Programmi ed obiettivi

# Perception and Action

## Introduzione

We explore the surrounding world with our senses: vision, audition, touch, temperature, odor, and smell. Each of the senses can be further broken down. We plan to investigate ***basic properties of vision*** (p. 1), such as the perception of contrast, motion, shape, color and space. Similarly we want to investigate ***basic properties of touch*** (p. 2) (frequency, intensity, and localization) and ***basic properties of audition*** (p. 2) (frequency, intensity, complexity, and localization) as well as synergetic effects of ***multisensory perception***.

Our environment is full of stimuli that we process in order to understand the world and act in it. Two fundamental cognitive operations we plan to investigate are ***individuation and identification*** (p. 2). An important related mechanism we are planning to investigate ***visual attention*** (p. 2), that is the process of selecting some information for further processing while ignoring other available information. An obvious mechanism to select visual information is moving the eyes to a location of interest, which allows visual processing of the fixated object at highest resolution. One research group will investigate the ***brain mechanisms of oculomotor control*** (p. 2),in particular how eye movements can be differentially driven by stimulus saliency and stimulus identity. However, moving the eyes means that the image moves on the retina, yet the world appears to us as stable. This will be investigated in a project on ***mechanisms of visual stability*** (p. 3). The available sensory evidence will lead to a representation of the observer and her surroundings and eventually the observer chooses one option or course of action from a set of alternatives, a process called ***perceptual decision making*** (p. 3). An important question to be addressed is whether decision making is represented in an abstract way or closely tied to the coding of actions. Representations of stimuli are used to perform ***mental operations*** such as rotations, or establishing of relations such as ‘in’, ‘on’, or ‘next to’, which we will investigate by means of decoding techniques.

Actions such as moving the eyes, the arms, the hands and fingers involve the translation of ***intentions to motor commands*** (p. 4). For humans observing other peoples’ actions is an important type of stimulus to guide our own behavior, which we address in our research of ***action understanding*** (p. 4). Furthermore, actions have consequences e.g. they can be rewarded or not. How reward changes not only response selection but actual perception will be investigated under the label of ***reward priming*** (p. 4).

Finally, we are interested in the interplay between perception, attention, action, and ***awareness***. How much can we perceive without being aware of it and does awareness change the way our brain manipulates representations?

## Basic properties of vision

Two Melcher projects

## Basic properties of touch

## Basic properties of audition

## Multisensory perception

## Individuation and identification

One Mazza project

## Visual attention

Two Schwarzbach projects

**Neural Mechanisms of Attention**: Natural scenes contain more information than the human visual system can efficiently process at once. Visual attention is the perceptual mechanism by which observers select important aspects of a scene for further cognitive processing. We have investigated the role of parietal cortex in shifts between spatial locations ([Yantis et al., 2002](#_ENREF_13)) and nonspatial shifts between object categories ([Serences, Schwarzbach, Courtney, Golay, & Yantis, 2004](#_ENREF_7)). Recently we tested three prominent models of attention in their relation to attentional modulation of motion processing in the human motion processing complex hMT+ ([Furlan & Schwarzbach, submitted](#_ENREF_4)). We found that attention leads to a baseline shift in hMT+ which can predict psychometric functions using signal detection models.

## Oculomotor control

The amount of visual information available to an observer at any given moment is enormous. Because people are unable to process all of the information at once, they are forced to select only a subset for further processing. Recently, we have shown that the manner in which information is selected depends on how much time an observer has spent encoding the visual scene ([van Zoest & Donk, 2005](#_ENREF_9), [2006](#_ENREF_10); [van Zoest, Donk, & Theeuwes, 2004](#_ENREF_11); [van Zoest, Hunt, & Kingstone, 2010](#_ENREF_12)). When observers respond quickly, salient stimuli are prioritized in processing regardless of their task-relevance. However, as time passes salience degrades and the representation changes. It becomes more sophisticated as other information, such as prior knowledge and observer goals, is integrated. These results suggest that the representation of visual information changes as a function of time.

Furthermore, it has been demonstrated that attentional and oculomotor processes are tightly integrated at the neuronal level ([Corbetta et al., 1998](#_ENREF_2)), and that attention leads to enhanced brain activity in retinotopic visual cortex ([Brefczynski & DeYoe, 1999](#_ENREF_1); [Datta & DeYoe, 2009](#_ENREF_3); [Yantis, et al., 2002](#_ENREF_13)). Both, the location of spatial attention and the location of targets for saccadic eye movements are topographically represented in parietal cortex ([Sereno, Pitzalis, & Martinez, 2001](#_ENREF_8)). However, it has yet to be demonstrated whether the anatomical overlap and similar organization of the attentional and oculomotor systems means that these systems are coding the same (location of overt and covert attention)

The goal of this project is to investigate how differences between salience-driven selection and identity-driven saccadic selection come about in the brain and to investigate the functional and anatomical overlap of covert and overt attention.

### Methods

Participants will be asked to search for a specific visual target and will measure saccadic eye movements to check whether participants selected the correct target or not. We predict that performance will depend on the salience of the target and the surrounding elements. We expect that timing of the saccadic response will covary with selection. MR responses will be separated on the basis of the selected location, that is, the salient location, the location of the target or the combination hereof.

* structural scans to precede functional run to allow for subsequent co-registration
* event-related design using echo-planar or gradient echo imaging
* DTI
* concurrent acquisition of eye movement data
* visual stimulation

### Il gruppo di ricerca

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### Partecipanti

160 volontari. Criteri di inclusione: Volontari sani di età compresa tra 18 e 60 anni.

I criteri di esclusione dei volontari sani are described in chapter 2, section ‘Esperimenti fMRI’) .

### Risultati attesi

The majority of MR research in visual selection concerns covert selection, that is, attentional selection without movement of the eyes. This proposal concerns overt selection, where eye movements are the primary dependent variable. The proposed work will provide a direct insight in the type of control that influenced saccadic behavior and the underlying brain areas that serve this selection processes. These studies would address by decoding techniques to which degree the oculomotor and attentional systems code for the same, and to which degree brain-areas involved in non-spatial attention are separated from the oculomotor system.

## Visual stability and memory

Four Melcher projects

## Perceptual decision making

Two Schwarzbach projects

This project aims at investigating whether response priming is implemented in the motor structures involved in the response affordances of the particular task (primary and supplementary motor cortices for manual responses vs. frontal, suppl., and parietal eye fields for oculomotor responses) or whether response priming is achieved by a general amodal decision module as it has been suggested to exist for perceptual decision making ([Heekeren, Marrett, Bandettini, & Ungerleider, 2004](#_ENREF_5); [Heekeren, Marrett, Ruff, Bandettini, & Ungerleider, 2006](#_ENREF_6)). To this aim we will investigate the role of the input modality (vision, audition, touch), the response modality (vocal, oculomotor, manual responses) and the role of responding itself (overt responses vs. task-shifts).

## Mental operations

Two projects Tse/Schwarzbach

## From intentions to motor commands

Two Cattaneo projects

Lingnau?

One Konkle project

## action understanding

One big Cattaneo project

Lingnau?

## Reward priming

Two Hickey projects

## Awareness

One Melcher project

One Schwarzbach project

# Concepts

# Language

# Social neuroscience and thinking

# Learning and plasticity

# Affective Neuroscience

# I criteri di reclutamento/esclusione dei volontari sani e dei pazienti

## Esperimenti fMRI

Criteri di esclusione:

* Età inferiore o superiore a quella dichiarata nei criteri di inclusione
* Incapacità di fornire un consenso informato
* Portatori di pacemaker cardiaci, stimolatori nervosi, impianti cocleari, cristallino artificiale
* Presenza di altro materiale ferromagnetico (protesi, punti meccanici di sutura, schegge e frammenti metallici per esiti di interventi chirurgici o traumi, IUD)
* Anemia falciforme
* Claustrofobia
* Stato di gravidanza
* Marcate alterazioni della termoregolazione riferite all’anamnesi
* Terapia farmacologica in corso
* Presenza di patologie neurologiche
* Patologie neurologiche ereditarie o familiari all’anamnesi
* Incapacità di eseguire i compiti richiesti dalla procedura sperimentale

In particolare, per verificare l’assenza di criteri di esclusione, il medico responsabile dell’esame compilerà anche un questionario di screening approvato dal Ministero della Salute sul modello indicato dal DM 2-8-91 (vedi allegato 1a). Alcuni tipi di prodotti cosmetici possono interferire con la qualità del segnale di risonanza magnetica. Per questo motivo verrà richiesto ai partecipanti, se fosse necessario, di struccarsi prima di essere sottoposti ad esame.

#### Esperimenti EEG ed fMRI combinati

I criteri di inclusione ed esclusione saranno costituiti dai criteri utilizzati per gli esperimenti fMRI e dall’ulteriore criterio aggiuntivo:

* Dermatiti, eczema, presenza di cicatrici estese sul cuoio capelluto

In particolare, per verificare l’assenza di criteri di esclusione, il medico responsabile dell’esame compilerà anche un questionario di screening (vedi allegato 1b)

#### Esperimenti TMS ed fMRI combinati

I criteri di inclusione ed esclusione saranno costituiti dai criteri utilizzati per gli esperimenti fMRI e dagli ulteriori criteri aggiuntivo:

* Pregressi episodi convulsivi
* Patologie neurologiche o psichiatriche
* Lesioni cerebrali risultanti in perdita di coscienza
* Abuso o dipendenza da sostanze stupefacenti negli ultimi 6 mesi
* In particolare, per verificare l’assenza di criteri di esclusione, il medico responsabile dell’esame compilerà anche un questionario di screening (vedi allegato 1c)

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