**Emotional self-body odours do not influence the access to visual awareness by emotional faces**

Marta Rocha, Joana Grave, Sebastian Korb, Valentina Parma,Gün R. Semin, and Sandra C. Soares

**Supplementary Materials**

# Sweat Donation Procedure

Before sweat donation, participants completed a 5-days washout period to avoid external stimuli and events that might affect body odour (BO) quality. Thus, during these five days, participants were instructed to wash their bodies (paying special attention to the armpit area) with an odorless shower gel (Laboratoires Dermatologiques A-DERMA, France), to dry their armpits with paper towels provided by the experimenter, to refrain from shaving their armpits, and to avoid using perfume or deodorant. They were also asked to avoid environments with strong smells (e.g., being surrounded by smokers), and to postpone the experimental session in case of any highly arousal events in the days before (e.g., academic evaluation), medication intake, and/or acute sickness (e.g., common cold). In addition, participants were asked to refrain from drinking alcohol and coffee, and from eating foods that could influence BO quality (e.g., garlic) in the three days prior to the session (Lenochova, Roberts, & Havlicek, 2008). To facilitate compliance with the procedure, a diary was generated for each participant, in which they had to check whether they met each of the hygiene, dietary, and behavioural restrictions. We also asked participants to write down the activities that deviate from their daily routines. Participants were encouraged to contact the experimenter in case of any doubt during the washout period.

After the 5-days washout period, participants came to the lab for the sweat donation. Before the beginning of the session, the experimenter asked participants if they had been able to comply with the protocol, the first day of their last menstruation, and if they were feeling sick or had taken any medication. Participants were then instructed to complete the Portuguese version of the Profile of Mood States (POMS-58; Azevedo, Silva, & Dias, 1991; McNair, Lorr, & Droppleman, 1971; the items of Confusion/ Bewilderment dimension were excluded) and the Portuguese version of the State-trait Anxiety Inventory (STAI; Silva & Spielberger, 2007).

McNair et al., 1971; Azevedo et al, 1991; Amaral et al., 2013).

The Portuguese version of POMS was used to evaluate positive and negative affect. The items of

Confusion/ Bewilderment dimension were excluded

McNair et al., 1971; Azevedo et al, 1991; Amaral et al., 2013).

The Portuguese version of POMS was used to evaluate positive and negative affect. The items of

Confusion/ Bewilderment dimension were excluded

After completing the questionnaires, participants were instructed to put on a t-shirt previously washed with an odorless detergent (ECOS – fragrance-free Ultraconcentrated pH balanced Plant-based laundry detergent 50 washes, 1,5L, Free from 1,4-Dioxane, phosphates, palm oil, formaldehyde). Next, the experimenter, wearing disposable gloves, washed participants’ armpits with paper towels and purified water (DIMOR, Portugal) and carefully placed the pads on the right and left armpits. For the sweat collection, we used two breastfeeding cotton pads in each armpit: one in contact with the armpit’s skin (Mercurochrome Baby, Laboratoires JUVA, Portugal) and one external pad (Wells Portugal), covering the first one and secured with adhesive tape (Batist Elastpore). This prevents the “main” pad (i.e., the one with direct contact to participant’s armpit) from contacting the adhesive tape and the t-shirt. Between sweat donations, participants were again asked to refrain from using any fragrance, eating spicy food, and drinking coffee or alcohol.

Each sweat donation started with a 5 min baseline film-clip, followed by the presentation of an approximately20 min set of fearful, happy, or neutral film-clips. The pads were weighed before and after film-clips visualization to measure sweat production. Lab temperature and humidity were also measured before and after each induction.

After each sweat donation, both pads (left and right armpits) were removed, weighted, and cut into four quadrants. For all sweat conditions, two samples were created, each with two quadrants of the left armpit and two quadrants of the right armpit, randomly chosen. This procedure ensures that we have an individual signature and avoid possible differences due to lateralization. The samples were then labeled and stored in a freezer at -20 °C until the date of use.

**Selection of Film-Clips**

The use of film-clips as emotional inducers in a laboratory context is growing given their dynamic and ecologically valid nature, compared to other types of emotional stimuli (e.g., images, music) (Gilman et al., 2017). The multisensory nature of film-clips engages subjects’ attention for longer periods and elicits stronger behavioural and physiological responses (e.g., Frazier, Strauss, & Steinhauer, 2004) compared to unisensory stimuli. Another reason that leads to the exponential use of this powerful technique lies in the fact that films can easily be transformed or adapted to fit specific needs (Gilman et al., 2017), providing an artificial experience that can elicit emotional states close to real-life events without the ethical problem of real-life techniques. Besides the fact that the film industry is constantly improving film’s quality, enhancing the similarity to real-life situations, each created database is specific to the aim of each study.

Sixty Caucasian women from the University of Aveiro took part in the validation study to create a new film-clip database for our emotional induction. To be included, participants should have normal or corrected to normal vision and hearing, and should report no psychological disorders. Since the study aimed to induce emotions, participants were screened using the Portuguese version of the Toronto Alexithymia Scale for an average level of alexithymia (TAS-20; Bagby, Parker, & Taylor, 1994; Portuguese version, translated and adapted by by Verissimo, 2001). Thirteen participants scoring above 57 were excluded from the final sample as high levels of alexithymia are associated with difficulties identifying and describing emotions, decrease of emotional experiences, and external focus of attention (for more information about this construct see Goerlich, 2018). The final sample thus included 47 women, aged between 18 and 35 years (*M* = 22.3, *SD* = 3.71), with Portuguese as their native language. Written informed consent was obtained from all the participants prior to the experiment.

The first step was to select film-clips that could induce fear and amusement as negative and positive emotions, respectively (emotional conditions), and a neutral state (neutral condition). For this purpose, we selected excerpts from comic and horror movies considering: a) previous research in the field, with emphasis on the studies by Arriaga and Almeida (2010), Gross and Levenson (1995), and Schaefer, Nils, Sanchez, and Philippot, (2010) (<https://sites.uclouvain.be/ipsp/FilmStim/film.htm>); b) results from a pilot study by Semin et al., (2015); c) subjective assess of film-clips by five researchers in the area of psychology (for more information see Table S1). Since we wanted to obtain short film-clips with a duration ranging from 1 to 4 min, we only included film-clips with a coherent segment, so subjects can easily understand the story behind them, which increases the emotional meaning of each excerpt. Some of the excerpts selected from the studies mentioned in a) and b) were edited (cut or augmented) to produce a coherent segment within the established duration. Additionally, we selected new excerpts (c) instead of just using the film-clips referred to in previous studies. The main reasons concern the growing development of the film industry at various levels, such as the image quality; the similarity of the film context to the context in which we live today; and the fact that the older and more recognizable the movie, the greater the likelihood that the participant had already seen it. As a result, 15 film-clips per emotional condition were selected (see Table S1).

Before film-clips visualization, participants were instructed to fill out the informed consent form and the sociodemographic questionnaire. Oral and paper instructions about the nature of the task were given. Participants were asked to view 15 scenes from different films with different valences and emotional intensities (five for each emotional condition), followed by a post-film questionnaire about how they felt during the visualization of each film-clip. The questionnaires were numbered from 1 to 45 and organized differentially for each participant according to the version they were undergoing. The films were also numbered from 1 to 45, and the participants were instructed to open the film-clip numbered in the questionnaire by the order they appeared. Participants were not asked to view the total of 45 film-clips as this would significantly increase task duration and potentially lead participants to feel tired and to provide “unreal” responses. Therefore, we created six versions to guarantee that each film-clip was presented with different orders and within different combinations of film-clips. During the task, they were instructed to keep their eyes on the computer screen, to avoid closing their eyes, and to put headphones provided by the experimenter. The task was performed in groups of three participants per room. However, each participant had their own space separated by folding screens to give privacy and avoid external distractions. The computers and headphones used had similar characteristics. As soon as all participants were ready, the intensity of the lights in the lab was reduced, and the task began. To avoid interrupting other participants’ task, those who finished first were instructed to wait on their site until the experimenter's order. After each visualization, they were asked to complete a post-film questionnaire about their emotional state (Rottenberg, Ray, & Gross, 2007). In this questionnaire, participants had to rate the emotions they felt during the film’s visualization, measuring both the discrete (specific) and dimensional (pleasantness) emotions. Participants rated each term on a 9-point Likert scale ranging from 0 (“not at all”) to 8 (“extremely”), while the dimensional valence was anchored by unpleasant and pleasant labels. It was also possible for the participants to name another emotion they felt while viewing the clip, in addition to those presented in the questionnaire. The emotions described in the questionnaire cover a wide range of positive and negative emotional states, which makes it possible to compare the films used to induce the different emotional states. Finally, they were asked whether they had looked away from the screen or closed their eyes. The experiment lasted an average of 60 min.

**Table S1.** Film-clips used in the pilot study and their duration.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Condition** | **Number** | **Name** | **Selected from** | **Duration** |
| Neutral | 1 | Easter Island – Solar Eclipse (2010) | Ferreira et al., (2017) | 20’ |
| Negative | 16 | The Ring (2002)\* | Semin et al., (2015) | 4' |
| 17 | Shining (1980) | Semin et al., (2015) | 2'15'' |
| 18 | Conjuring\* (2013) | Semin et al., (2015) | 3’08’’ |
| 19 | The Exorcist (1973) | Schaefer et al., (2010) | 1’43’’ |
| 20 | A Nightmare on Elm Street (2010)\* | Our team | 2’42’’ |
| 21 | Blair Witch Project (1999)\* | Schaefer et al., (2010) | 3’58’’ |
| 22 | Child’s Play 2: Chucky’s Back (1990) | Schaefer et al., (2010) | 1’09’’ |
| 23 | Sleepy Hollow (1999) | Semin et al., (2015) | 3’06’’ |
| 24 | ﻿ Paranormal Activity 1 (2007)\* | Our team | 3’24’’ |
| 25 | Misery (1990) | Schaefer et al., (2010) | 3’35’’ |
| 26 | Seven (1995) | Schaefer et al., (2010) | 1’47’’ |
| 27 | The Silence of the Lambs (1991) | Rottenberg, Ray and Gross (2007) | 3’29’’ |
| 28 | Scream (1996) | Semin et al., (2015) | 3’49’’ |
| 29 | It (1990)\* | Our team | 2’12’' |
| 30 | Sinister (2012) | Our team | 3’07’ |
|  | 31 | The Dinner Game (1998) | Schaefer et al., (2010) | 1’43’’ |
|  | 32 | When Harry Met Sally (1989) | Schaefer et al., (2010) | 2’53’’ |
|  | 33 | There Is Something About Mary (1998) | Schaefer et al., (2010) | 2'54 |
| Positive | 34 | Due Date (2010) | Our team | 2’29’’ |
| 35 | Les Visiteurs (1993) | Schaefer et al., (2010) | 2’14’’ |
| 36 | Mr. Bean (1990)\* | Our team | 3’26’’ |
| 37 | Goodnight Mr. Bean (1995)\* | Our team | 3’27’’ |
| 38 | The Intouchables (French film, 2011) | Our team | 2’51’’ |
| 39 | There Is Something About Mary (1998) | Schaefer et al., (2010) | 2’33’’ |
|  | 40 | Mr. Bean. – Back to school (1994) \* | Our team | 3’59’’ |
|  | 41 | Mr. Bean. – Back to school (1994) \* | Our team | 2’22’’ |
|  | 42 | The 40 Year-old Virgin (2005) | Our team | 3’27’’ |
|  | 43 | Mr. Bean. – Back to school (1994) \* | Our team | 3’21’’ |
|  | 44 | Mr. Bean – Best off (1995) / The Trouble with Mr. Bean (1992) | Our team | 3’26’’ |
|  | 45 | Mr. Bean. – Back to school (1994) \* | Our team | 3’30’’ |

\*Film-clips selected to induce emotions during the BO collection based on the participant’s ratings.

**Room temperature and humidity**

We ran two repeated-measure-ANOVA with two within-subject factors (session: fearful, happy, neutral; time: before, after donation) for temperature and humidity. Data from 7 participants are missing due to technical problem. Concerning temperature, the Mauchly’s test indicated that the assumption of sphericity had been violated for the main effect of session χ2(2) = 23.39, *p*<.001. Therefore, degrees of freedom were corrected using Creenhouse-Geisser estimates of sphericity (ε = 0.64). Results showed a main effect of session, *F*(1.28, 37.03) = 8.70, *p* = .003. Particularly, temperature in neutral session (*M* = 22.72, *SE* = .41) was significantly lower than in fearful (*M* = 23.14, *SE* = .37, *p* < .001) and happy sessions (*M* = 23.34, *SE* = .36, *p* = .008).

With respect to the humidity, the results revealed a main effect of session, *F*(2, 60) = 3.64, *p* = .032, and time, *F*(1, 30) = 10.99, *p* = .002. Concerning the main effect of the session, humidity in happy session was significantly higher (*M* = 51.4%, *SE* = 1.3%) than neutral session (*M* = 50.5%, *SE* = 1.2%, *p* = .023). For the main effect of time, humidity was significantly higher after *(M* = 51.0%*,* *SE* = 1.3%) than before collection (*M* = 50.7%, *SE* = 1.3%).

**Visual Stimuli for the bCFS and noCFS tasks**

A total of 18 male faces depicting fearful, happy, and neutral expressions were retrieved from the Karolinska Directed Emotional Faces (identity-numbers: AM05, AM08, AM10, AM11, AM17, AM28, BM28 – only fearful and neutral expressions were selected for AM28, and only happy expression was selected for BM28) (Lundqvist et al., 1998). Face stimuli were chosen with the following criteria: 1) comparable attractiveness; 2) comparable intensity of the emotion of reference; and 2) matching of important low-level visual features across conditions (e.g., presence of teeth in the fearful and happy conditions). Faces were translated and rotated using the GIMP software (http://www.gimp.org) so that the position of the eyes was aligned across all stimuli. To improve suppression, each face was put into grayscale, a grey frame with a central oval-shaped opening was superimposed onto each face, and the oval edge of the superimposed frame was smoothed using a Gaussian filter. The luminance of all stimuli was equalized using the SHINE toolbox (Willenbockel et al., 2010a) in Matlab (http://www.mathworks.com/). A grey background was set to the mean luminance resulting from normalization. We also verified that facial expressions did not differ in terms of power in spatial frequency bands. Low (<1 cycles/degree), medium (1 - 4 cycles/degree), and high (4 - 20 cycles/degree) spatial frequency bands were selected based on the literature (Corradi-Dell’Acqua et al., 2014; Schyns & Oliva, 1999; Vuilleumier et al., 2003). Using in-house made Matlab scripts, partly adapting the sfPlot.m script of the SHINE toolbox (Willenbockel et al., 2010b), power in these spatial frequency bands were extracted for each face image, averaged across all directions, and analysed in a one-way ANOVA with the factor emotion (happy, fearful, neutral). No significant effect of emotion was found in the low, *F*(2, 17) = 1.78, *p* = .20, medium, *F*(2, 17) = 3.09, *p* = .07, and high-frequency bands, *F*(2, 17) = 2.81, *p* = .09. Also, using Bonferroni correction, no significant differences between emotional faces in each frequency band were found (*ps* > .050).

## Results

## *Sweat Donation*

Based on the nine emotion intensity ratings, we created two scores: one for positive emotions (averaging ratings of happiness, joy, and amusement) and one for negative emotions (averaging ratings of fear and anxiety). We ran a repeated-measure-ANOVA with three within-subject factors (session: fearful, happy, neutral; emotion: positive, negative; time: baseline, film-clip). The Mauchly’s test indicated that the assumption of sphericity had been violated for the two-way interaction between emotion and session, *ω2*(2) = 6.96, *p* = .031, and for the three-way interaction, *ω2*(2) = 7.26, *p* = .027. Therefore, degrees of freedom were corrected using Greenhouse estimates of sphericity (*ε* = 0.85 and *ε* = 0.85 for the two-way interaction and the three-way interaction, respectively).

All main effects and interactions were significant (all *p* < .010). Concerning the three-way interaction, *F*(1.69, 62.57) = 176.67, *p* < .001, post-hoc comparisons showed, as expected, significantly higher negative emotions (*p* < .001) and lower positive emotions after film-clips than baseline in fearful session (*p* < .001), and significantly higher positive emotions after film-clips than baseline in happy session ( *p* < .001). No other significant differences between baseline and film-clips were found (all *p* > .050) (Figure 2). Concerning baseline, we found that positive and negative emotions did not significantly differ between sessions (all *p* > .050).

### *bCFS versus noCFS*

The winning model included task (bCFS, noCFS) × face (fearful, happy, neutral) × self-BO (fear, happiness, neutral) as fixed effects; trial number as covariate; and by-subject intercept and slope for face (1 + face|subject), and by-actor intercept (1|actor) as random factors. The remaining fixed effects did not significantly modulate untransformed RTs. The winning model showed a marginal R-squared of 0.25, a conditional R-squared of 0.42, and an ICC of 0.22.

Type-III F-tests with Satterthwaite’s method revealed a main effect of task, *F*(1, 15797) = 6658.38, *p* < .001, with significantly shorter RT in the noCFS (*M* = 1.49, *SE* = 0.08) than the bCFS task (*M* = 2.31, *SE* = 0.08). There was also a main effect of face, *F*(2, 38) = 26.39, *p* < .001. Post-hoc analyses showed (Figure S1) that RT were significantly shorter in happy faces (*M* = 1.83, *SE* = 0.08) than fearful (*M* = 1.95, *SE* = 0.08, *p* < .001) and neutral faces (*M* = 1.93, *SE* = 0.08, *p* < .001), with no significant difference between fearful and neutral faces (*p* = .971). Although the interaction between task and face was significant, *F*(2, 15798) = 6.89, *p* = .001, post-hoc analyses showed that, for both the bCFS and the noCFS tasks, happy faces (bCFS: *M* = 2.21, *SE* = 0.08; noCFS: *M* = 1.44, *SE* = 0.08) broke visual suppression significantly faster than fearful (bCFS: *M* = 2.37, *SE* = 0.08, *p* < .001; noCFS: *M* = 1.53, *SE* = 0.08, *p* = .002) and neutral faces (bCFS: *M* = 2.36, *SE* = 0.08, *p* < .001; noCFS: *M* = 1.51, *SE* = 0.08, *p* = .014), with no significant difference between fearful and neutral faces (both *p* = 1.000). Moreover, for all facial expressions, RTs were significantly shorter in the noCFS than the CFS task (all *p* < .050).[[1]](#footnote-1) Lastly, there was a main effect of trial number, *F*(1, 15870) =174.76, *p* < .001, with faster RTs as tasks progressed. No other significant effects or interactions were found (*p > .*050).

Chart, box and whisker chart

Description automatically generated

**Figure S1.** Boxplot with jittered datapoints for RT (untransformed) to detect the location of a face stimulus, as a function of task (bCFS, noCFS) and facial expression (fearful, happy, neutral). To facilitate visualization, significance levels were calculated from individual models for each face. \*\*\* *p* < .001, \*\* *p* < .01, \* *p* < .050.

**References**

Arriaga, P., & Almeida, G. (2010). Fábrica de emoções: A eficácia da exposição a excertos de filmes na indução de emoções. Laboratório de Psicologia, 8(1), 63–80. https://doi.org/10.14417/lp.649

Azevedo, M., Silva, C., & Dias, M. O. (1991). “Perfil de Estados de Humor”: Adaptação à População Portuguesa. PsiquiatriaClínica, (93), 12–187.

Bagby, R. M., Parker, J. D. A., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia scale-I. Item selection and cross-validation of the factor structure. Journal of Psychosomatic Research, 38(1), 23–32. https://doi.org/10.1016/0022-3999(94)90005-1

Corradi-Dell’acqua, C., Schwartz, S., Meaux, E., Hubert, B., Vuilleumier, P., & Deruelle, C. (2014). Neural responses to emotional expression information in high- and low-spatial frequency in autism: evidence for a cortical dysfunction. Frontiers in Human Neuroscience, 8, 189. http://doi.org/10.3389/fnhum.2014.00189

Frazier, T., Strauss, M., & Steinhauer, S. (2004). Respiratory sinus arrhythmia as an index of emotional response in young adults. Psychophysiology, 41, 75–83. https://doi.org/10.1046/j.1469-8986.2003.00131.x

Gilman, T. L., Shaheen, R., Nylocks, K. M., Halachoff, D., Chapman, J., Flynn, J. J., … Coifman, K. G. (2017). A film set for the elicitation of emotion in research: A comprehensive catalog derived from four decades of investigation. Behavior Research Methods, 1–22. https://doi.org/10.3758/s13428-016-0842-x

Goerlich, K. S. (2018). The multifaceted nature of alexithymia - A neuroscientific perspective. Frontiers in Psychology, 9(AUG), 1614. https://doi.org/10.3389/FPSYG.2018.01614/BIBTEX

Gross, J. J., & Levenson, R. W. (1995). Emotion elicitation using films. Cognition & Emotion, 9(1), 87–108. https://doi.org/10.1080/02699939508408966

Lenochova, P., Roberts, S. C., & Havlicek, J. (2008). Methods of Human Body Odor Sampling: The Effect of Freezing. Chemical Senses, 34(2), 127–138. https://doi.org/10.1093/chemse/bjn067

McNair, D., Lorr, M., & Droppleman, L. (1971). Edits manual for the profile of mood states.

Rottenberg, J., Ray, R. D., & Gross, J. J. (2007). Emotion Elicitation Using Films. In A. Coan & J. J. B. Allen (Eds.), Handbook of emotion elicitation and assessment (pp. 9–28). Oxford: Oxford University Press.

Schaefer, A., Nils, F., Sanchez, X., & Philippot, P. (2010). Assessing the effectiveness of a large database of emotion-eliciting films: A new tool for emotion researchers. Cognition and Emotion, 24(7), 1153–1172. https://doi.org/10.1080/02699930903274322

Schyns, P. G., & Oliva, A. (1999). Dr. Angry and Mr. Smile: when categorization flexibly modifies the perception of faces in rapid visual presentations. Cognition, 69(3), 243–265. https://doi.org/10.1016/S0010-0277(98)00069-9

Silva, D. R., & Spielberger, C. D. (2007). Manual do inventário de estado-traço de ansiedade (STAI). Manual of the State-Trait Anxiety Inventory]. Published by Mind Garden, Inc.

Verissimo, R. (2001). The Portuguese version of the 20-item Toronto Alexithymia Scale--I. Linguistic adaptation, semantic validation, and reliability study. Acta Medica Portuguesa, 14(5–6), 529–536.

Vuilleumier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. Nature Neuroscience, 6(6), 624–31. https://doi.org/10.1038/nn1057

Willenbockel, V., Sadr, J., Fiset, D., Horne, G. O., Gosselin, F., & Tanaka, J. W. (2010). Controlling low-level image properties: the SHINE toolbox. Behavior Research Methods, 42(3), 671–684. http://doi.org/10.3758/BRM.42.3.671

1. Similar analysis using log-transformed RTs instead for untransformed RT as dependent variable showed a non-significant interaction between task and face, *F*(2, 15799) = 0.80, *p* = .447. All other main effects remained the same. [↑](#footnote-ref-1)