Journal of Visualized Experiments

Post-Movie Subliminal Measurement (PMSM), for investigating implicit social bias

--Manuscript Draft--

Article Type:	Invited Methods Article - Author Produced Video
Manuscript Number:	JoVE60817R2
Full Title:	Post-Movie Subliminal Measurement (PMSM), for investigating implicit social bias
Section/Category:	JoVE Neuroscience
Keywords:	Face perception subliminal movie social bias implicit respons naturalistic viewing ingroup, outgroup automatic response subconscious
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Additional Information:	
Question	**Response**
Please indicate whether this article will be Standard Access or Open Access.	Standard Access (US$1200)

TITLE:

Post-Movie Subliminal Measurement (PMSM), for Investigation of Implicit Social Bias

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KEYWORDS:

face perception, subliminal, movie, social bias, implicit response, naturalistic viewing, ingroup, outgroup, automatic response, subconscious

SUMMARY:

This protocol describes the use of movies to investigate brain mechanisms underlying implicit social biases during functional magnetic resonance imaging. When the face of a protagonist is presented after a movie subliminally, it evokes an implicit response based on knowledge of the protagonist gained during the movie.

ABSTRACT:

New knowledge is continuously gained from a social environment that can influence how people respond to each other. Such responses often occur implicitly, at a subliminal perceptual level, and related brain mechanisms can be experimentally isolated by presenting the stimuli quickly. Subliminal presentation of faces that belong to different ethnicity groups, races, or gender has been shown to be successful in investigating social implicit responses. However, many implicit responses are based on knowledge previously gained about the faces (e.g., sexual orientation, political views, and socioeconomic status) and not solely on physical appearance. Here, a novel method called post-movie subliminal measurement (PMSM) is presented. When watching a socially engaging movie, a spectator gains knowledge about the protagonist and becomes familiar with his/her identity and world views. When the face of the protagonist is presented subliminally after the movie, it evokes an implicit neural response depending on what is learned about the protagonist. With a vast number of movies available, each depicting a variety of people with different identities, the PMSM method enables investigation of the brain's complex implicit biases in a manner that resembles real-life social perceptions.

INTRODUCTION:

Recent studies show that initial social judgment becomes formulated within the first 32–100 ms of meeting another person[1–7]. Subliminal presentation of faces has been used extensively to investigate implicit biases towards different ethnic and racial groups (e.g., by presenting Caucasian American and African American faces that differ in skin color to subjects from both groups)[8–14]. However, social groups are also characterized by factors other than physical facial characteristics[15].

Facial perception has been shown to be highly sensitive to contextual cues (i.e., body posture[16], eye-gaze direction of the face[17], a priori knowledge about the face[18], visual background of the presented face[19], presentation of the face separately or with other faces[20]). These factors can all affect facial perception. Weiser and Brosch[21], in their extensive review, suggested to investigate facial perception in more naturalistic settings by ensuring that laboratory experiment is similar to real-life environments. Indeed, even simple tasks, such as recognizing people, have been shown to be more accurate when presented with video footage closer to real-life perception than when using static images[22].

During the last several decades, brain imaging studies have proven that video clips can be successfully used to study realistic social perception[23–29]. The presented method is based on results from these studies and additional findings demonstrating that movie narratives can temporarily transport viewers to the world of a protagonist[30]. The protocol combines movie viewing with subliminal stimulus presentation as an alternative method to investigate implicit social bias formation under naturalistic conditions.

The protocol for this novel approach, post-movie subliminal measurement (PMSM), is presented here. When watching a socially engaging movie, the spectator gains knowledge about the protagonist and becomes familiar with his/her identity and world views. In contrast with other narrative art forms, movies are unique in that they present a compelling, rich, and complex story over a short time period. Furthermore, audiovisual and cinematic properties of movies synchronize brain activity across spectators[23,25,29,31]. Thus, it is helpful to ensure that subjects are presented with the information in a considerably similar way.

The PMSM method shows that when the face of a protagonist is presented subliminally after the movie (vs. before), implicit neural responses are successfully evoked. These responses depend on knowledge that the viewer gains about the protagonist's character with respect to his/her implicit social views. As there is a vast number of movies available that depict a variety of social characters, the PMSM method enables investigation of the brain's complex implicit views in a manner that is close to real-life social perceptions.

PROTOCOL:

The protocol was approved by the Aalto University Research Ethics Committee.

1. Participant screening and preparation

1.1. Match the different groups of recruited participants (here, heterosexual and homosexual groups) according to age, handedness, and level of education. Ensure that all participants can fully comprehend the language of the movie and feel comfortable watching it without subtitles. Alternatively, consider screening a movie in the native tongue of participants.

1.1.1. Exclude participants who have seen the planned movie within the past couple of years, as this can affect baseline measurements. Ideally, recruit participants who have not seen the movie previously. Do this by asking participants to indicate, from a list of movie titles (including the name of the move to be used in addition to 20 other movie titles), which movies they have seen in the past couple of years.

1.2. Follow the specific institution's ethical guidelines for non-medical experiments with healthy participants under no psychiatric medication and no current neurological disease diagnosis. Recruit participants with normal or corrected vision for the fMRI scan. Recruit non-smokers and people that are comfortable with not moving for the duration of the experiment to avoid corruption of fMRI data due to unnecessary head motion.

1.3. Scan all participants at a similar time of the day, preferably morning or early evening (9:00 A.M. to 5:00 P.M.), with no excessive consumption of coffee or food directly prior to scanning.

1.4. Perform blinded recruitment to assure that participant responses are genuine and not emotionally regulated. Do not inform participants of the aim of the experiment (e.g., investigating implicit bias among homosexual and heterosexual subjects). For example, tell participants that the experiment is about movie viewing and that the real aim of the study will be explained only after the experiment. Exclude participants who know the aim of the study in advance.

1.5. Perform a behavioral measurement such as the Implicit Association Task IAT[32] to assure that the experimental groups have implicit biases. Use the measurement to assure that the groups do show biases, as strengths of implicit biases differ. Use IAT after the scan to prevent the participants from guessing the goal of the experiment.

2. Procedure outside MRI

2.1. Upon arrival, brief participants with stages of the experiment, risks, and use of their experiment data. Conclude the briefing by asking if they have any questions regarding the experiment and that further explanation will be provided afterwards. Ask participants to read the briefing of the experiment and sign the consent form.

2.2. Ask participants to remove all metal objects from their clothing or (preferably) change to a metal-free lab cloth to ensure safe access to the fMRI magnet. Scan participants using a metal

detection device to assure that no metal was left behind (i.e., watch, belt, etc.). Standard contraindications to MRI should be respected[33].

2.3. Ask participants to enter the fMRI laboratory for configuration of the video projector and audio system. Instruct participants to lay down on the fMRI bed. Play a sample video to ensure that the picture is easily visible and audio level is comfortable and clear. If any complaints are made, adjustments should be made accordingly. Ensure that the headphones are presenting sound correctly.

2.4. Connect the fMRI-compatible eye-tracking system. Tracking is used to ensure that subjects are attentive during the experiment and do not fall asleep or daydream during the scan. The eye-tracking is for data quality assurance only. Once tracking is secured, start the calibration process to begin recording eye movements.

2.5. Inform subjects that the experiment is about to begin and that the scanning time will take 30 min to complete. Instruct participants to 1) relax as if they are watching a TV program in their home and 2) follow the instruction slides that will guide them through the different steps during the scan. Start the fMRI scan.

2.6. Once the scanning is done, move participants to a different room, in which additional behavioral measurements will be collected (i.e., how much they identified with the character in different parts of the movie, IAT measurements to assess implicitly biases).

2.7. Once all data are collected, debrief participants regarding the real goal of the experiment and answer any additional questions.

3. Procedure inside MRI

NOTE: During the fMRI session, participants are presented with a 30 min audiovisual content, which includes instruction slides, 4 min pre-movie subliminal measurement (for baseline), a 20 min movie, 4 min post-movie subliminal measurement, and concluding slides. In this section, follow the protocol to become familiar with the steps needed to create different parts of the stimuli as well as the order of presentation. Since the flash of the face during the subliminal portion has a 40 ms duration (a duration of a one video frame), it is possible to use an off-the-shelf video editing program (e.g., AVID media composer software or Adobe Premiere Pro editing software) to create the subliminal stimuli as well as edit the movie, if needed. When presenting the stimuli in the correct order using locked timing, use a software that is compatible with fMRI stimuli presentation (e.g., Presentation software, Neurobehavioral Systems Inc., Albany, California, USA).

3.1. The 4 min periods of subliminal measurements (baseline and post-movie) are identical. Do not inform participants of their nature or purpose at this stage, and present them during the beginning of the scan with the following instruction slide:

"Soon you will see a calibration clip. This clip is meant for calibrating the MRI scanner for your responses. The clip is only four min long and will look like white noise on a TV screen. Please keep your eyes fixated at the mark in the center of the screen until notified otherwise".

NOTE: The 4 min stimuli period contains white noise, virtually divided into 16 blocks of 15 s each. The 16 blocks of white noise contain two types of blocks: a rest block (white nose without subliminal flashes) followed by a condition block (white noise with flashes of the protagonist face). See **Figure 1** for an illustration of the stimulus structure.

3.2. To create the 4 min subliminal stimuli, start with a 15 s white noise clip. The white noise serves as a masking stimulus for the face that is being flashed. Since the brain is sensitive to face presentation, it is important to use good masking, even if the face is presented subliminally. Therefore, use a dynamic white noise clip that has large distortion and movements in difference of a homogeneous white noise (e.g., with small random white and black dots).

3.2.1. Create the 15 s condition block by inserting the 10 flashes of the protagonist's face into the dynamic white noise. The subliminal flashes should occur in 40 ms durations, starting at the onset of the condition block inserted every 1,500 ms.

3.2.2. The face of the protagonist should be facing the camera with neutral face expression. If possible, take a frame from the movie (a close-up of the character in the movie) or search for an image of the actor/actress from the internet. Ensure that the actor/actress appears similar to his/her appearance in the movie (e.g., no significant differences in features such hair or beard or accessories). Make sure the face has a neutral face expression and is clear and well-lit.

3.2.3. Adjust the image by centering it in the middle of the screen. Avoid using an image with a small size face and with bad resolution. Make sure there are no salient objects in the background of the face, such as other people, text, or identifiable visuals. If there are, cut them out or mask them to create a neutral image. Flip the image from color to black-and-white before inserting.

3.2.4. Once the white noise rest-block and the condition block (with the face flashes) are ready, duplicate them to create the 4 min subliminal stimuli, ordering the blocks one after the other starting with the rest-block. By the end of the process, one should have 4 min containing 16 blocks each of 15 s (eight rest blocks and eight condition blocks).

3.2.5. Add a fixation mark in the middle of the screen of the 4 min subliminal measurement. Make sure it is easily noticeable. Add a 2 s fixation mark before the 4 min clip to make it easy for participants to find and start the task.

3.3. 3.3 At the end of the baseline (the 4 min pre-movie subliminal measurement), insert a text slide indicating the beginning of the movie, length of the movie, and reminder to the to be relaxed and freely watch the movie. For example:

"Thank you. The calibration was done successfully! You are now about to watch a 20 min movie. Try to relax and to enjoy the story."

3.4. Choose a movie that is emotional, engaging, and character-driven (i.e., has a clear protagonist with a strong conflict). For example, a previous experiment regarding social bias was conducted on homosexual and heterosexual subjects to whom a movie about a homosexual priest was presented. The story was about a priest who struggles between his wish to serve his beliefs as a catholic priest and his desire to be loved by another man.

NOTE: The film can be documentary or fiction. It can be a short film or stand-alone episode from a TV series. It is important that the movie has a clear story with a beginning, middle, and end that can be easily understood and followed. It is also possible to edit a shorter version from a longer film. For example, our stimuli from the homosexual/heterosexual experiment was a 20 min version story edited by a professional filmmaker (the first author) from a longer film titled Priest (directed by Antonia Bird, 1994). The more relevant to the subject group a movie is, the more engaging the viewing will be.

3.5. After the movie, the 4 min subliminal measurement for PMSM should be repeated to observe how implicit neural responses to the protagonist's face are biased after watching the movie (*vs.* before). To indicate this, insert the following slide:

"Thank you! We are almost done. Before finishing the measurement, we need to recalibrate our MRI device to your response. The clip is only four minutes long and will look like white noise on a TV screen. Please keep your eyes fixated at the mark in the center of the screen until notified otherwise"

3.6. Finally, present the 4 min PMSM (the same 4 min used to perform the pre-movie baseline measurement).

REPRESENTATIVE RESULTS:

Presented here are some results using PMSM from the published article by Afdile et al.[34]. Here, implicit bias was investigated among homosexual and heterosexual subjects (15 heterosexuals, 14 homosexuals) toward the protagonist after realizing he is homosexual in the movie, making him an "ingroup" to the homosexual participants and "outgroup" to the heterosexual participants. In line with our IAT results, this factor was shown to be significant in both groups, in which the heterosexual subjects were implicit in favor of heterosexuals over homosexuals, and homosexual subjects were implicit in favor of homosexuals over heterosexuals (mean heterosexuals = -0.26, mean homosexuals = 0.3, t = 3.72, $p < 0.01$). Both groups were significantly different from zero (homosexual: $p = 0.0059$, heterosexual: $p = 0.043$).

Our results revealed significantly larger differences in the homosexual *vs*. heterosexual subjects in response to the face post-movie in the bilateral superior frontal gyrus (sFG), right temporal parietal junction (rTPJ), anterior cingulate cortex (ACC), bilateral frontal pole (FP), and medial

prefrontal cortex (mPFC). **Figure 2** depicts the "strong" and "weak" representative results after performing the PMSM in homosexual and heterosexual Finnish participants.

FIGURE LEGENDS:

Figure 1: **Illustration of the PMSM stimulus structure.** (**A**) 4 min baseline measurement (pre-movie subliminal measurement) with flashes of the protagonist's face. (**B**) 20 min movie depicting the story of the protagonist. (**C**) 4 min post-movie subliminal measurement [replication of (A)]. (**D**) Illustration of a 1 min clip from the 4 min subliminal measurement consisting of four blocks (rest, condition, rest, condition). The rest of the blocks are 15 s of dynamic white noise. The condition block contains 10 flashes of the protagonist face at a duration of 40 ms with intervals of 1,500 ms of white noise. This figure has been modified from Afdile et al.[34].

Figure 2: Representative results. BOLD signals in response to the subliminal presentation of the homosexual protagonist's face after viewing the movie. Left side: representation of strong results from homosexual *vs*. heterosexual ($p < 0.01$, cluster corrected). Right side: heterosexual vs. homosexual, significant but weak results that did not survive correction ($p < 0.05$, uncorrected). This figure has been modified from Afdile et al.[34].

DISCUSSION:

This paper outlines the novel method for investigating the implicit brain using a post-movie subliminal measurement referred to as PMSM. In a recently published study, this method has shown that 1) implicit brain response is dynamic and 2) there is continuous learning from the social environment as well as formulation of judgment based on contextual knowledge (and not solely based on facial characteristics). Therefore, the proposed PMSM method can provide an alternative to the classical method when investigating implicit bias (e.g., when presenting faces that belong to different ethnical, gender, or race groups). The PMSM brings the experimental setting closer to real-life social perception, in which the results are based on naturalistic viewing.

The presented protocol uses fMRI techniques; however, it is also possible to conduct PMSM using other neuroimaging measures including electroencephalography (EEG) or magnetoencephalography (MEG). The experimental design presented here is for a two-group comparison; however, there are no limitations when using PMSM for multiple group or within group comparisons. Furthermore, it may be possible to extend PMSM to measuring the implicit response to more than one face (i.e., both the protagonist and antagonist in a movie). This can further shed light on the investigated subject group (i.e., measuring the implicit response to two characters carrying opposing world views in a movie).

Researchers interested in investigating other aspects of social perception and their interactions with memory and bias, such as attention and emotion under naturalistic conditions, can take advantage of the fMRI data collected during PMSM to run various analysis (i.e., inter-subject

correlation, functional connectivity, and model-based analyses of activity elicited by various events in the movie). However, it is important to have a hypothesis to start with as this can help in collecting additional behavior data during the experiment that can be very helpful in interpreting the results.

Furthermore, by editing the videos presented in PMSM it should be possible to investigate various aspects of attitude formation towards in/outgroup members (e.g., manipulate the conversation between ingroup and an out-group character to assess how intergroup bias effects how opinions and world views of in/outgroup members are perceived). Another advantage of PMSM is its feasibility to measure implicit bias towards groups that are hard to differentiate based on appearance. For example, by showing videos of interactions of natives vs. newcomers, PMSM can measure implicit bias towards newcomers. Afdile et al. provides further reading regarding the limitation of past implicit and priming method in comparison with PMSM[34].

In acknowledgement of PMSM's limitations, the representative results show that implicit bias may not be symmetrical across groups (e.g., among non-conflict social groups ingroup bias might be a stronger response than outgroup bias). This is reflected in our representative results, in which 14 homosexual subjects showed a robust ingroup implicit response to the face of the homosexual protagonist. In contrast, results from the 15 heterosexual subjects were not strong enough to survive correction.

Although this is not purely a PMSM limitation, and it is possible that using other neuroimaging methods may have shown stronger results in both groups, it is advised to use a larger number of participants when conducting PMSM with fMRI. Furthermore, a limitation in PMSM can be found in the number of faces that can be tested, as movies carry a finite number of significant characters within the story, especially in short movies. Although PMSM may be closer to life-like social perception, there must be caution in interpreting the results and drawing generalized conclusions (in comparison with more simplified task paradigms that have repeated tasks with a high number of conditions). PMSM should be chosen for cases in which it best suits testing of the hypothesis.

A critical step in the PMSM method is the choice of the movie. There are inter-individual differences in the level of how easily people identify with characters and get immersed or transported to the world of the story[35,36]. However, there are several approaches that can overcome this challenge. For example, movies that have been commercially successful tend to be highly structured (through cohesive editing style) and have simple and coherent inner logic to follow, which are two important factors that increase the engagement of the viewer[37,38].

Furthermore, documentaries or movies depicting topics that are relevant to the viewer can further increase the transportability (see Green)[39]. Another strategy is choosing a movie of a genre that the experimental subjects will enjoy watching[40]. Successful choice of a movie can increase the efficiency of PMSM and also provide additional data for those who are interested

in learning how the implicit brain formulates its judgment by analyzing brain activity during movie viewing.

DISCLOSURE:

The authors have nothing to disclose.

ACKNOWLEDGEMENTS:

This work was supported by Academy of Finland, grant numbers [259952, 276643]. We would like to thank Mikko Sams for the supervision and Enrico Glerean, Jussi Alho, Anna Äimälä for helping with the data, Johan Westö for helping with the visualization as well as Marita Kattelus and Toni Auranen from Advanced Magnetic Imaging (AMI) Centre, Aalto NeuroImaging, Aalto University, Espoo, Finland for their help and support.

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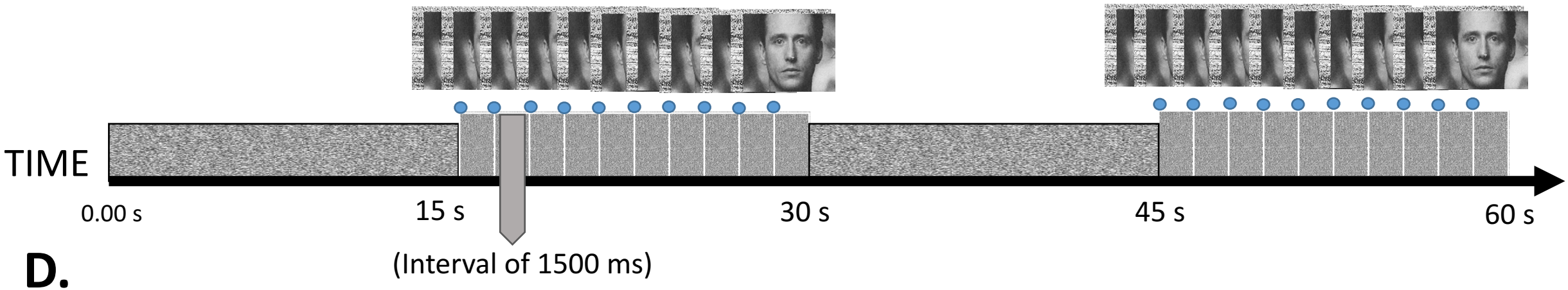
Figure

15 s white noise
Rest

15 s white noise
With 10x(40 ms **Face flash**)

15 s white noise
Rest

15 s white noise
With 10x(40 ms **Face flash**)



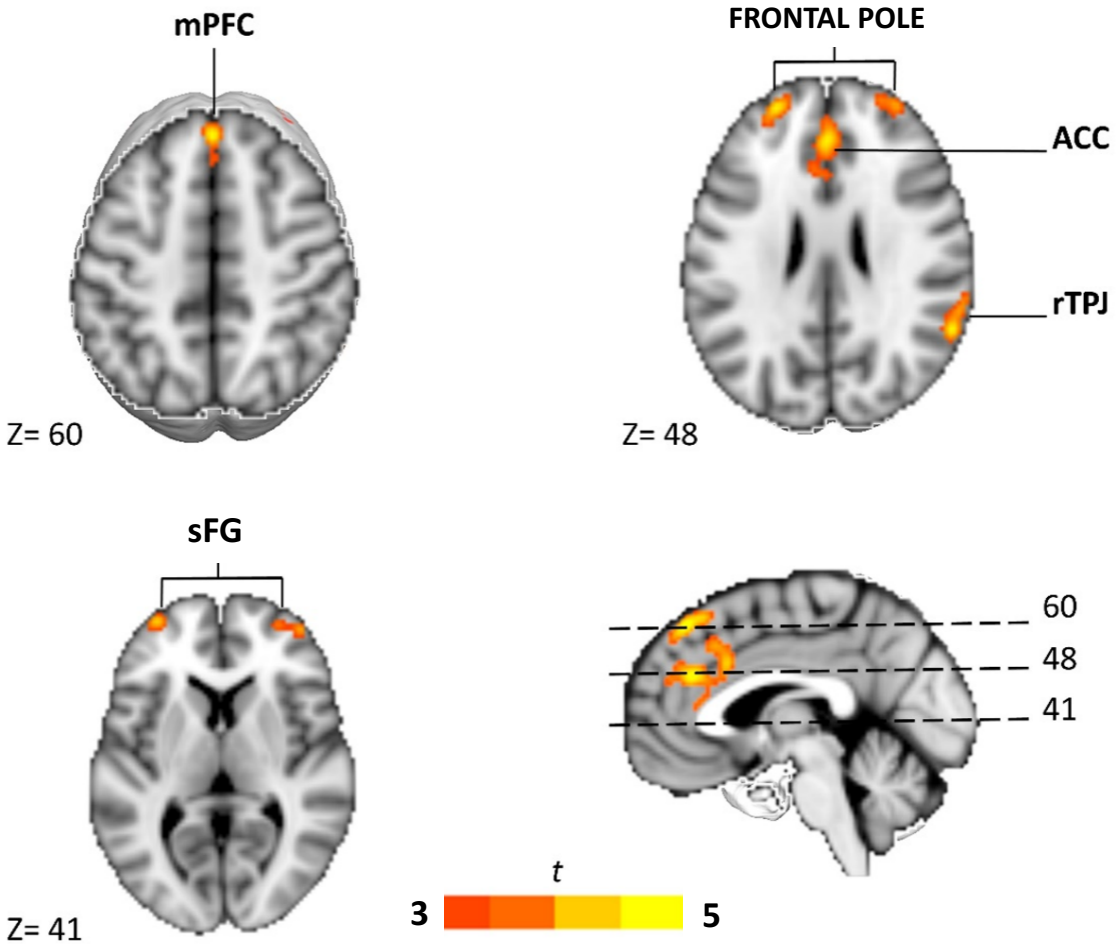
D.

Figure

Click here to access/download;Figure;Figure2.pdf

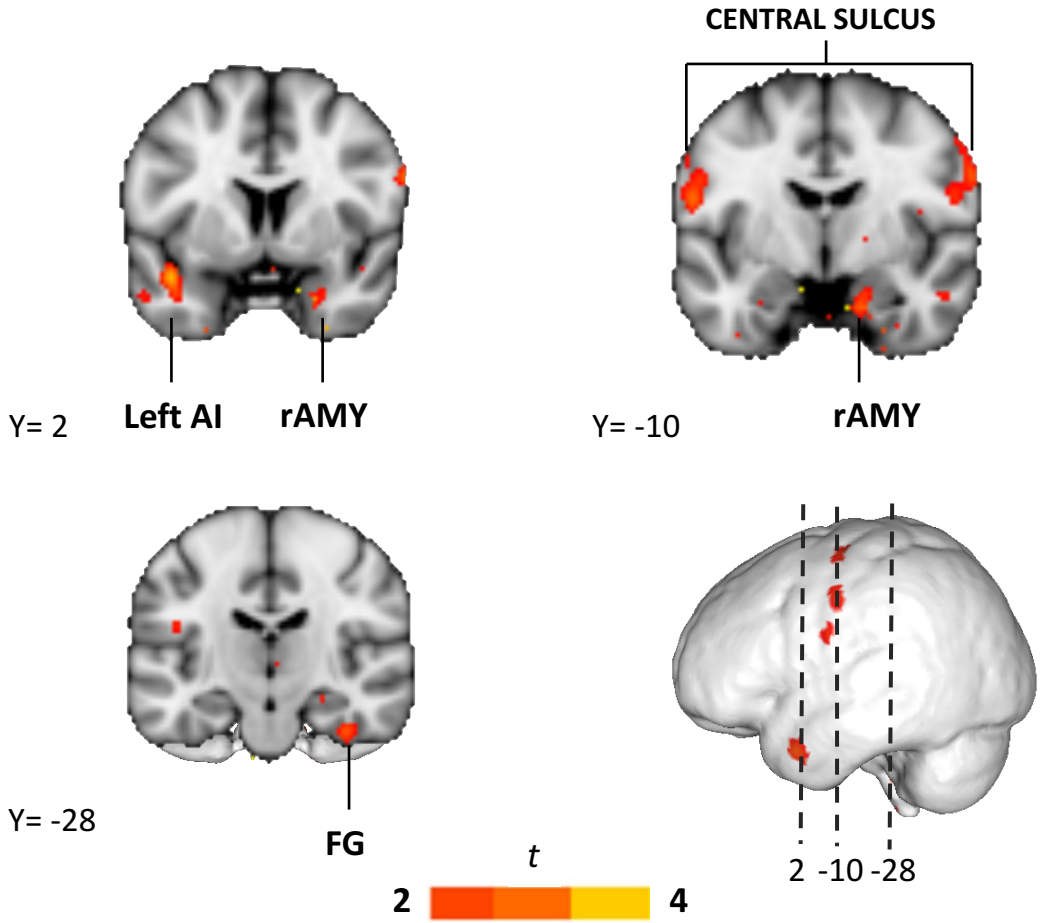
Strong results

Homosexual > Heterosexual



Weak results

Heterosexual > Homosexual



Name of Material/Equipment	Company	Catalog Number
3T Siemens MAGNETOM Skyra	Siemens Healthcare, Erlangen, Germany	
Avid Media Composer	https://www.avid.com/media-composer	
EAR-tip	Etymotic Research, ER3, IL, USA	
FSL software	www.fmrib.ox.ac.uk, version 5.0.9	
Panasonic PT-DZ110X projector	Panasonic Corporation, Osaka, Japan	
Presentation software	Neurobehavioral Systems Inc., Albany, California, USA	
Sensimetrics S14 insert earphones	Sensimetrics Corporation, Malden, Massachusetts, USA	

Comments/Description
MRI device, using a standard 20-channel receiving head-neck coil
Video editing software used to create the stimuli.
Earplugs compatible for MRI
Software used to analyse the data.
The stimuli were back-projected on a semitransparent screen
Software used to present stimuli during the fMRI scan
Auditory stimulation was delivered through Sensimetrics S14 insert earphones

Dear Phillip Steindel, Ph.D. Review Editor,

We would like to thank you for your comments. Kindly, see attached the revised manuscript with track changes showing corrected references, as well as the new version of the visualization video updated with all requested changes. Kindly, see below our answers to the minor changes you asked us to address before officially publishing.

Editorial comments:

1. 3:41-4:04: please include a space before ‘min’ (e.g. ‘1 min’).

Addressed (see revised video).

2. 5:11-5:48: Please change to match Figure 1D better-‘s’ instead of ‘sec’, ‘1500 ms’, ’40 ms’.

Addressed (see revised video).

3. In the lower thirds, please capitalize the "U" in "Aalto University" as seen @00:07, @00:20, @01:12, @08:21, at @08:33.

Addressed (see revised video).

4. Some references (38, 39, and 40) are cited out of order; please number in order of appearance in the manuscript.

Addressed (see revised manuscript with the order of all references corrected).

We would like to thank you again for helping us improve our manuscript. We hope you will find our manuscript ready to be published. We look forward to having our publication at JoVE.

BR

Mamdooh Afdile

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