

Study of Human Olfaction Using fMRI

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Overview

- 1 Introduction
- 2 Literature Review
- 3 Applications
- 4 Materials and Methods
- 5 Roadmap

Objectives

The Main Objective: A study of human olfaction and olfactory dysfunction detection (judicial 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 repetition 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), Neurolmage.

- 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
 - Judicial 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

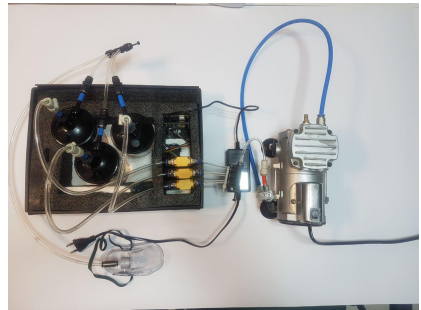
- *Advantages:* cheap and easy to conduct
- *Disadvantages:* low time resolution / can lead to subject's bias toward stimuli

② Olfactometer

- *Advantages:* computer-controlled / high time resolution
- *Disadvantages:* expensive to buy / demanding technical ability to build

Stimulus Presentation - Olfactometer

- 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

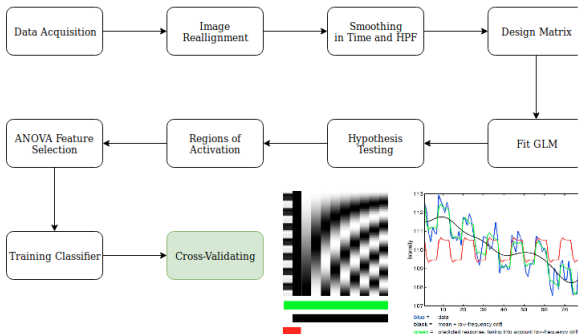
- one odor, different durations, and one no-odor control (for resting)
- rest time: 10s / stimulus time: from 5s to 1min
- number of stimuli per trial: 10 / number of trials: 10
- synchronized respiration (using an auditory or visual stimulus)

fMRI Data Analysis with SPM



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

y : vector of observed data
 X : design matrix
 β : vector of parameters to be estimated
 ϵ : error term



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*)