Study of Human Olfaction Using fMRI

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Overview

Objectives

The Main Objective: a study of human olfaction and olfactory dysfunction detection (judical use)

Side Objectives:

1. decoding *surprise* in an olfactory oddball task
2. studying the effect of *stimulus length* on brain signals

Above methods are used to classify normal and dysfunctional olfaction

Literature Review - Stimulus Duration

1. **Activation and Habituation in Olfaction**
   Poellinger et al. (2001), NeuroImage.
   - a study of olfactory stimulus duration effect on human BOLD response

2. **Olfactory fMRI: Implications of Stimulation Length and Repetition Time**
   Georgiopoulos et al. (2018), Chemical Senses.
   - Two stimulation lengths and two repititon times.
   - plotting the event related time course of brain activation in the four olfactory regions of interest.

Literature Review - Oddball Paradigm

3. **Neural Correlates of Olfactory Change Detection**
   Merav Sabri et al. (2004), NeuroImage.
   - a study of both passive and active detection of olfactory change
   - fMRI and the common oddball paradigm
4. **Detection of Olfactory Dysfunction Using Olfactory Event Related Potentials in Young Patients with Multiple Sclerosis**
   Fabrizia Caminiti et al. (2014), PLOS ONE.
   - detection of olfactory dysfunction
   - Olfactory Event Related Potentials (OERP signals) used (no fMRI)

Literature Review - Olfactometer

5. **A Computer-Controlled Olfactometer for fMRI and Electrophysiological Studies of Olfaction**
   Tyler S.Lorig et al. (1999), Behavior Research Methods, Instruments, & Computers.
   - design for an inexpensive and reliable olfactometer
   - computer-controlled odor administration
   - no ferrous material near the subject (for fMRI use)
6. **Methods for Building an Inexpensive Computer-Controlled Olfactometer for Temporary-Precise Experiments**
   Johan N. Lundström et al. (2010), International Journal of Psychophysiology.
   - a complete guide for building an olfactometer suitable for behavioral experiments

Significance and Application of Olfaction Study

1. Diagnosis of Olfactory Dysfunction
   - Judical use of malingering Detection
   - Early Diagnosis of Various Disorders

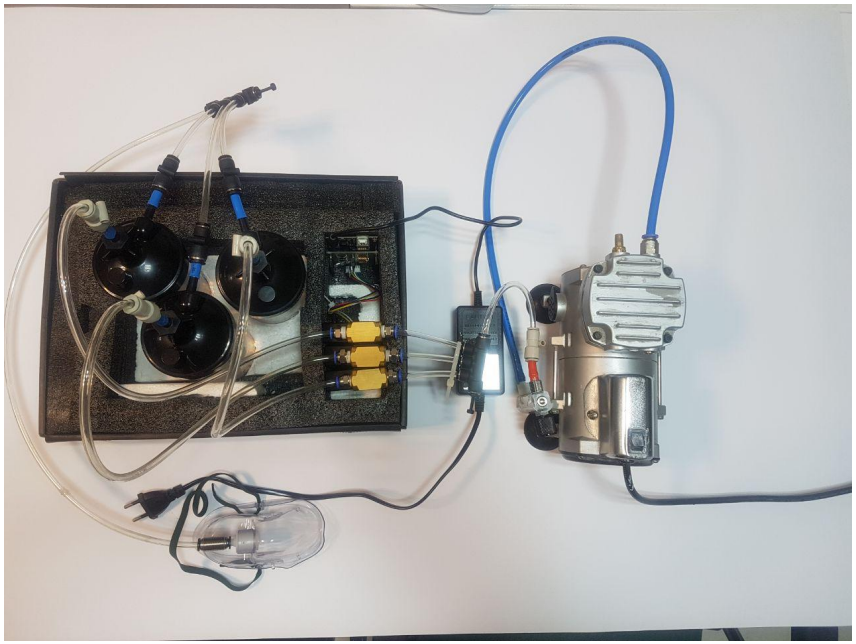
2. Getting to know how the brain functions to perceive olfactory stimuli (Olfaction is the least understood sense among all senses)
   - Do common sensory tasks work the same for olfaction?
   - Olfactory oddball paradigm and surprise decoding

Methods for Stimulus Presentation

1. Presenting Odor via Vial
   - *advantages:* cheap and easy to conduct
   - *disadvantages:* low time resolution / can lead to subject's bias toward stimuli
2. Olfactometer
   - *advantages:* computer-controlled / high time resolution
   - *disadvantages:* expensive to buy / demanding technical ability to build

Stimulus Presentation - Olfactomerter

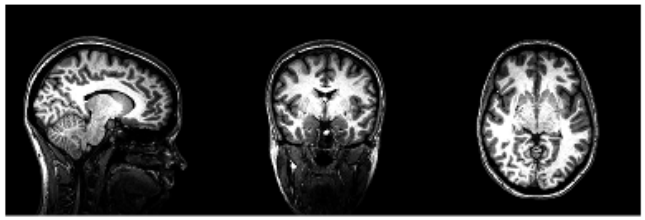
- An inexpensive but efficient olfactometer
- Completely designed and built by our researchers
- Computer-controlled stimulus time and sequence pattern
- presenting up to three different odors
- using oil-free air compressor due to health concerns



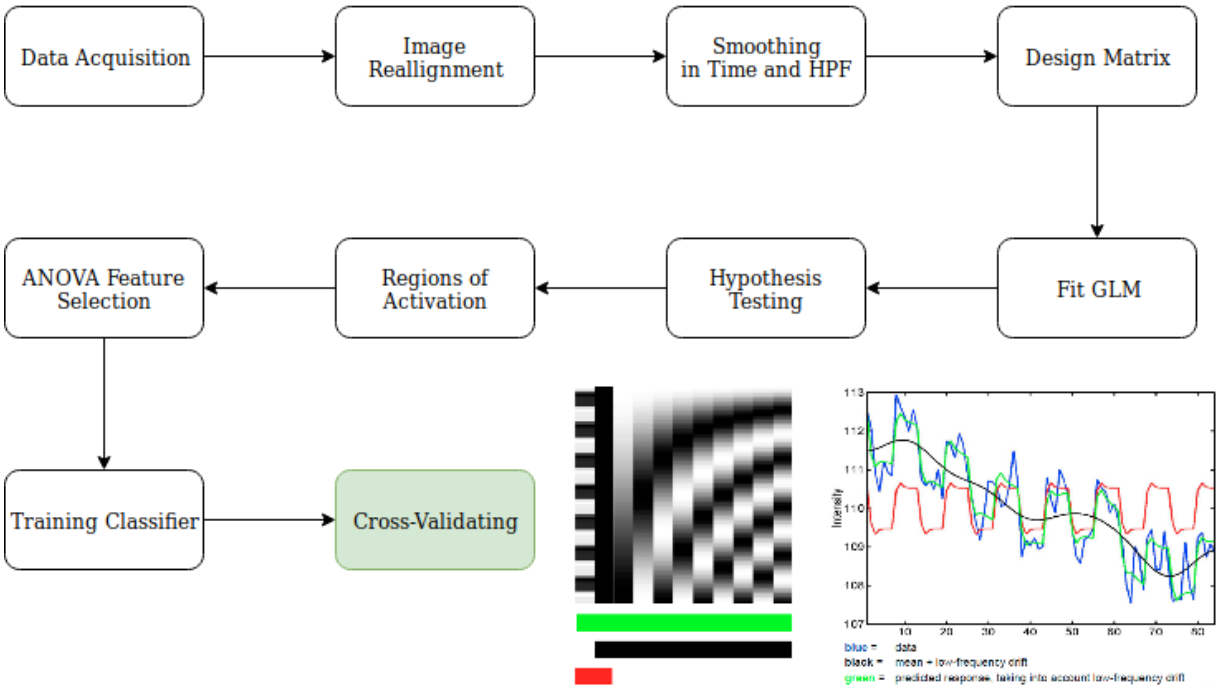
Experimental Protocols

1. Task 1: The Oddball Paradigm
   - two odors and one no-odor control (for resting)
   - one rare and one frequent stimuli
   - rest time: 6s / stimulus time: 4s
   - number of stimuli per trial: 40 / number of trials: 10
   - synchronized respiration (using an auditory or visual stimulus)
2. Task 2: Variable-Length Stimuli
   - one odor, different durations, and one no-odor control (for resting)
   - rest time: 10s / stimulus time: from 5s to 1min
   - number of stimuli per trial: 10 / number of trials: 10
   - synchronized respiration (using an auditory or visual stimulus)

fMRI Data Analysis with SPM



$$y = X * \beta + \varepsilon$$



Stages of Data Analysis

Project Roadmap

1. Developing a setup for presenting olfactory stimulus *(ALREADY DONE)*
2. finding subjects with olfaction dysfunction
3. fMRI data acquisition
4. data analysis and conclusion (*Estimated Time: 4 months*)