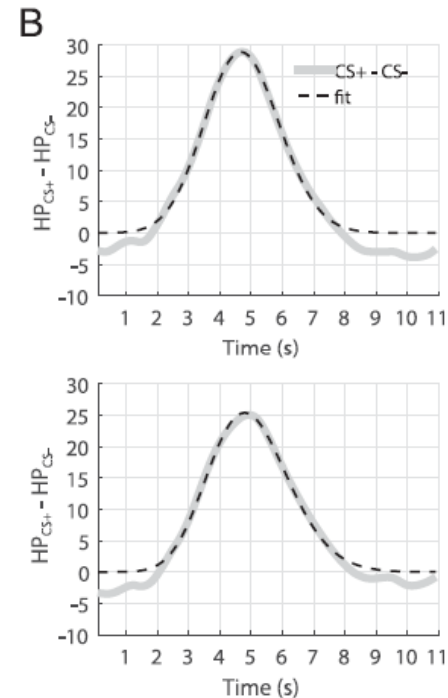
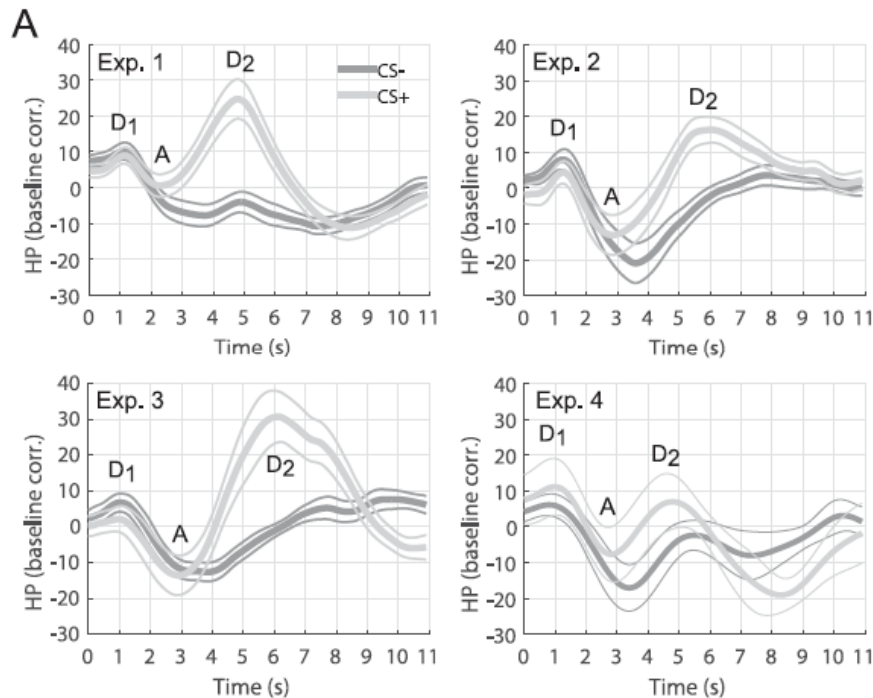


[PsPM course 05_HPR_Paulus, 2020]

Conditioned stimuli (CS) → parasympathetic neural inputs → HPR

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia

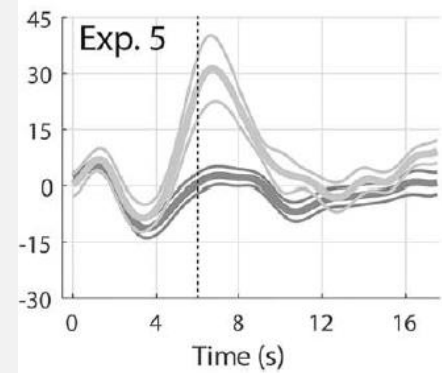
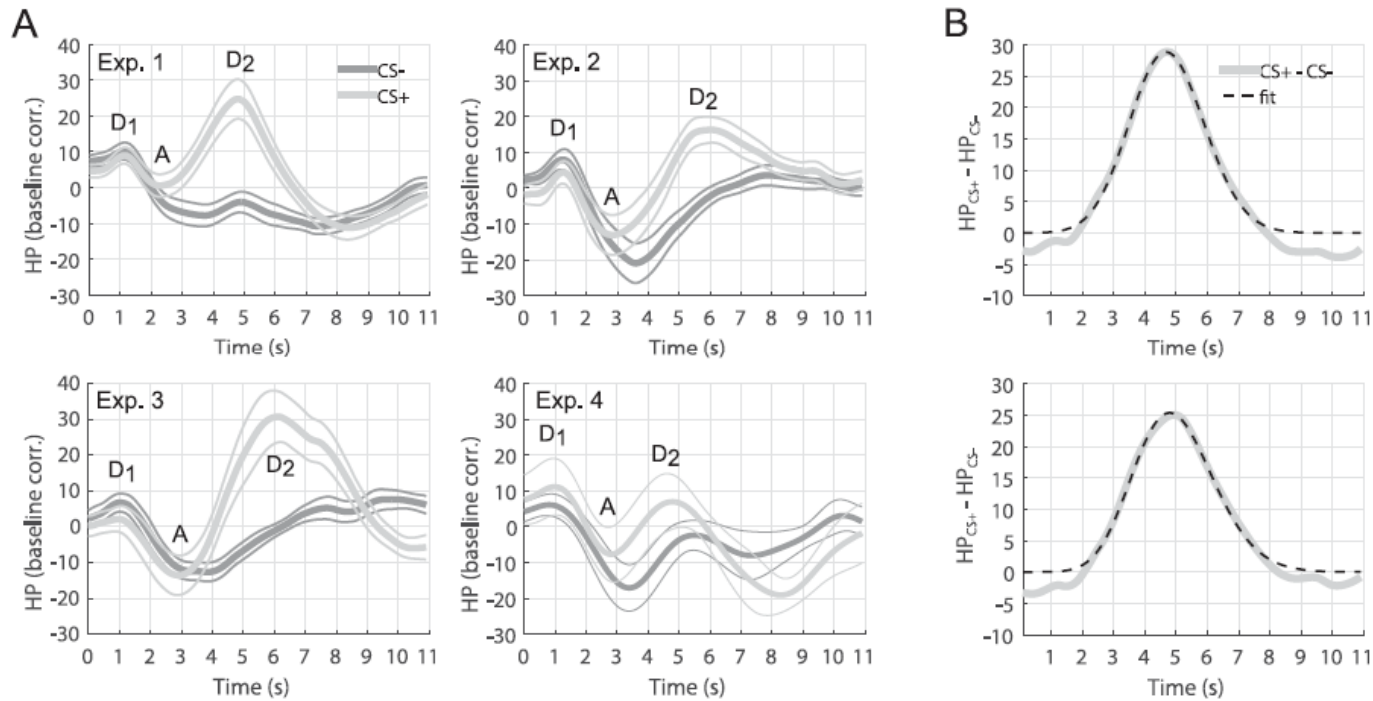


- Exp 1: 29 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement
- Exp 3: 19 participants;
Visual CSs; trace fear conditioning;
4 s SOA; 50% reinforcement
- Exp 5: 18 participants;
Auditory CSs;
6 s SOA; 50% reinforcement

- Exp 2: 17 participants;
Auditory CSs;
3.5 s SOA; 50% reinforcement
- Exp 4: 17 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement

MODEL COMPARISON

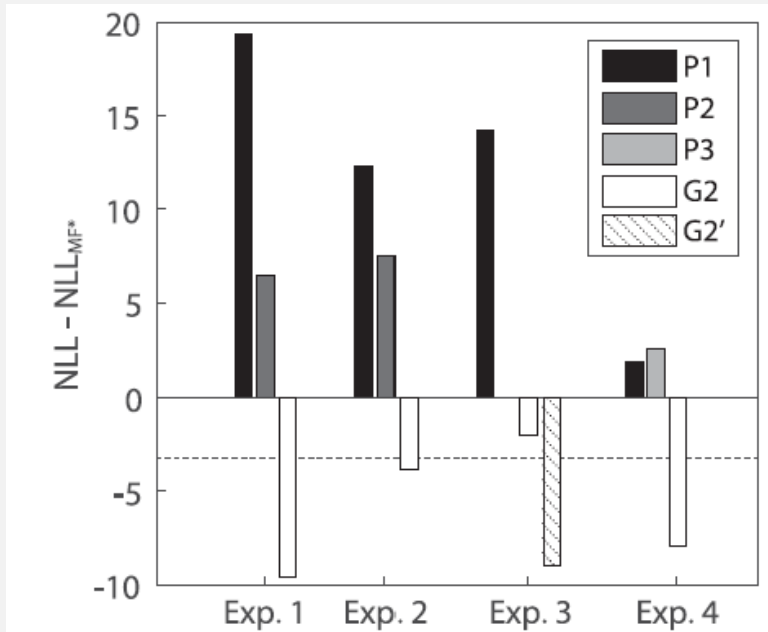
Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia



- A gamma probability density function, together with its time derivative, in a General linear model (GLM)
- Condition-by-condition
- US-locked
- Experiments with different CS types and SOA

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia

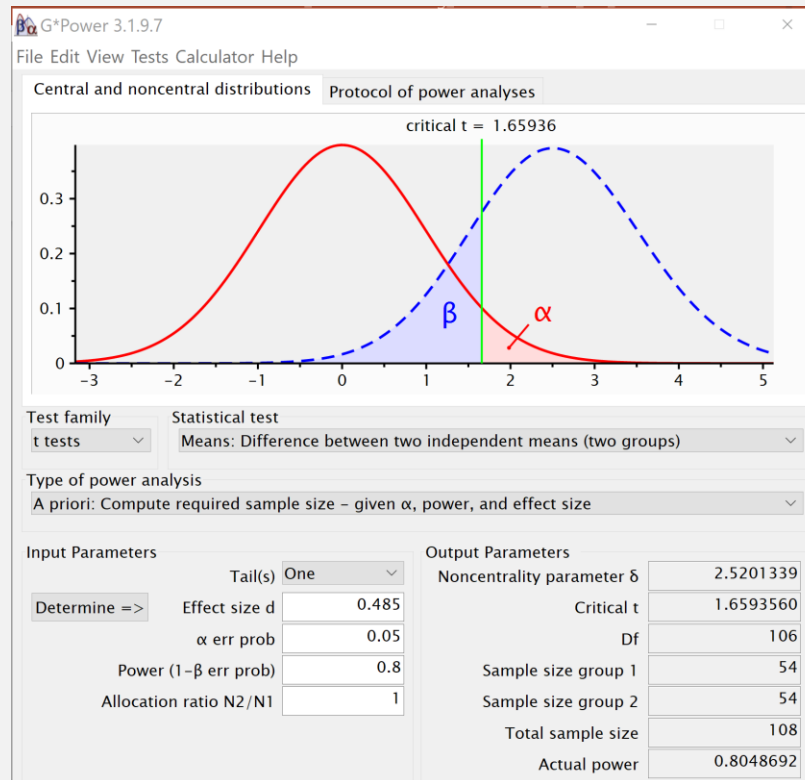


Experiment	Effect size (Cohen's d)
Exp 2	1.05
Exp 3	1.27
Exp 4	0.59

Weighted average effect size (Cohen's d)	
PsPM	0.97

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia



	Cohen's d	Sample size
PsPM	0.97	108

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Conditioned Bradycardia

The screenshot shows the 'Batch Editor' window with the 'Preprocess heart data' module selected. The 'Module List' on the left includes 'Preprocess heart data'. The main area displays the module's help text and configuration options:

- Help on: Preprocess heart data
- Data File: DEP Trim: Output File
- Preprocessing
 - Type of preprocessing
 - Convert ECG to Heart Period
 - Channel
 - Default
 - Options
 - Semi automatic mode: Off
 - Sample rate: 10
 - Limit
 - Upper limit: 2
 - Lower limit: 0.2
 - Channel action: Replace

The 'Current Item: Data File' section shows a reference from 'Trim: Output File'. The 'Data File' section at the bottom contains the text: 'Specify data file. In case data/model file(s) are chosen via the dependency button, make sure the number of output files of the preceding module corresponds with the allowed number of input files for this module.'

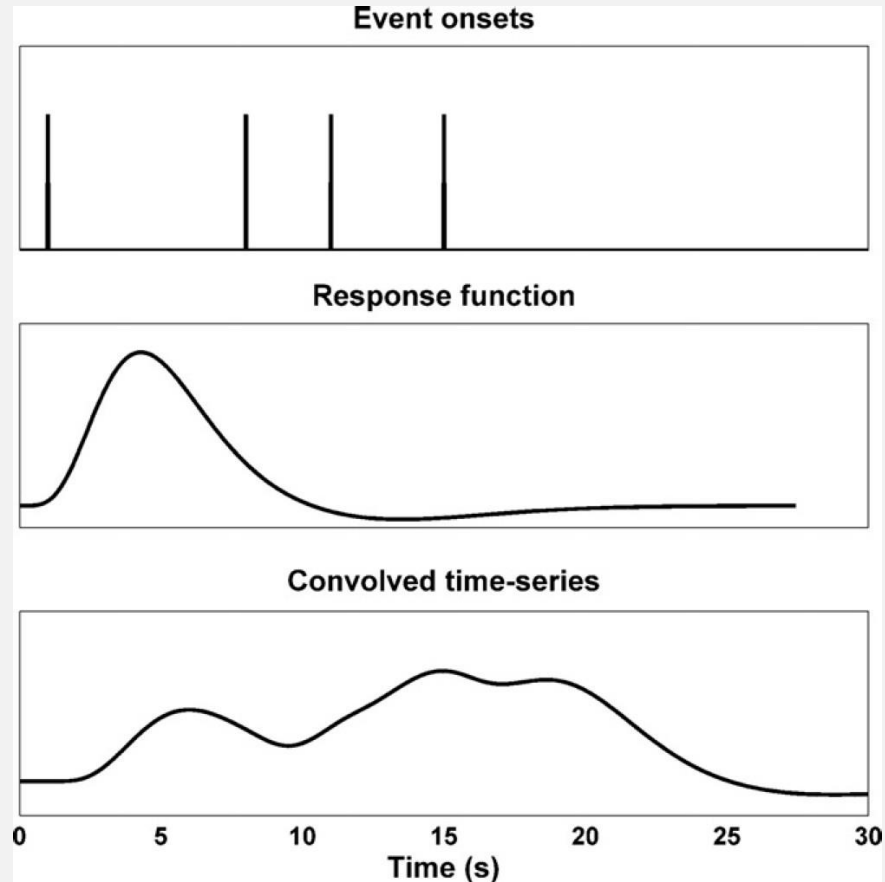
The screenshot shows the 'Batch Editor' window with the 'GLM for HP (fear-conditioning)' module selected. The 'Module List' on the left includes 'GLM for HP (fear-conditioning)'. The main area displays the module's help text and configuration options:

- Help on: GLM for HP (fear-conditioning)
- Model Filename: mdl_hp_xxxx
- Output Directory: <-X
- HPR Channel
 - Default
 - Time Units
 - Markers
 - Marker Channel: 0
 - Data & Design
 - Session
 - Data File: ...ss heart data: Output File
 - Missing Epochs
 - No Missing Epochs
 - Design: <-X
 - Nuisance File
 - Basis Function
 - Function
 - HPRF_FC 1
 - SOA: 3.5
 - Normalize: No

The 'Current Item: Model Filename' section shows a text input field containing 'mdl_hp_xxxx'. The 'Model Filename' section at the bottom contains the text: 'Specify file name for the resulting model. A string is entered. The character array may have arbitrary size.'

MODEL COMPARISON

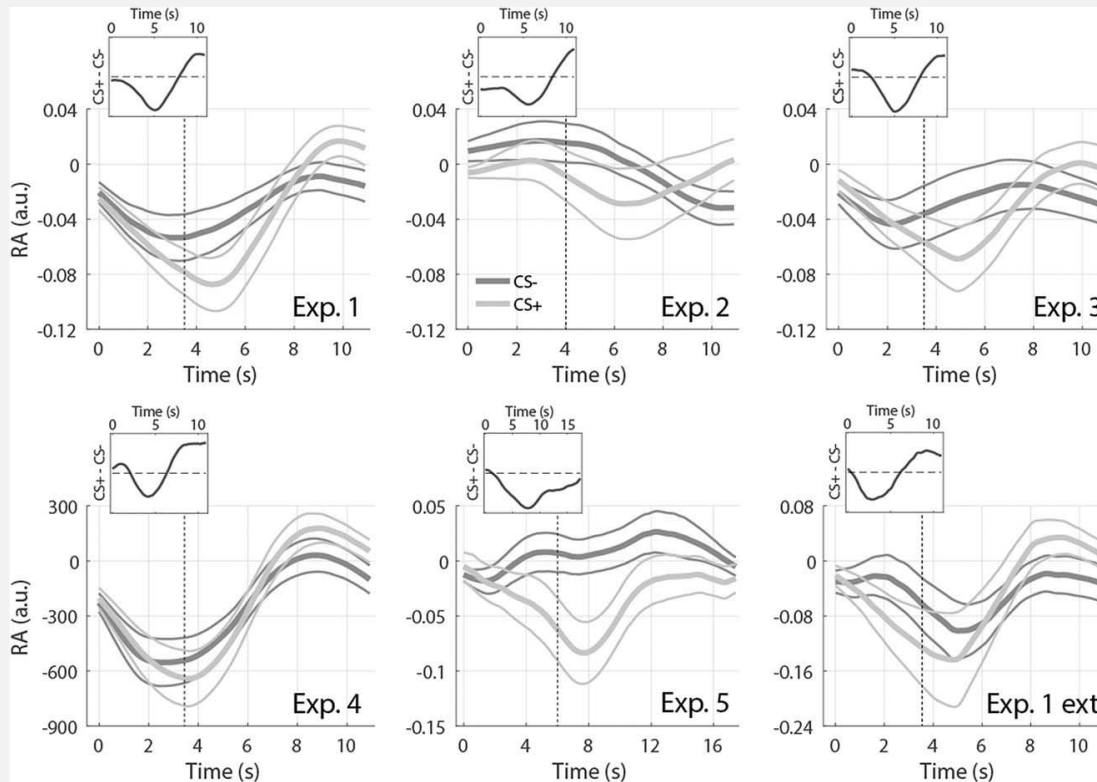
Fear Conditioning measures in PsPM – Respiration Amplitude Responses



Conditioned stimuli (CS) → neural inputs → RAR

MODEL COMPARISON

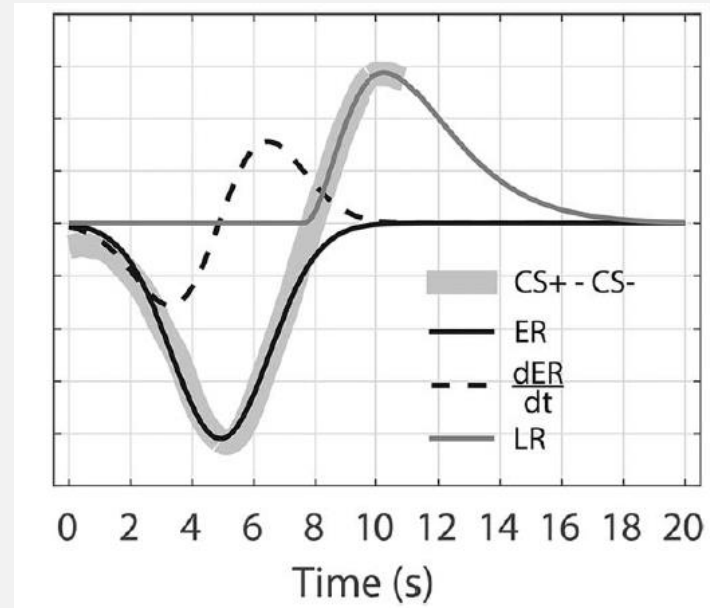
Fear Conditioning measures in PsPM – Respiration Amplitude Responses



- Exp 1: 33 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement
- Exp 2: 19 participants;
Visual CSs; trace fear conditioning
4 s SOA; 50% reinforcement
- Exp 3: 20 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement
- Exp 4: 16 participants;
Visual CSs;
3.5 s SOA; 50% reinforcement
- Exp 5: 18 participants;
Auditory CSs;
6 s SOA; 50% reinforcement

MODEL COMPARISON

Fear Conditioning measures in PsPM – Respiration Amplitude Responses



- A gamma probability density function, with ER + LR, in a General linear model (GLM)
- Condition-by-condition
- Possibly US-locked
- Model of ER + LR for experiments with short SOA

MODEL COMPARISON

Fear Conditioning measures in PsPM – Respiration Amplitude Responses

Experiment	Model of ER + dt	Model of ER + LR
Exp 2	0.40	0.83
Exp 3	0.64	0.59
Exp 4	0.29	0.64
Exp 5	0.71	0.38
Exp 1 retention	0.20	0.42

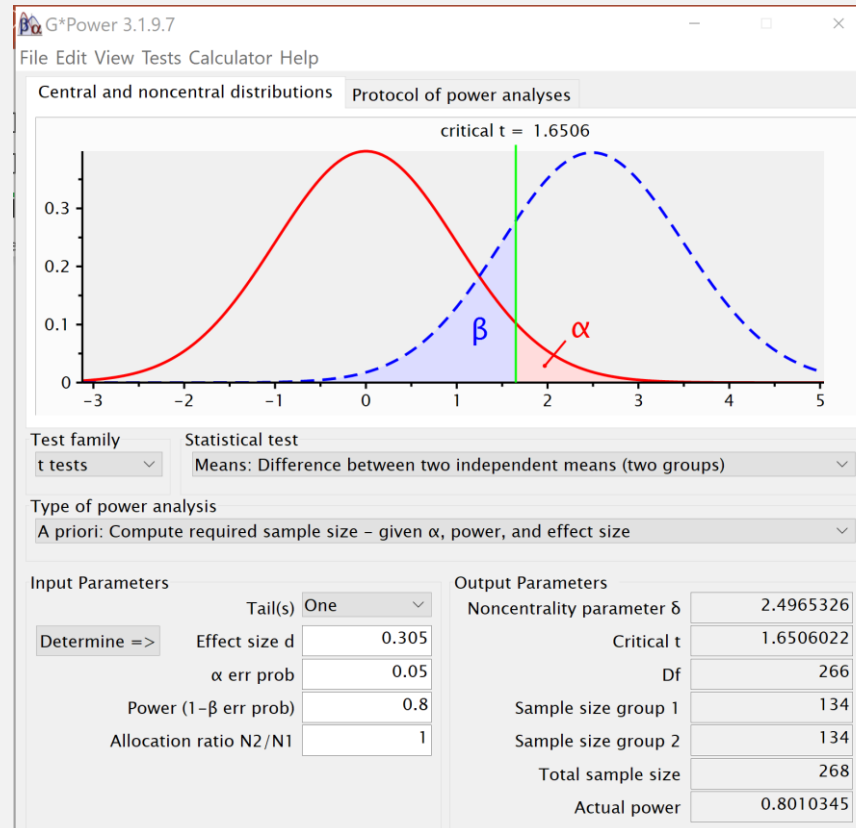
Weighted average effect size (Cohen's d)

PsPM

0.61

MODEL COMPARISON

Fear Conditioning measures in PsPM – Respiration Amplitude Responses



	Cohen's d	Sample size
PsPM	0.61	268

MODEL COMPARISON

Fear Conditioning measures in PsPM – Respiration Amplitude Responses

The image displays two side-by-side screenshots of the PsPM Batch Editor interface, showing the configuration for two different modules.

Left Window: Preprocess respiration data

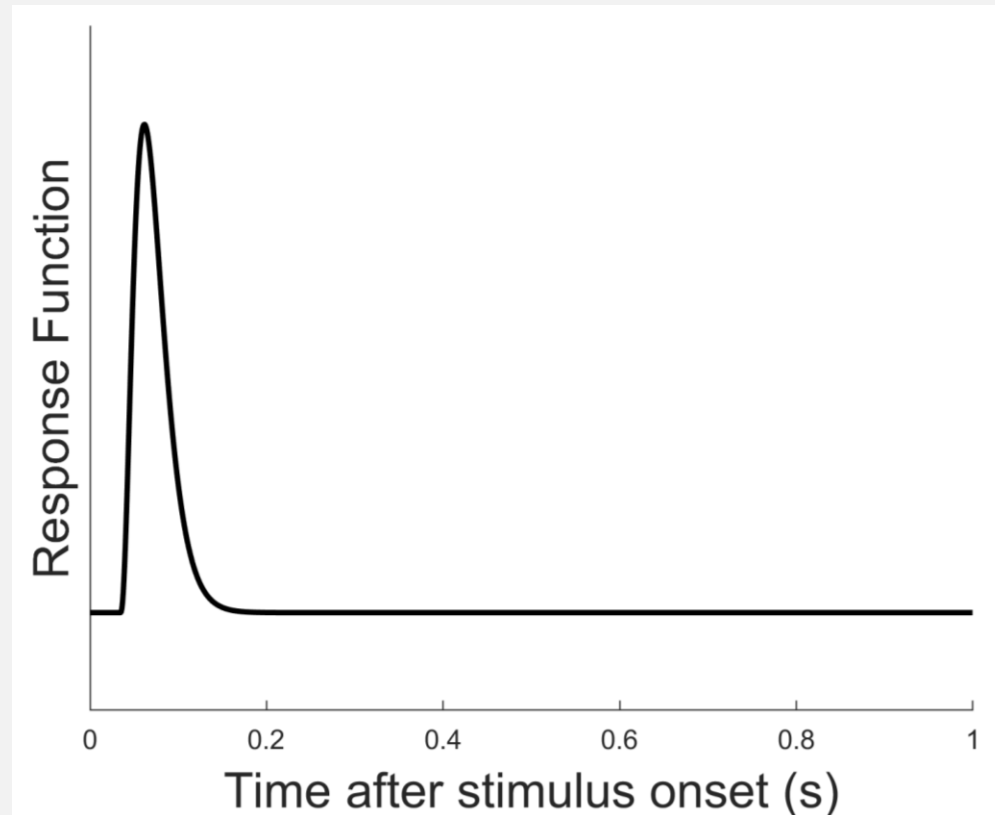
- Module List:** A list of modules including Import, Trim, Non-Linear Model, Pupil preprocessing, Find valid fixations, Pupil foreshortening error, Preprocess heart data, **Preprocess respiration data** (selected), Find startle sound onsets, Preprocess startle eyeblinks, GLM for SEBR, GLM for PS (fear-conditioning), GLM for HP (fear-conditioning), and GLM for RA (fear-conditioning).
- Current Module: Preprocess respiration data**
 - Help on: Preprocess respiration data
 - Data File: DEP Trim: Output File
 - Sample Rate: 10
 - Channel: . Default
 - Channel action: Add
 - Options
 - . System type
 - . . Cushion
 - . Data type
 - . . Respiration period: Yes
 - . . Respiration amplitude: Yes
 - . . Respiratory flow rate: Yes
 - . . Respiration time stamps: Yes
 - . Diagnostic plot: No
- Current Item: Data File**
 - Reference from: Trim: Output File
- Data File:** Specify data file. The processed respiration data will be written to a new channel in this file. In case data/model file(s) are chosen via the dependency button, make sure the number of output files of the preceding module corresponds with the allowed number of input files for this module.

Right Window: GLM for RA (fear-conditioning)

- Module List:** A list of modules including Import, Trim, Non-Linear Model, Pupil preprocessing, Find valid fixations, Pupil foreshortening error, Preprocess heart data, Preprocess respiration data, Find startle sound onsets, Preprocess startle eyeblinks, GLM for SEBR, GLM for PS (fear-conditioning), GLM for HP (fear-conditioning), and **GLM for RA (fear-conditioning)** (selected).
- Current Module: GLM for RA (fear-conditioning)**
 - Help on: GLM for RA (fear-conditioning)
 - Model Filename: mdl_rar_xxxx
 - Output Directory: <-X
 - RAR Channel: . Default
 - Time Units: . Markers
 - . . Marker Channel: 0
 - Data & Design
 - . Session
 - . . Data File: ...spiration data: Output File
 - . . Missing Epochs
 - . . . No Missing Epochs
 - . . Design: <-X
 - . . Nuisance File
 - Basis Function
 - . RARF_FC 0
 - Normalize: No
 - Filter Settings: . Default
 - Create information on missing data values
- Current Item: Model Filename**
 - mdl_rar_xxxx
- Model Filename:** Specify file name for the resulting model. A string is entered. The character array may have arbitrary size.

MODEL COMPARISON

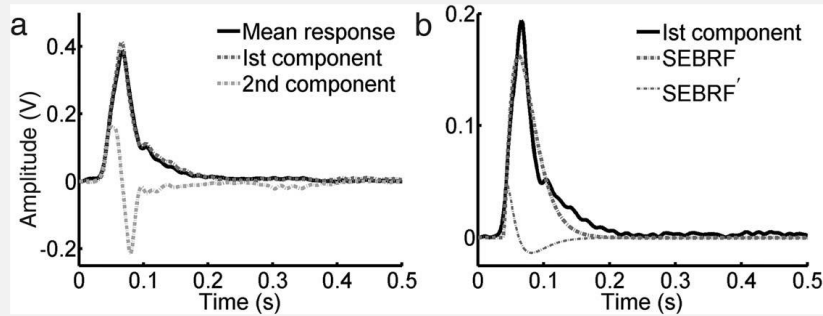
Fear Conditioning measures in PsPM – Fear-Potentiated Startle



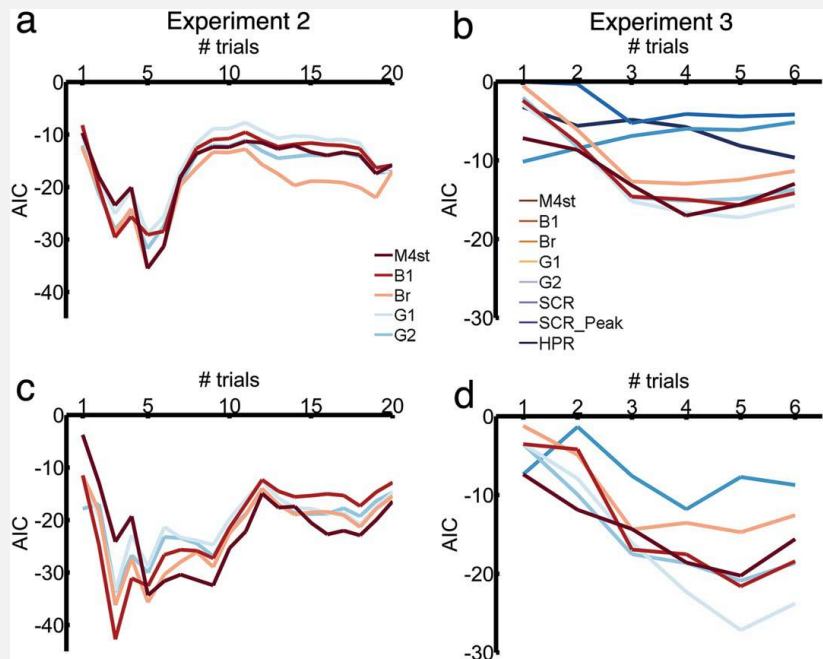
Conditioned stimuli (CS) + Startle probe
→ neural inputs → orbicularis oculi responses (SEBR)

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Potentiated Startle



- A gamma probability density function, with flexible latency, in a General linear model (GLM)
- Trial-by-trial
- Startle-probe-elicited
- Experiments with startle sounds
- 3-5 trials for fear memory retention assessment



MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Potentiated Startle

Table 3. Paired T Test for the Difference Between CS+/CS- for Different Methods

#	Model description	Experiment 2			Experiment 3			Experiment 4		
		<i>t</i> (19)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>
M4ST	Best model-based method	5.21	<.0001	1.17	3.09	<.05	0.80	3.12	<.01	0.81
B1	Barker et al. (2014)	4.51	<.001	1.01	3.10	<.05	0.80	3.23	<.01	0.96
Br	Bradford et al. (2014)	5.21	<.0001	1.17	2.69	<.05	0.69	3.72	<.005	0.96
G1	Grillon et al. (1991)	4.49	<.001	1.00	3.30	<.01	0.85	0.92	.37	0.24
G2	Balderston et al. (2015)	4.80	<.001	1.07	3.00	<.05	0.77	4.63	<.001	1.20

Table 4. Paired T Test for the Difference Between CS+/CS- for Normalized Estimates from Different Methods

#	Model description	Experiment 2			Experiment 3			Experiment 4		
		<i>t</i> (19)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>
M4ST	Best model based method	5.08	<.0001	1.14	3.67	<.01	0.95	3.70	<.005	0.96
B1	Barker et al. (2014)	4.88	<.001	1.09	3.84	<.01	0.99	4.12	<.005	1.06
Br	Bradford et al. (2014)	5.23	<.0001	1.17	2.98	<.05	0.77	3.68	<.005	0.95
G1	Grillon et al. (1991)	4.48	<.001	1.00	4.54	<.001	1.17	1.17	.26	0.30
G2	Balderston et al. (2015)	4.61	<.001	1.03	3.75	<.01	0.97	4.24	<.001	1.10

Exp 1: 19 participants;

no manipulation except acoustic startle probes

Exp 2: 20 participants;

Visual CSs; retention under extinction 7 days after acquisition

3.5 s SOA; 50% reinforcement

Exp 3: 30 participants;

Visual CSs; retention under extinction 1 day after acquisition

3.5 s SOA; 50% reinforcement

Exp 4: 14 participants;

Visual CSs; acquisition

3.5 s SOA; 50% reinforcement; startle probes in 25% of CS+US- and 25% of CS- trials

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Potentiated Startle

Table 3. Paired T Test for the Difference Between CS+/CS- for Different Methods

#	Model description	Experiment 2			Experiment 3			Experiment 4		
		<i>t</i> (19)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>
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Table 4. Paired T Test for the Difference Between CS+/CS- for Normalized Estimates from Different Methods

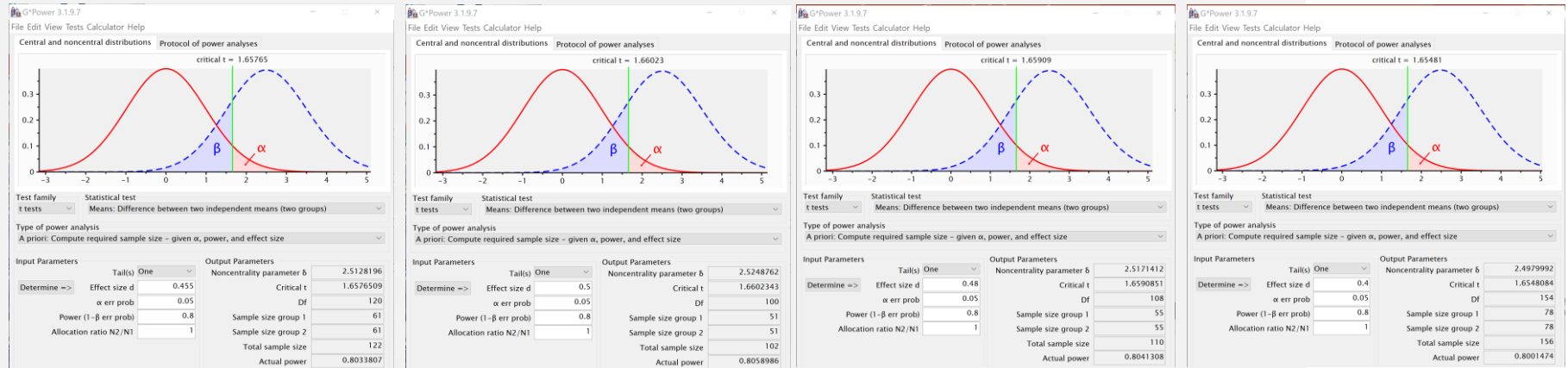
#	Model description	Experiment 2			Experiment 3			Experiment 4		
		<i>t</i> (19)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>	<i>t</i> (14)	<i>p</i>	Cohen's <i>d</i>
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Br	Bradford et al. (2014)	5.23	<.0001	1.17	2.98	<.05	0.77	3.68	<.005	0.95
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G2	Balderston et al. (2015)	4.61	<.001	1.03	3.75	<.01	0.97	4.24	<.001	1.10

Weighted average effect size (Cohen's *d*)

Peak Scoring G2 (non-normalized)	0.91
Peak Scoring G2 (normalized)	1.01
PsPM (normalized)	0.96
PsPM (non-normalized)	0.80

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Potentiated Startle



	Cohen's d	Sample size
Peak Scoring G2 (non-normalized)	0.91	122
Peak Scoring G2 (normalized)	1.01	102
PsPM (normalized)	0.96	110
PsPM (non-normalized)	0.80	156

MODEL COMPARISON

Fear Conditioning measures in PsPM – Fear-Potentiated Startle

Batch Editor
File Edit View PsPM BasicIO

Module List

Current Module: Find startle sound onsets

Help on: Find startle sound onsets

Data File DEP Trim: Output File

Channel

. Default

Threshold 0.1

Region of interest

. Whole file

Output

. Diagnostic

. . Diagnostic output

. . Text only

. . Create channel with specific sounds

. . Yes

. . . Channel action add

. . Marker channel

. . Default

. . Max delay 0.3

. . Min delay -0.2

. . Expected sound count 0

Find startle sound onsets

Translate continuous sound data into an event marker channel. The function adds a new marker channel to the given data file containing the sound data and returns the added channel number. The option threshold, passed in percent to the maximum amplitude of the sound data, allows to specify the minimum amplitude of a sound to be accepted as an event.

This branch contains 5 items:

- * Data File
- * Channel

Batch Editor
File Edit View PsPM BasicIO

Module List

Current Module: Preprocess startle eyeblink EMG

Help on: Preprocess startle eyeblink EMG

Data File ...expiration data: Output File

Options

. Channel

. First EMG channel

. Mains frequency 50

. Channel action Add

Preprocess startle eyeblink EMG

Preprocess startle eyeblink EMG data for further analysis. Noise in EMG data will be removed in three steps: Initially the data is filtered with a 4th order Butterworth filter with cutoff frequencies 50 Hz and 470 Hz. Then, Mains frequency will be removed using a notch filter at 50 Hz (can be changed). Finally, the data is smoothed and rectified using a 4th order Butterworth low-pass filter with a time constant of 3 ms (= cutoff at 53.05 Hz). The applied filter settings are according to the literature. While the input data must be an 'emg' channel, the output will be an 'emg_pp' channel which is the requirement for startle eyeblink GLM.

References:

Batch Editor
File Edit View PsPM BasicIO

Module List

Current Module: GLM for SEBR

Help on: GLM for SEBR

Model Filename mdl_sebr_xxxx

Output Directory ... projectPsPM_workshop

SEBR Channel

. Default

Time Units

. Seconds

Data & Design

. Session

. . Data File DEP Trim: Output File

. . Missing Epochs

. . No Missing Epochs

. . Design <-X

. . Nuisance File

Latency

. Free latency

. Time window 0.15

Basis Function

. Function

. SEBRF 0

Normalize Nn

Current Item: Model Filename

mdl_sebr_xxxx

Specify...

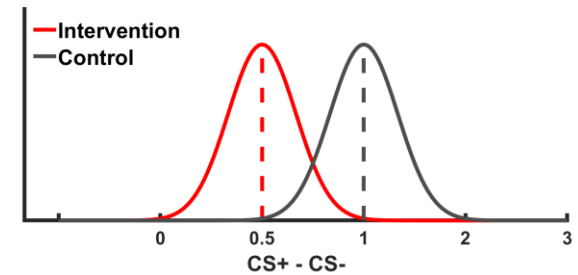
Dependency

Model Filename

Specify file name for the resulting model. A string is entered. The character array may have arbitrary size.

MODEL COMPARISON

Fear Conditioning measures in PsPM – Summary



Measure	Cohen's d	Sample size
SCR peak scoring	0.44	514
SCR model-based	0.75	174
HPR model-based	0.97	108
RAR model-based	0.65	236
PSR peak scoring	0.60	278
PSR model-based	0.82	150
Peak Scoring G2 (non-normalized)	0.91	122
Peak Scoring G2 (normalized)	1.01	102
SEBR model-based (normalized)	0.96	110
SEBR model-based (non-normalized)	0.80	156

CONTENTS

- **Comparison of Models in PsPM**
 - Skin Conductance Response
 - Pupil Size Response
 - Fear-Conditioned Bradycardia
 - Respiration Amplitude Responses
 - Fear-Potentiated Startle

- **New Methods**
 - Pavlovian-to-Instrumental Transfer
 - Scanpath Length / Speed

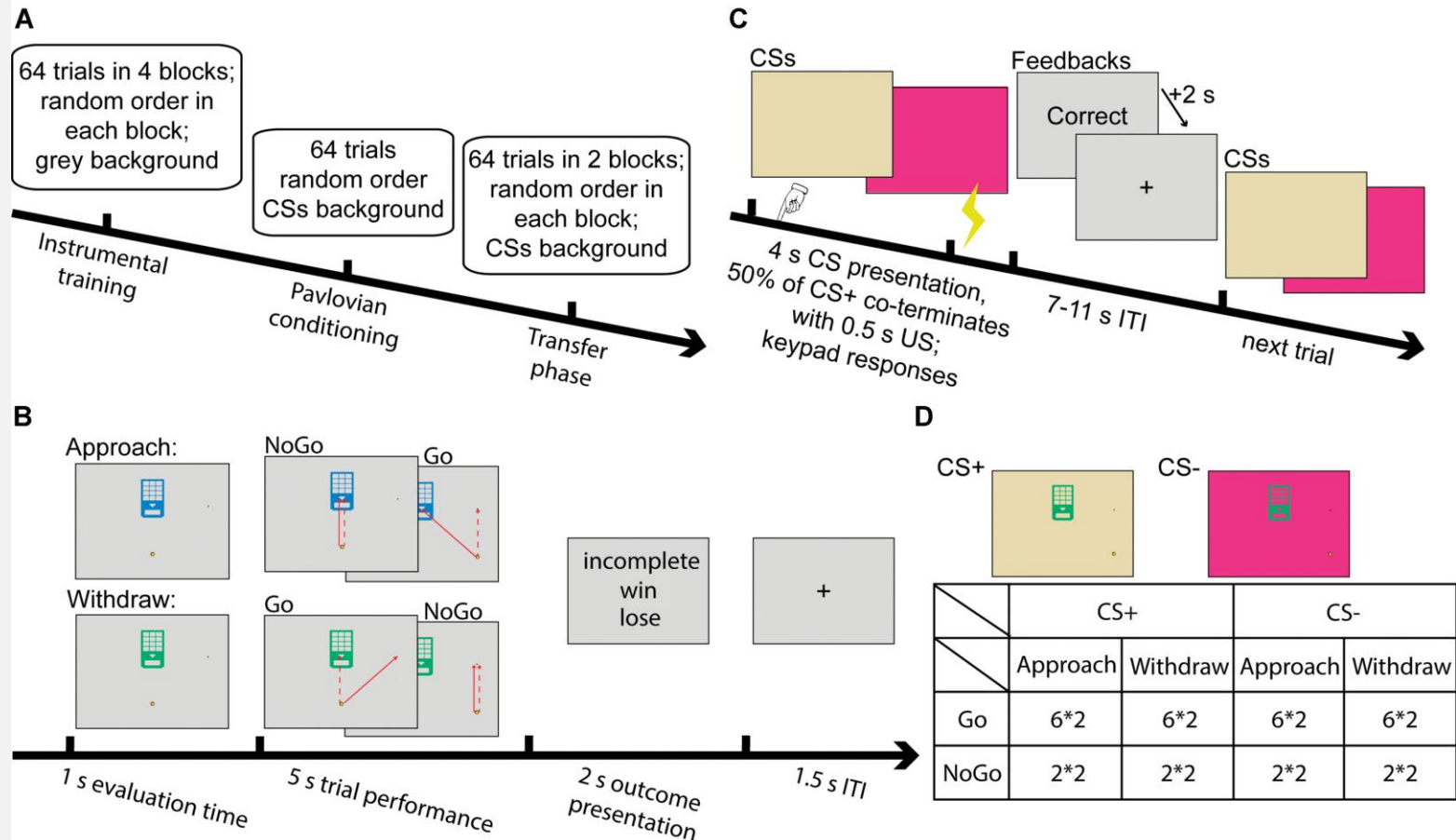
NEW METHODS

Pavlovian-to-Instrumental Transfer (PIT)

Instrumental Behaviors	Pavlovian State			
	Appetitive US		Aversive US	
	Excitor (CS+)	Inhibitor (CS-)	Excitor (CS+)	Inhibitor (CS-)
Approach	↑	↓	↓	↑
Avoidance	↓	↑	↑	↓

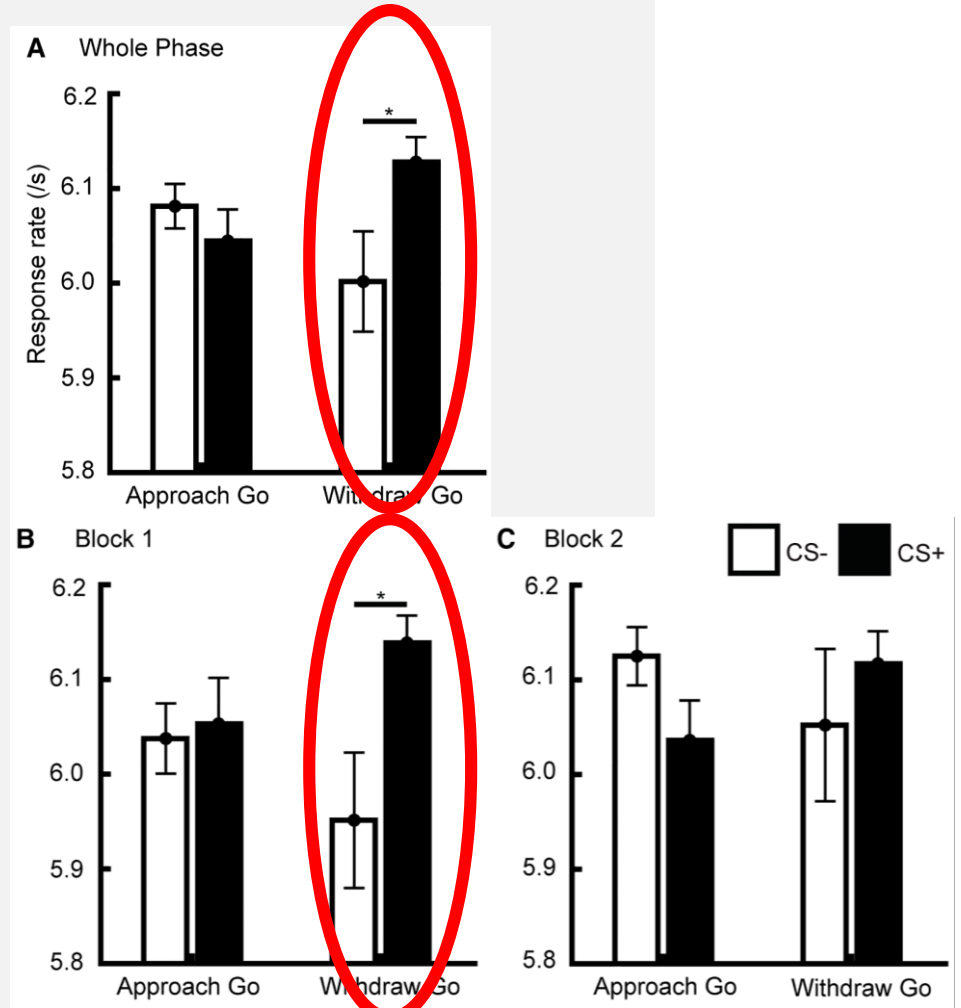
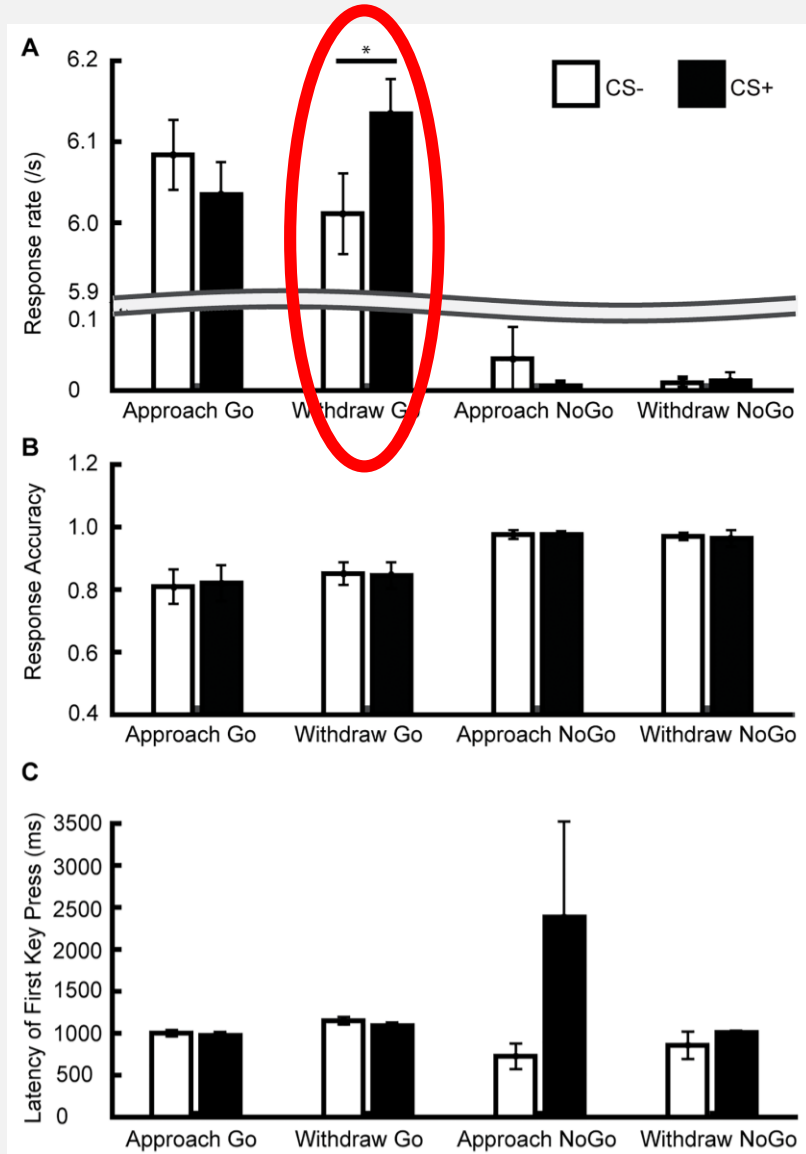
NEW METHODS

Pavlovian-to-Instrumental Transfer (PIT)



NEW METHODS

Pavlovian-to-Instrumental Transfer (PIT)



NEW METHODS

Pavlovian-to-Instrumental Transfer (PIT)

Model	Model Description	df	LBF	t	p	d
PIT #1	Response Rate in Withdraw Go trials *	34	reference	2.37	.024	.40
PIT #2	Response Rate in Withdraw Go trials in block 1	34	-0.62	2.51	.017	.42
PsPM #1	Heart Period	34	-11.67	4.61	< .001	.78
PsPM #2	Skin Conductance Responses	34	-8.05	3.98	< .001	.67
PsPM #3	Pupil Size	34	-3.17	3.06	.004	.52

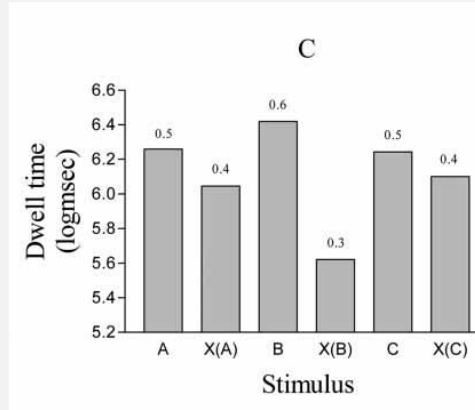
Weak points:

- Effect size
- Complicated process

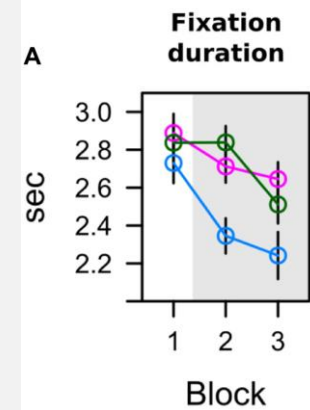
NEW METHODS

Scanpath Length ($^{\circ}$, SPL)

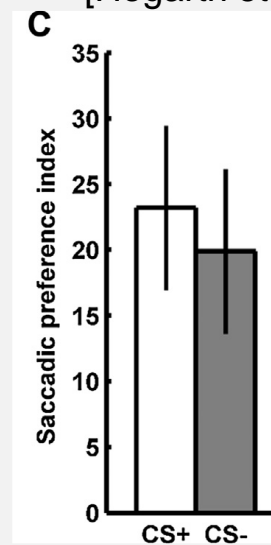
- Attention
 - priority to fear-related cues
 - contribute to survival
 - inconsistency of selective attention to CS+ compared to CS-
 - fixation
 - saccades



[Hogarth et al. 2008]



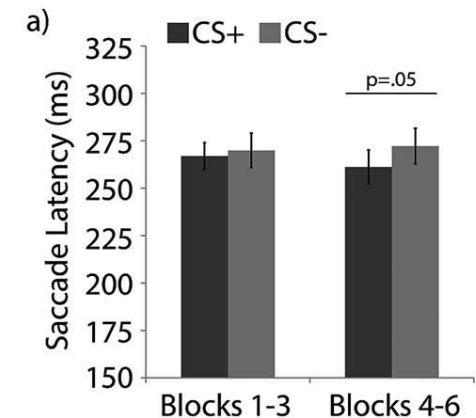
[Koenig et al. 2017]



[Madipakkam et al. 2016]

EXPERIMENT 2

Training Phase



[Hopkins et al. 2016]

NEW METHODS

Scanpath Length ($^{\circ}$, SPL)

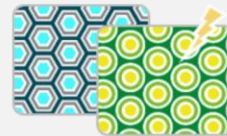
Exploratory
Exp 1



Confirmatory
Exp 2



Generalisability
Exp 3



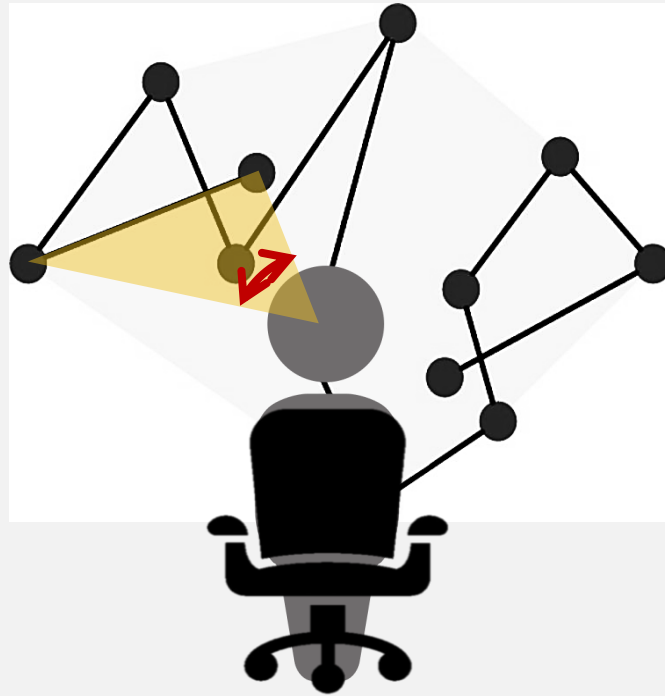
Generalisability
Exp 4



Experiment (Data set code)	CS	SOA	ITI	Fixation cross	Sample Size
Exploratory Exp 1 (PIT1)	visual	3.0	2.5 s	only in ITI	21
Confirmatory Exp 2 (PIT2)	visual	3.5	7-11 s	only in ITI	35
Generalisability Exp 3 (ViS)	visual	3.5	7-11 s	only in ITI	26 (25 for SCR)
Generalisability Exp 4 (PubFe)	auditory	3.5	7, 9, 11 s	always	22

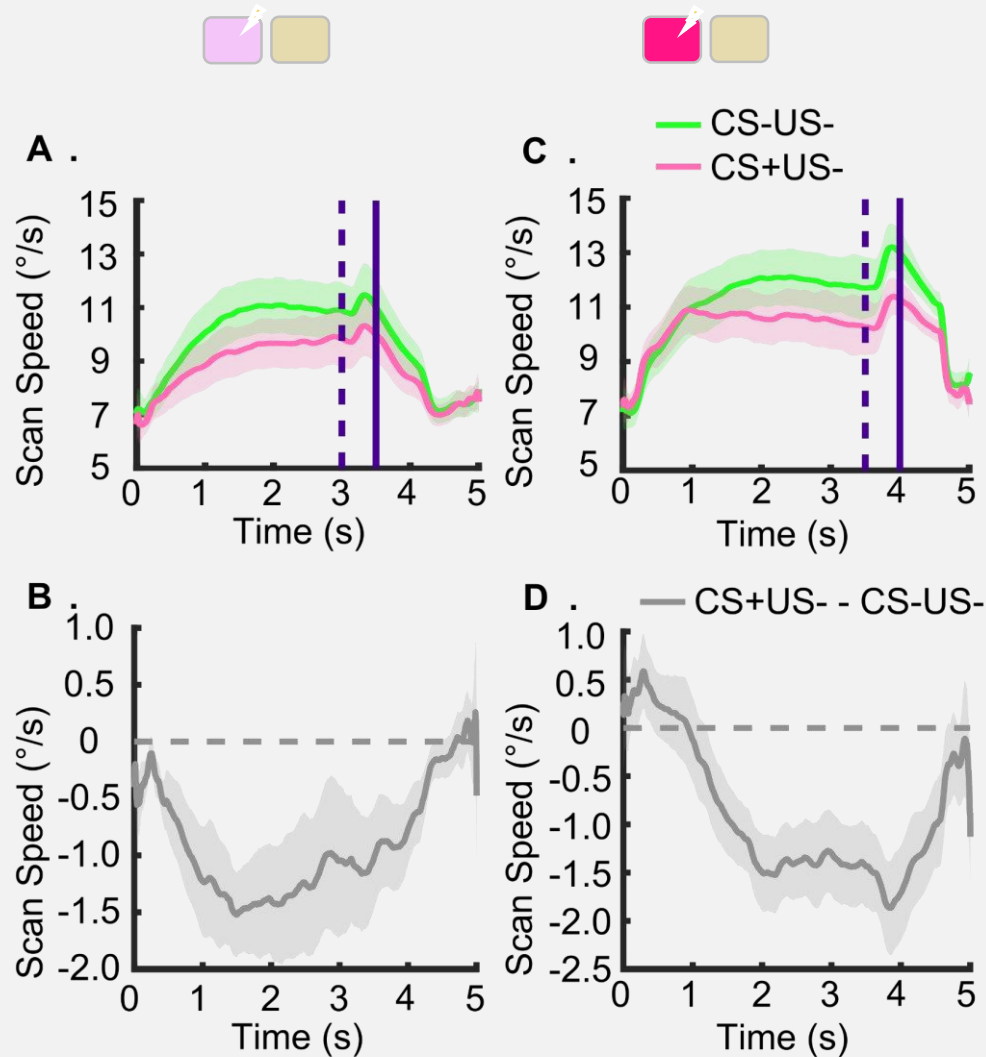
NEW METHODS

Scanpath Length (°, SPL)







NEW METHODS

Scanpath Length ($^{\circ}$, SPL)



NEW METHODS

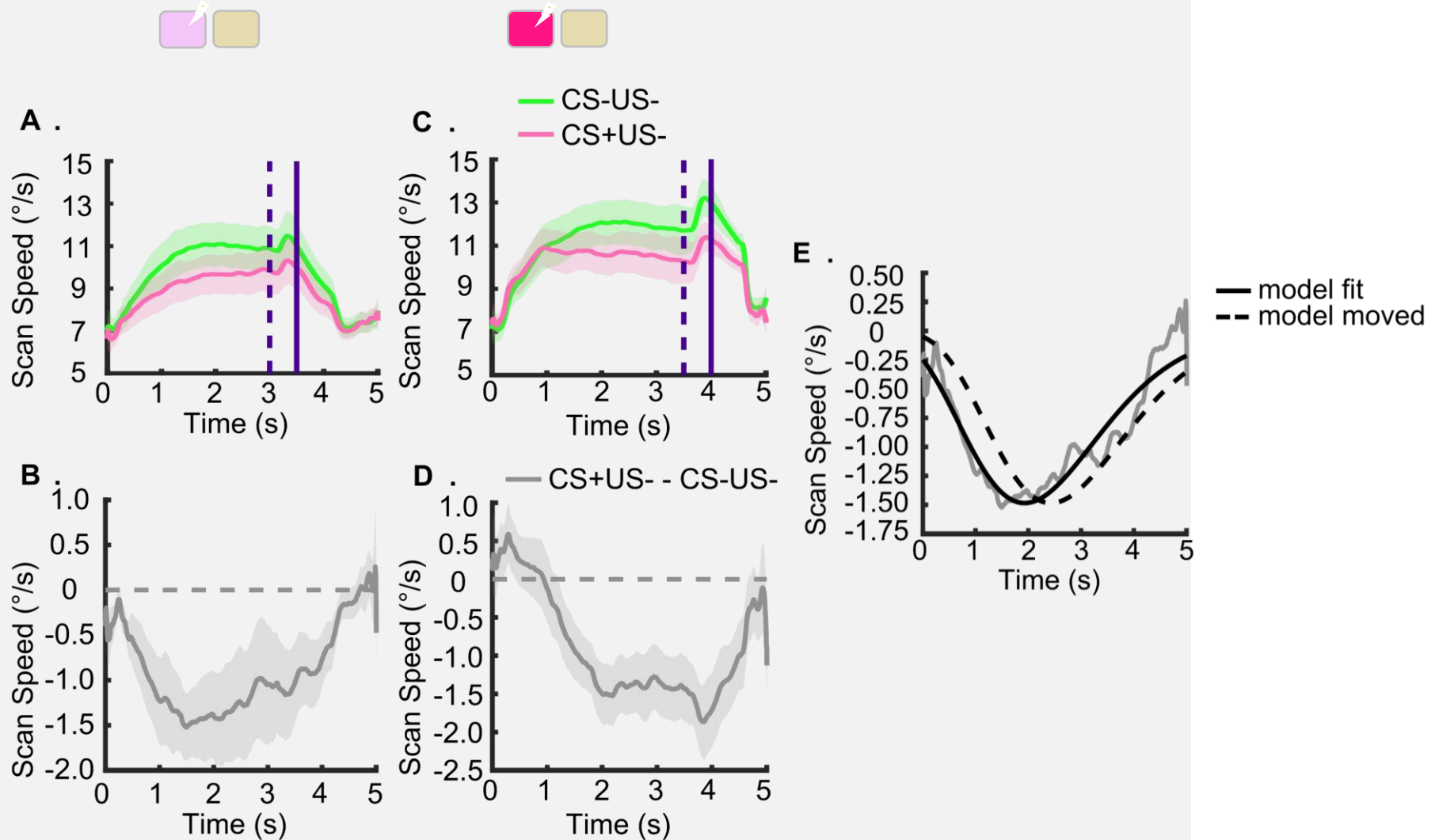
Scanpath Length ($^{\circ}$, SPL)

				Exploratory Exp 1					
		3.0 s	2.5 s	2.0 s	1.5 s	1.0 s	0.5 s	GLM	
df		20	20	20	20	20	20	20	
LBF		0.00	0.18	-0.17	2.32	3.81	5.71	-0.48	
 g 		0.63	0.62	0.63	0.51	0.43	0.30	0.65	
				Confirmatory Exp 2					
		3.5 s	3.0 s	2.5 s	2.0 s	1.5 s	1.0 s	0.5 s	GLM
df		34	34	34	34	34	34	34	34
LBF		0.00	-1.53	-4.85	-6.69	-4.86	-0.91	1.42	-5.27
 g 		0.47	0.52	0.62	0.68	0.62	0.50	0.41	0.63

* Each time window is defined as time period before US onset

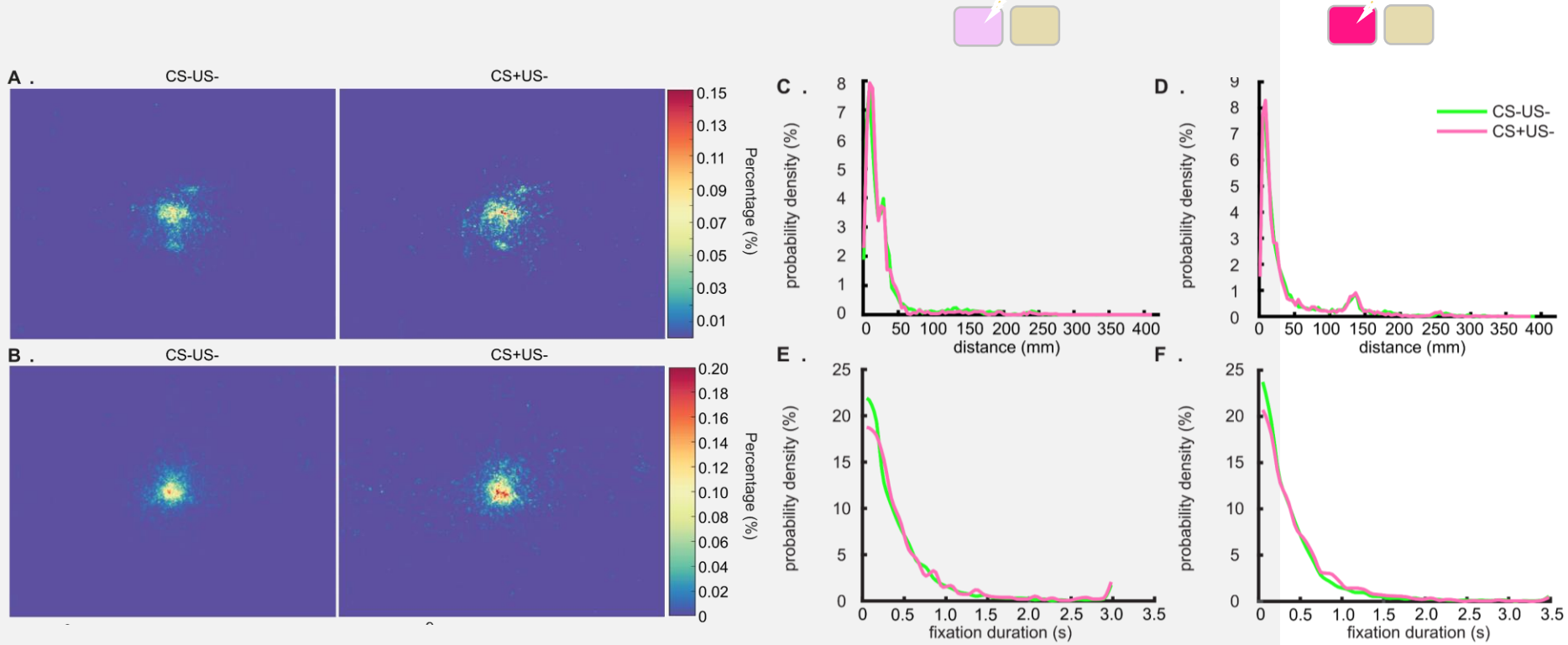
NEW METHODS

Scanpath Length ($^{\circ}$, SPL)



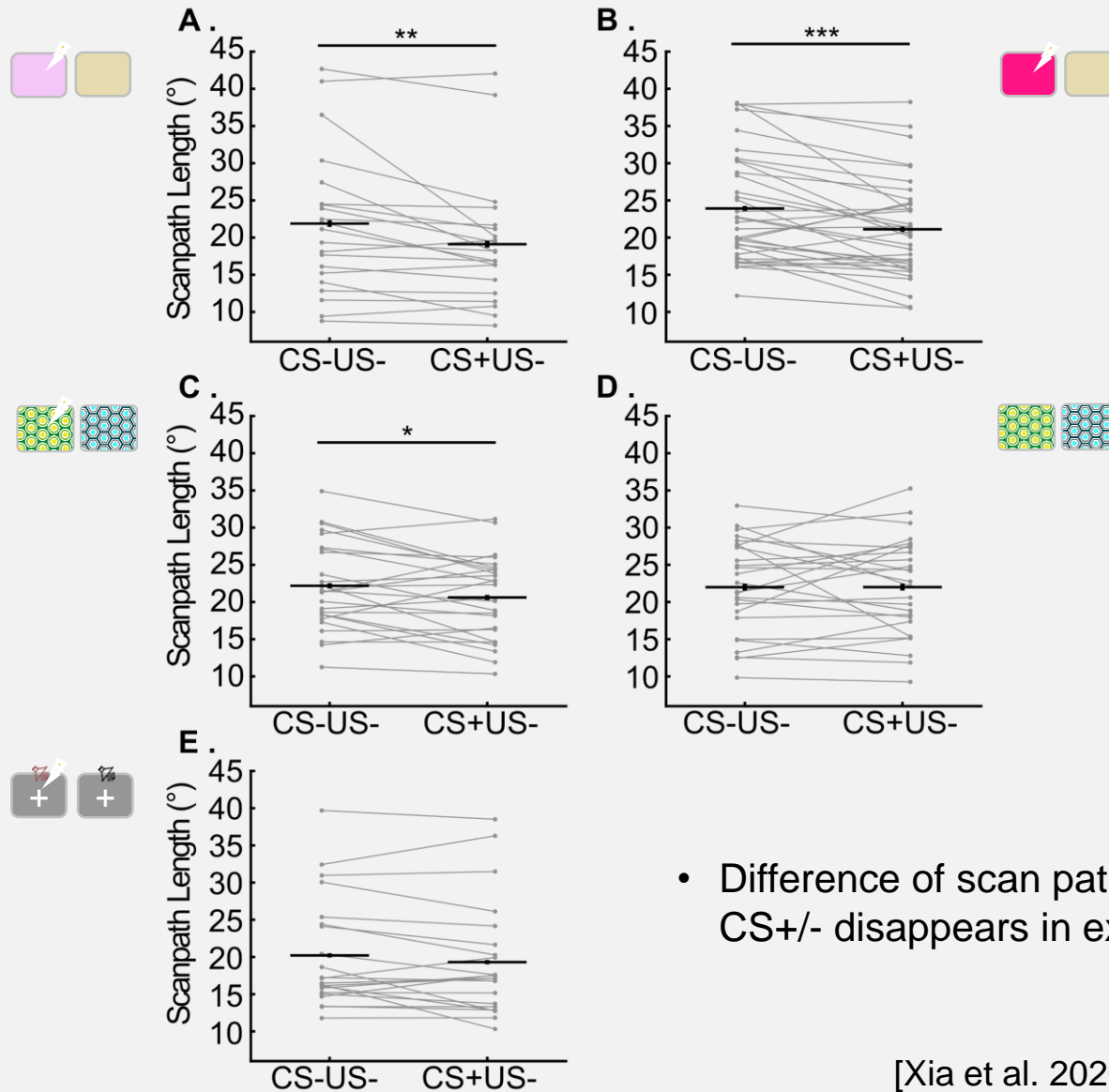
NEW METHODS

Scanpath Length ($^{\circ}$, SPL)



NEW METHODS

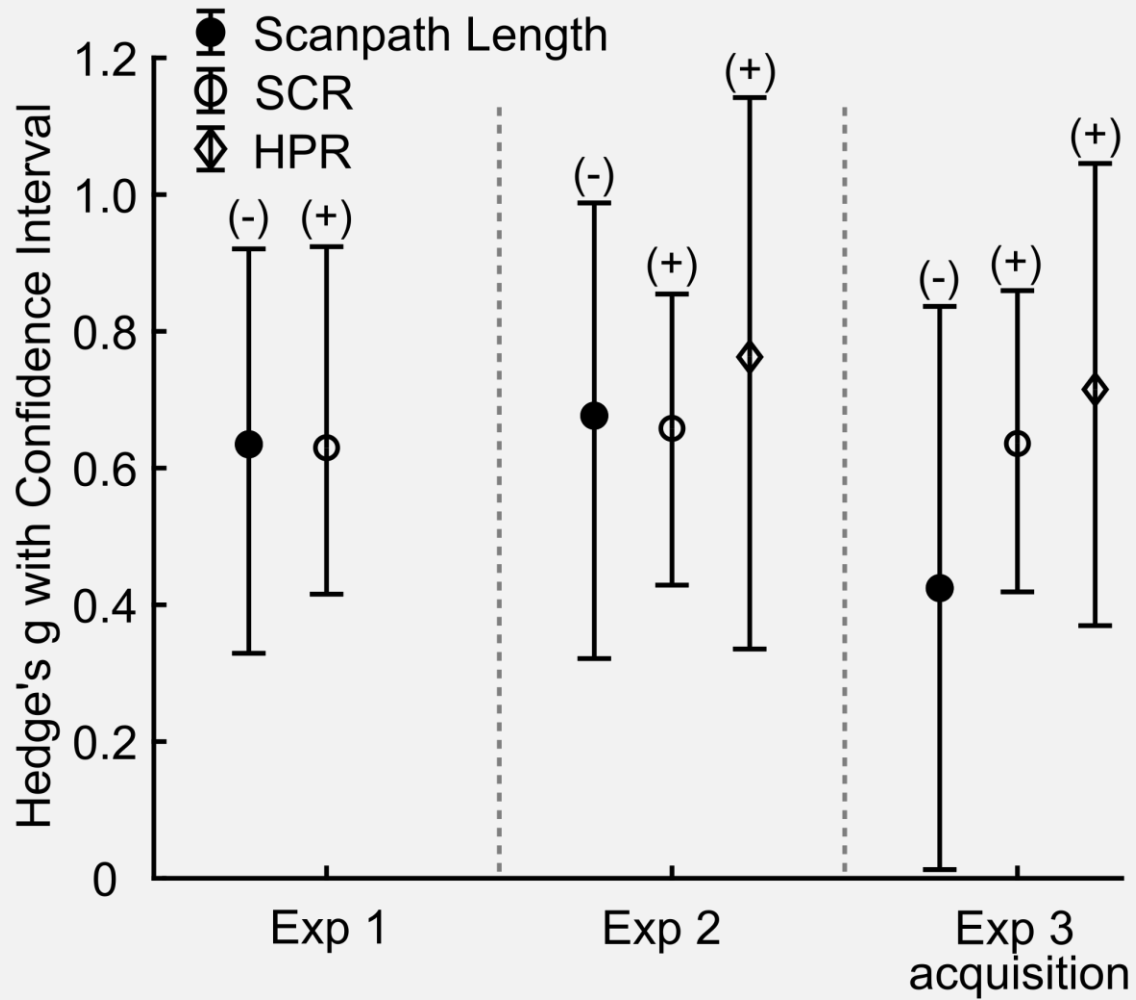
Scanpath Length ($^{\circ}$, SPL)



- Difference of scan path length between CS+/- disappears in extinction phase

NEW METHODS

Scanpath Length ($^{\circ}$, SPL)



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Universitätsklinik Zürich

THANK YOU!

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14.05.2020

