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Testing the effects of a disgust placebo with eye tracking

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ABSTRACT

Previous neuroimaging research showed that a disgust placebo (inert pill presented with the verbal suggestion of disgust relief) reduced visual cortex activation during the viewing of disgust-inducing images. In order to investigate whether this effect of automatic emotion regulation was associated with changed visual scanning patterns of the pictures, we conducted two eye tracking experiments. In the first study, 23 women underwent a retest design during which they passively viewed images depicting disgusting, fear-eliciting, neutral items and fractals both with, and without a placebo. The placebo provoked a substantial decrease in experienced disgust. Although none of the recorded eye movement parameters (number of fixations, fixation duration, saccade amplitude, blinking rate) showed placebo-related changes, placebo effects were suggested by an analysis of spatial fixation patterns. In the second study, which focused on attentional (dis)engagement, 46 women looked at two pictures which were presented side-by-side on the screen. These picture pairs (disgust-neutral, neutral-neutral) were once viewed with and once without a placebo. The placebo again provoked a marked decrease of experienced disgust and enhanced the number of fixations for disgusting images. This change might reflect a greater willingness of the participants to view these stimuli while on the placebo.

1. Introduction

A placebo is defined as 'a substance or procedure … that is objectively without specific activity for the condition being treated' (Moerman and Jonas, 2002). The most commonly studied placebo phenomenon is 'placebo analgesia', during which a patient receives a physiologically ineffective intervention (e.g., a pill filled with sugar) with the verbal suggestion that this is a pain-reducing treatment. Several studies were able to demonstrate that this approach leads to pain relief as well as to altered activation in pain-sensitive brain regions (e.g., Wager, 2005).

Investigations with a focus on other somatic response systems or on affective processing showed that placebo effects can be relatively specific. Schienle et al. (2014a, 2014b) administered a 'disgust placebo', an inert pill presented with the verbal suggestion that it reduces disgust symptoms. The participants of this functional magnetic resonance imaging (fMRI) experiment had been asked to passively view disgusting pictures once with, and once without the placebo. The placebo treatment reduced experienced disgust as well as activation in the insula and the visual cortex. The placebo had not evoked neuronal changes during the presentation of fear-relevant pictures, which constituted a control condition. Thus, the explicit verbal suggestion of disgust reduction induced an emotion-specific change of brain activation. The authors had classified this effect as automatic emotion regulation, which does not require overt shifts of (visual) attention, insight or awareness (Gyurak et al., 2011).

As a short-coming of this study it has to be noted that eye movements had not been recorded, which would have been helpful to interpret the placebo-induced reduction of visual cortex activation. Eye tracking can be used to study scanning patterns and changes in visual information intake. To the best of our knowledge, eye tracking has not been used before to evaluate placebo effects. However, it has been employed to study affective picture processing (e.g., Bradley et al., 2011; Pannasch et al., 2008; Kaspar et al., 2013). The findings for passive viewing designs during which the participants were presented with images from the International Affective Picture System (IAPS; Lang et al., 1999) were heterogeneous. Whereas Bradley et al. (2011) demonstrated that pleasant and unpleasant scenes (compared to neutral ones) prompted more fixations and broader scanning of the visual array, Kaspar et al. (2013) found no valence-dependent effects on mean fixation duration and saccade length.

On the other hand, studies which used affective pictures as mood primes or combined the picture presentation with emotion regulation instructions observed more homogenous effects on visual explorative behavior (e.g., Kaspar et al., 2015; Bebko et al., 2011; van Reekum et al., 2007; Xing and Isaacowitz, 2006). For example, van Reekum et al. (2007) asked their participants to perform cognitive reappraisal during the viewing of aversive pictures. When instructed to decrease negative affect, the participants spent less time fixating the picture,

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than in an increase and passive viewing condition. Additionally, the participants looked at emotion-irrelevant details of the pictures more in the decrease condition than in the two other conditions. Similarly, Bebko et al. (2011) showed that participants who conducted cognitive reappraisal or expressive suppression during affective picture viewing looked away from emotion-relevant areas.

We conducted two eye-tracking experiments in order to find out whether a disgust placebo is able to influence visual exploration behavior. In the first study, we chose a passive viewing design as in the previous fMRI investigation (Schienle et al., 2014a). The participants were presented with images depicting disgusting, fear-eliciting, neutral items and fractals both with, and without placebo administration. In the second study two pictures were presented side-by-side on the computer screen followed by a reaction time task. The picture pairs consisted of a disgust image and a neutral image or two neutral scenes. The goal of the two exploratory studies was to investigate whether a disgust placebo would be able to change eye movement parameters (e.g., fixation duration, number of fixations, saccade amplitude) during the viewing of disgust-inducing pictures. In addition, we investigated the spatial exploration behavior. Previous research pointed out, that emotional and motivational states not only influence the number and duration of fixations, but also their spatial distribution (e.g., Kaspar and König, 2011). It is possible that placebo treatment not only alters how long something is inspected, but also where gaze is directed in the picture (e.g., van Reekum et al., 2007; Bebko et al., 2011).

2. Study 1

2.1. Method

2.1.1. Participants

Twenty-three healthy female students with a mean age of M = 25.4 years (SD = 6.6) participated in the experiment. They had normal or corrected-to-normal vision, were free of somatic/mental disorders and the intake of medication (as assured by the Brief Symptom Inventory, Derogatis, 1993). We only included participants with at least moderate disgust proneness in our sample in order to assure sufficient disgust responses to the pictures. The women reported an average score on the questionnaire for the assessment of disgust proneness (QADP) of M = 2.77 (SD = 0.3), which was significantly higher ($p < .001$) than the mean score of the construction sample (Schienle et al., 2002a, 2002b). The sample had been restricted to women because they describe themselves as more disgust-prone than males. The study had been approved by the ethics committee of the University of Graz.

2.1.2. Material and design

The participants viewed a total of 60 pictures from the categories Disgust, Fear, Neutral and Fractal for 6000 ms each.[1] The disgust scenes showed repulsive animals (e.g., maggots, snails), poor hygiene (e.g., dirty toilet, garbage) and unusual/spoiled food (e.g., a man eats a grasshopper). Fear pictures showed attacks by humans or animals (e.g., a man attacks a woman with a knife, a white shark). The neutral pictures depicted nature scenes. The pictures had previously been used in an fMRI study on disgust placebo effects (Schienle et al., 2014a, 2014b). The disgust images were able to induce the target emotion to a significantly higher degree than any other basic emotion, especially fear, and therefore can be considered specific disgust elicitors. Moreover, disgust and fear images had received comparable arousal/intensity ratings (e.g. Schienle et al., 2014a). Fractals were included as an additional control category consisting of a more homogenous set of synthetic stimuli with respect to low- and high-level visual properties. Thus, they allow for a more unambiguous assessment of attentional differences between participants (Benson et al., 2007).

2.1.3. Procedure

All 23 women underwent two sessions during which they passively viewed the pictures while their eye movements were recorded. The sessions were separated by approximately one week.

In one session (the placebo condition), the participants received a placebo pill (a 1 cm long silica-filled capsule) prior to the presentation of the pictures. They were told that the pill contains the homeopathic medicine Anamirta Cocculus, which is used to treat disgust-related symptoms (nausea, diarrhea). Further, they were informed that a previous investigation had already demonstrated that Anamirta Cocculus effectively reduces disgust symptoms, and that the positive effect occurs approximately 15 min after the application. The efficacy of the treatment was investigated with a sham salivary cortisol measurement. An absorbent swab was placed into the mouth of each participant subsequent to the picture viewing. This procedure was introduced in order to direct participants' attention away from the eye tracking.

In the other session (No-placebo condition), the participants received no capsule and viewed the same pictures. The sequence of the pictures within one session was random. The sequence of the two sessions (Placebo, No-placebo) was counterbalanced (12:11) across participants.

Subsequent to the eye tracking sessions, the participants were presented with four sheets of paper depicting the 15 pictures representing an affective category (Disgust, Fear, Neutral, Fractal). They were asked to rate the intensity of elicited fear and disgust for each category by means of 9-point Likert scales (1 = little; 9 = very intense). Mean judgments were obtained for each of the four picture categories. The order of the sheets was randomized to control for sequence effects.

The study was conducted at the University Hospital in Graz, and the experimenters wore white coats during the conduction of the study in order to enhance the credibility of the cover story.

2.1.4. Eye movement recording and analysis

We recorded two-dimensional eye movements using an Eye-Link II eye tracker (SR Research, Canada). The eye tracker is a head-mounted system that uses two infra-red cameras that monitor the eyes at a sampling rate of 250 Hz. It also uses a head movement compensation mechanism. We calibrated both eyes and recorded from the eye that produced the superior spatial resolution, which was better than 0.35° visual angle (v.a.). Displays were presented on a 17-in. TFT monitor with a resolution of 1280 × 1024 pixels running at 60 Hz. All pictures had a size of approximately 20° × 15° v.a. and were presented on a gray background. Participants were seated in a dimly lit room in front of the monitor with a viewing distance of 60 cm. A chin rest was used to minimize head movements. The velocity threshold for saccade detection was set to 35°/s, the acceleration threshold was set to 9500°/s^2. Fixations were defined by the absence of a saccade. The eye tracker was calibrated before the recording using a 9-point calibration procedure. At the beginning of each trial, a white fixation cross was presented in the center of the screen on a gray background. The trial was started by the experimenter only when the fixation on the cross was registered. This step took no longer than 1000 ms. It also served as a drift correction of the eye tracker. Immediately thereafter, a picture was presented for 6000 ms. The experiment was controlled with the Experiment Builder software (SR Research, Canada). Data analysis was conducted using DataViewer software (SR Research, Canada) and custom-written MATLAB scripts.

We analyzed the number of fixations, mean fixation duration, mean saccade amplitude, number of blinks for each picture category (Disgust, Fear, Neutral, Fractal) and compared them between the two conditions (Placebo, No-placebo). In order to investigate the spatial distribution of fixations, we divided each picture into 16 rectangular regions of size 5.0° × 3.75°, forming a 4 × 4 grid. We counted the number of fixations

[1] The numbers of the IAPS pictures (Lang et al., 1999) were: disgust (9140, 9300), fear (1300, 3500, 3530, 6212, 6230, 6312, 6350, 6370, 6510, 6540, 6940, 9910, 99,211), and neutral 5395, 7096, 7160, 7185, 7205, 7211, 7491). The remaining pictures were taken from validated picture sets from Schienle et al. (2002b).