

Supplementary materials

As outlined in the manuscript, our first-year undergraduate course included 4 EMOTIV-based labs: A Primer Lab, Vision Lab, Motor Lab, and a Cognition Lab. The latter three 'experimental' labs adhered to a similar structure. Here we describe one of these – the Motor Lab – in detail including lesson plans for the Testing and Analysis sessions and associated activity sheets.

Overview:

Topic: Exploring the organization of the motor system using lateralized readiness potentials (LRPs)

Duration: 1-hour Testing Session and 1-hour Analysis Session

Key neuroscience concept: Basic organization of the motor cortex

Brief background: The primary motor cortex has a contralateral and somatotopic organization. EEG and ERPs can be used to non-invasively explore this organization by measuring activity in the motor cortex when participants are required to make a motor response. Specifically, an ERP reflecting motor preparation is observed prior to movement onset, called the readiness potential, and a portion of this component is lateralized (i.e., specific to the contralateral limb)

Lesson plan: testing session

1. Review relevant background from textbook and lectures including:
 - Basic neuroanatomy of the primary motor cortex and premotor areas
 - Contralateral organization of the primary motor cortex
 - Contralateral organization of the primary motor cortex
2. Introduce ERP component of interest
 - Basic information on the lateralized readiness potential (LRP)
 - Calculating the difference waveform to visualise and isolate the LRP
 - Using a polarity flip in the LRP to assess somatotopic organization
 - LRP preceding foot movements is opposite in polarity to that preceding hand movements (Miller, 2012)
3. Introduce experiment
 - Goal: Replicate study of Miller (2012) using EMOTIV
 - Task: Respond to the central digit with the limb corresponding to that digit (see Figure 1)
 - Experiment design: Independent variable (left vs. right; hand vs. foot); dependent variables (mean LRP size and latency)
4. Run experiment

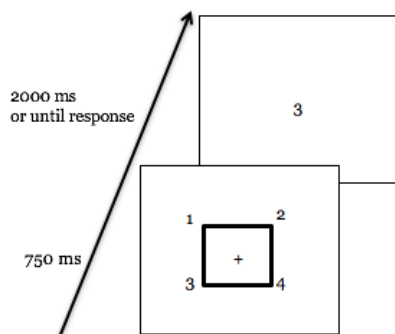


Figure 1. Experimental paradigm.

Lesson plan: analysis session

1. Brief review of the experiment and central findings
2. Overview of steps for running a replication study
3. How do we get from EEG to ERP?
 - Step-by-step guide to data processing steps using MATLAB EEGLAB, including artefact rejection and correction; filtering; epoching or time-locking data to trial events; and computing ERP waveforms.
 - Calculate LRPs using EMOTIV data including contralateral and ipsilateral waveforms (for both hand and foot responses); compute the difference waveforms (for both hand and foot responses); and compare results to Miller (2012).



Activity Sheet

THE MOTOR LAB (EXPERIMENT)

TESTING KIT (CIRCLE ONE)

Blue Green White Yellow Red

DATE & TIME

GROUP MEMBERS

1. _____
2. _____
3. _____
4. _____
5. _____

BEFORE THE EXPERIMENT

1. IS A GOOD CONNECTION ESTABLISHED FOR ALL ELECTRODES?

2. WHICH ELECTRODES ARE THE ONES OF INTEREST TO US IN TODAY'S LAB SESSION?

DURING THE EXPERIMENT

3. DESCRIBE THE TASK (E.G., WHAT IS PRESENTED ON THE SCREEN, WHAT IS THE PARTICIPANT ASKED TO DO?)

4. HOW DID THE PARTICIPANT MAKE THEIR RESPONSES?

AFTER THE EXPERIMENT

5. WHAT ARE WE EXPECTING TO SEE IN THE DATA NEXT WEEK? (E.G., WHERE DO WE EXPECT THE AMPLITUDE TO BE THE LARGEST, WHAT DO WE EXPECT TO SEE WHEN WE COMPARE HAND AND FEET RESPONSES?)

6. HOW DO WE CALCULATE THE LRP?

REPORT ON ANY EVENTS THAT COULD AFFECT THE QUALITY OF THE DATA WE JUST RECORDED AND/OR QUESTIONS THAT CAME UP



Activity Sheet

THE MOTOR LAB (ANALYSIS)

TESTING KIT (CIRCLE ONE)

Blue Green White Yellow Red

DATE & TIME

GROUP MEMBERS

1. _____
2. _____
3. _____
4. _____
5. _____

CALCULATING THE LRP

1. WHAT DOES CONTRALATERAL AND IPSILATERAL MEAN?

2. WHAT DOES THE CONTRALATERAL WAVEFORM REFLECT? EXPLAIN WHICH ELECTRODE IS SELECTED FOR WHICH HAND.

OUR LRP WAVEFORMS

3. WHAT DO WE EXPECT TO SEE IN THE DATA WHEN COMPARING THE LRP FOR HAND AND FOOT RESPONSES?

4. WHAT DO WE SEE IN OUR DATA WHEN COMPARING THE LRP FOR HAND AND FOOT RESPONSES?

5. DISCUSS THE STRENGTHS AND LIMITATIONS OF OUR STUDY. SOME THINGS YOU COULD THINK ABOUT: WHAT DID WE HAVE TO DO DURING THE TASK? WHICH RESPONSES DID WE RECORD? WHICH ELECTRODES DID WE FOCUS ON? HOW DIFFICULT WAS THE TASK?