ECG-EEG-Based BCI Experiment Structure

Block Structure

- Number of blocks and trials per block are set by operator
- Each trial results in one of three feedback types:
  - **Win**: Green positive feedback (+$)
  - **Loss**: Red negative feedback (-$)
  - **Neutral**: Blue neutral feedback (=$) - No response/timeout

Reward Probabilities

- **Good Symbol**: 70% win probability
- **Bad Symbol**: 30% win probability

Reversal Sequence (Within Each Block)

- **First Half Trials**: Symbol A is good (70% win), Symbol B is bad (30% win)
- **Second Half Trails**: Symbol B is good (70% win), Symbol A is bad (30% win)

Cardiac Windows

- **Systolic Window**: 0-300ms post R-peak
- **Diastolic Window**: 300-700ms post R-peak
- Timing grid resolution: **10ms steps**

Cardiac Phases Determination

- Waits for **TWO R-peaks** after choice
- Uses **second R-peak** as timing reference
- Feedback timing synchronized to the cardiac cycle:
  - **Systole**: 0-300ms post **second** R-peak
  - **Diastole**: 300-700ms post **second** R-peak

Outcome Timing Conditions (Within Each Block)

1. **First Third**: Systolic timing only
2. **Second Third**: Diastolic timing only
3. **Final Third**: Mixed timing (random systole/diastole)

Single Trial Structure

Time	Display	Action/Event	Duration
0.0s	Choice Phase	Two symbols presented	1.25s (max)
		(location randomized)	
		Left/Right arrow response	
~1.5s	[variable]	Cardiac-based delay	1.5-2.0s
~3.5s	Feedback	Outcome Display	4.0s
	WIN/LOSS/NEUTRAL		
~7.5s	Fixation	Inter-trial Interval	2.0-3.0s

Learning Features

- Reward probabilities fixed at **70% (good)** vs **30% (bad)**
- Symbol positions (**left/right**) randomized each trial
- Reversals occur at block midpoint
- Cardiac timing transitions through three phases per block

Participants must:

1. Learn which symbol is currently **good**
2. Detect and adapt to **probability reversals**

Data Collection

- Continuous recording of:
  - Response times
  - Choices
  - Cardiac timing
  - R-peak timestamps
  - Feedback timing
  - Trial outcomes
- **LSL markers** sent for:
  - Task events
  - Responses
  - Feedback
  - Block structure
  - Cardiac timing