Measuring the Mirror Neuron System: A Combined EEG/fMRI Study

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Ethical review	Approved WMO
Status	Recruitment stopped
Health condition type	Other condition
Study type	Observational non invasive

Summary

ID

NL-OMON32442

Source
ToetsingOnline

Brief title
Measuring the Mirror Neuron System

Condition

- Other condition

Synonym
it is a healthy subject study

Health condition

gezonde proefpersonen

Research involving
Human

Sponsors and support

Primary sponsor: Universitair Medisch Centrum Groningen
Source(s) of monetary or material Support: NWO VIDI 452-04-305

Intervention

Keyword: EEG, fMRI, mirror neurons, rolandic alpha and beta suppression

Outcome measures

Primary outcome

The main analysis strategy will be as follows. First, we will use a general linear model to identify voxels in the brain that have a BOLD signal which is negatively correlated with the power in the EEG signal within the alpha (8-13 Hz) and beta (13-30 Hz) range during the observation and the execution conditions. These maps will then be compared with those obtained from a classical fMRI identification of the mirror neuron system (i.e. (complex action observation * complex control observation) and (complex action execution * complex control execution)) to test if the neural correlates of alpha and/or beta suppression indeed coincide with the mirror neuron system. Finally, we will use the passive and active manipulation of a ball conditions to examine the contribution to the EEG signal of proprioceptive brain regions that should be similarly involved in both conditions and of motor brain regions that should be more involved in the active manipulation condition. Finally, the resting state fMRI condition will be used to examine the degree to which somatosensory and motor brain regions are connected and these parameters will be compared to the correlation between the power in the alpha and beta range.

Secondary outcome

n.a.

Study description

Background summary

By simply observing others, humans can infer a great deal about their goals, sensations, and emotions. The neural basis of this "mind reading" ability is poorly understood, but the discovery of mirror neurons in macaque monkeys was a great step forward for a scientific account of social cognition. Mirror neurons fire either when a macaque performs an action, such as grasping, or when the macaque observes another human or macaque performing this action. It has therefore been proposed that mirror neurons serve to translate observed actions into the neural activity associated with the macaque's own actions, therefore turning the problem of understanding others' actions into the easier problem of understanding one's own actions.

While mirror neurons have been invoked to explain an impressive variety of human cognitive functions, including language and imitation in addition to action understanding, studying the mirror neuron system in human subjects remains elusive. fMRI researchers often study mirror neurons by finding "shared voxels"--small volumes of brain tissue which are active during both action execution and observation In contrast, EEG researchers usually quantify mirror neuron activity using the suppression of the rolandic alpha (8-13 Hz) and beta (13-30 Hz) rhythms during action observation and execution, suppressions which are believed to reflect modulation of the primary sensorimotor cortex by premotor mirror neurons. While these two approaches, shared voxels in fMRI and rolandic rhythm suppression in EEG, are assumed to both reflect activity in the mirror neuron system, to date there is no evidence that they measure the same underlying neural activity. To address this issue, the present study was designed to determine the relationship between shared voxels and rolandic alpha and beta suppression.

Study objective

In this experiment, we intend to determine how shared voxels, as measured with fMRI, are related to rolandic alpha and beta suppression, as measured by EEG. Because they are believed to both measure mirror neuron activity, we hypothesize that rolandic alpha and beta will correlate with activity in shared voxels such that rolandic alpha and beta suppression will be enhanced on blocks in which shared voxels are particularly active.

Study design

During the experiment, fMRI BOLD signal and EEG will be recorded simultaneously to be analyzed off-line.

In complex action observation blocks, participants will be shown videos in which an actor will perform a goal-directed hand action with an object, such as spreading jam on bread or placing a flower in a vase. Only the actor's arm and the object will be visible. The complex action condition will have two control conditions: complex control, in which the videos will show an arm moving in a similar trajectory in an identical environment, but without a clear goal and no object interaction; and static control, in which the videos will show an arm in an identical environment but with no movement.

Four additional conditions are needed to isolate regions that respond to the execution of actions, and to disenntangle the contribution of motor and proprioceptive brain regions to the rolandic alpha and beta rhythms. In complex action and control blocks, a small green or red circle will alert participants that a complex action or control block, respectively, is starting. Following the initial circle, large green circles or red circles will be presented and will subsequently shrink and eventually disappear. In the complex action blocks, the location of the circle will indicate which object (a bowl and spoon, a wine glass, or a mug) participants should interact with and the shrinking of the circle will indicate how long to interact with the object. In control blocks, participants will fixate on the red circles without performing actions. Additionally, there will be two simple action execution conditions. In each block of the voluntary movement condition, participants will squeeze a foam ball. In involuntary movement blocks, however, the experimenter will squeeze the participant*s hand around the foam ball. A small green or red circle will alert participants that a voluntary or involuntary movement block is, respectively, is starting, and shrinking green or red circles will indicate how long the participant should interact with the foam ball.

A period of resting state, during which participants will passively watch a fixation cross for 12 minutes, will also be acquired after the observation and execution sessions to estimate the connectivity between brain regions as their correlations within the frequency range below 0.1Hz [6]. Finally, an 8-minute anatomical scan will be acquired at the end of the experiment.

Thus, there will be four types of sessions (as well as an anatomical scan): complex action observation, complex action execution, simple action execution, and resting state. Because the Keysers lab has used the stimuli previously in fMRI studies but not in EEG studies, 30-60 minute piloting will be conducted in 5 healthy participants using EEG only in the dummy scanner while the scanner noise is played from a loudspeaker to determine how many trials are necessary to reliably record rolandic alpha and beta suppression, how long the pauses must be between trials to ensure that the rhythms return to baseline levels, and whether it is preferable to utilize a block design with three movies/complex actions per block or if rolandic alpha and beta suppression are

observed more reliably when pauses break up the movies/complex actions into single events. The final design of the study will be such that participants spend no more than 1.5 hours in the scanner (including anatomical scanning), and we anticipate that a scanner session of 1.0 hours will likely be sufficient.

Additionally, prior to combined EEG/fMRI testing, the first five subjects will be pretested with EEG only while they perform the observation and execution sessions (but not the resting-state session) in the dummy scanner while the scanner noise is played. After the first five subjects, we will evaluate whether the pretesting is useful for predicting whether participants display rolandic alpha and beta suppression during the combined EEG/fMRI experiment. If the pretesting proves useful (i.e., subjects who display rolandic alpha and beta suppression during pretesting also reliably display this suppression during the combined EEG/fMRI experiment), then we will pretest the remaining subjects. But if the pretesting is not useful (i.e., there are participants who display rolandic alpha and beta suppression during pretesting but not during the combined EEG/fMRI experiment), then we will cease to pretest participants.

Note that the piloting is distinct from the pretesting. The purpose of the piloting is to collect the data needed to fine-tune the procedure, and therefore certain features of the experiment, such as the length of the pauses between blocks, will be varied systematically. The pretesting, however, aims to determine whether a particular participant reliably displays rolandic alpha and beta suppression, and therefore the final procedure will be used.

Study burden and risks

The experiments will not entail more than minimal risk or burden to the participants. EEG, which will be measured across 32 channels embedded in an elastic cap, is a routine and noninvasive technique used in neuroscience research. In order to collect simultaneous fMRI data, subjects will be exposed to a magnetic field of 3 Tesla and rapidly alternating magnetic gradients and radio frequency fields. This field strength is used routinely in fMRI and MRI research. On rare occasions, a peripheral nerve in the abdomen in stimulated by the changing magnetic gradients, which is innocuous but results in an itching sensation. While fMRI requires that participants lie still in a confined space, our experience is that most participants can easily make it for 90 minutes and are very glad to participate. Additionally, short breaks will be provided between sessions at the request of the participant or if the experimenter believes it is necessary. Combined EEG-fMRI research has already been conducted at UMCG and it has been verified that the EEG apparatus is MRI-compatible and poses no risks to participants.

The study is not intended to benefit the subjects directly, but our experience suggests that individual volunteers often feel rewarded from participating in this sort of study. Moreover, the data collected during this study could

improve our understanding of the mirror neuron system. In particular, this investigation could help clarify the relationship between the fMRI phenomenon of shared voxels and the EEG phenomenon of rolandic alpha and beta suppression, which have each been used individually to study the mirror neuron system.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)
Elderly (65 years and older)

Inclusion criteria

1. Healthy males and females
2. Between 18 - 40 years old
3. Normal vision and hearing
4. Right-handed

Exclusion criteria

1. MR incompatible implants in the body (through questionnaire)
2. Neurological complaints present as well as past (through questionnaire)
3. Use of drugs that may influence the task performance (through questionnaire)
4. Claustrophobia (through questionnaire)
5. Wishes not to be informed of brain abnormalities that may be noticed in the scans
6. (Suspected) Pregnancy
7. Tattoos containing red pigments

Study design

Design

Study type: Observational non invasive

Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Other

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	23-07-2019
Enrollment:	30
Type:	Actual

Ethics review

Approved WMO

Application type:	First submission
Review commission:	METC Universitair Medisch Centrum Groningen (Groningen)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL29796.042.09