Motor learning and crossmodal interactions within the human mirror-neuron system in fMRI

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This project aims at investigating the crossmodal interactions and crossmodal transfer during the perception of different newly learned motor patterns using fMRI. Before scanning, participants will learn to perform key sequences on a piano keyboard…

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

Summary

ID

NL-OMON32643

Source
ToetsingOnline

Brief title
Learning to play piano melodies and perception of actions in fMRI

Condition

- Other condition

Synonym
n.a.

Health condition

n.v.t.

Research involving
Human

Sponsors and support

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

Intervention

Keyword: crossmodal interactions, fMRI, mirror neuron system, motor learning

Outcome measures

Primary outcome

Main study parameter will be the hemodynamic response measured with fMRI. More specifically, the repetition suppression effect, which is due to repeated presentation of stimuli will be analyzed. This effect will be compared for the different experimental conditions (please see study design). The visual mirror system will be determined by identifying the areas that show a repetition effect in the experimental condition (1) Vtrain Vtest. The auditory mirror system will be determined by identifying the areas that show a repetition effect in the experimental condition (4) Atrain Atest. For the comparison of the experimental conditions 1, 2 and 3, we hypothesize that within the areas of the visual mirror system the repetition suppression effect will be largest for (1) Vtrain Vtest, diminished in (2) Atrain Vtest and smallest for (3) no-train Vtest. Analogously we expect that within the areas of the auditory mirror sytem the repetition suppression effect will be largest for (4) Atrain Atest, diminished in (5) Vtrain Atest and smallest for (6) no-train Atest.
In the third fMRI scan, we test whether there are trimodal brain areas by examining the crossmodal repetition effect. This will be done by identifying areas that show a repetition suppression effect when sequences will be

presented successively auditorily and visually. We expect that overlapping areas of the auditory and the visual mirror system show a crossmodal repetition suppression effect.

Secondary outcome

Furthermore, we analyze properties of the integrity of white matter tracts reflected by the fractional anisotropy (FA) for the directional dependence of water diffusion. These values will be correlated with learning parameter (e.g., learning time for the key sequences) as well as with the individual hemodynamic responses in brain areas which show a repetition suppression effect.

Study description

Background summary

The mirror-neuron system is assumed to be the neural basis for a direct matching between observation and motor representations of actions and is considered to mediate the understanding of actions and intentions (see [1]). There seems to be a similar system for the auditory domain that matches a heard action to the according motor representation (see e.g., [2]). However, the crossmodal interactions within the system have not yet been investigated systematically.
[1] Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. Annual Review of Neuroscience, 27, 169-192.
[2] Gazzola, V., Aziz-Zadeh, L., & Keysers, C. (2006). Empathy and the somatotopic auditory mirror system in humans. Current Biology, 16, 1824-1829.

Study objective

This project aims at investigating the crossmodal interactions and crossmodal transfer during the perception of different newly learned motor patterns using fMRI. Before scanning, participants will learn to perform key sequences on a piano keyboard either within a purely auditory learning condition or within a purely visual learning condition.
Firstly, it will be examined whether the auditory and the visual mirror system share common neural substrates.
Secondly, we test which brain areas and which parts of the mirror system

respond to the sound of an action (i.e., a melody), if this action was learned by observation of according finger movements. Correspondingly, it will be tested, which brain areas and especially which parts of the mirror system are activated during the observation of an action (finger movements on a piano keyboard) which was learned to perform by listening to the corresponding melody. In other words, we investigate whether there is a crossmodal transfer if one action was learned within one modality. Thirdly, we examine whether there are trimodal areas, which respond to the sound as well as to the observation of an action. Furthermore, structural as well as functional data will be related to behavioural data: Differences in white matter pathways in each single participant will be examined using diffusion tensor imaging, in order to correlate the obtained values to differential performance parameters during the motor training and individual hemodynamic responses in relevant brain areas during a (motor) perception task.

Study design

There are two different learning conditions:
1. observing finger movements showing a key sequence, while participants see their own fingers during reproduction, but can*t hear a sound (learning by vision only) or
2. listening to a key sequence (i.e., a melody), without seeing their own finger movements during training, but hearing the result of own key presses (learning by listening only).
After completing each of one training session, participants will take part in scanning sessions including functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) after three days training and fMRI and an anatomical MRI scan after 6 days training.
Within the fMRI scan they will hear (within one trial two, either same or different) melodies, which they have learned to perform during the auditory or the visual training or which they haven*t learned to perform. Accordingly, participants will observe different finger movements which they have learned to perform during the auditory or the visual training or which they haven*t learned to perform.
This results in 6 different experimental conditions (for the first fMRI scan, after visual or the auditory training only, there are 4 conditions, respectively):
1. Vtrain Vtest: observing sequences that were previously trained to perform visually
2. Atrain Vtest: observing sequences that were previously trained to perform auditorily
3. no-train Vtest: observing sequences that were not trained to perform
4. Atrain Atest: hearing sequences that were previously trained auditorily
5. Vtrain Atest: hearing sequences that were previously trained visually
6. no-train Atest: hearing sequences that were not trained to perform
After that, participants receive a further training session during which they are trained to perform all melodies presented auditorily and visually

simultaneously. During a third fMRI scan, within each trial, two (either same or different) of the trained key sequences will be presented either both visually, both auditorily or one visually and one auditorily.

Study burden and risks

Participants will be exposed to a 3 T magnetic field. No side effects have been described so far. On rare occasions a peripheral nerve (abdomen) is stimulated by the changing magnetic gradients. This will cause an itchy feeling, but is not harmful.

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

between 18 - 40 years of age
male and female
normal vision and hearing
right handed
people without musical training

Exclusion criteria

1. Individuals learned to play a musical instrument, or had singing lessons
2. left handedness
3. MR incompatible implants in the body
4. Neurological complaints present as well as past
5. Use of drugs that may influence the task performance
6. Claustrophobia
7. Wishes not to be informed of brain abnormalities that may be noticed in the scans
8. (Suspected) Pregnancy
9. Red tattoos

The fMRI exclusioncriteria will be checked by way of a questionnaire.

Study design

Design

Study type:	Observational non invasive
Intervention model:	Parallel
Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Other

Recruitment

NL

Recruitment status:	Recruitment stopped
Start date (anticipated):	23-07-2019
Enrollment:	25
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	NL29720.042.09