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# The Influence Of Natural And Induced Emotional States On The Recognition Of Emotional Facial Expressions

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# THE INFLUENCE OF NATURAL AND INDUCED EMOTIONAL STATES ON THE RECOGNITION OF EMOTIONAL FACIAL EXPRESSIONS[3,4]

There are a number of factors that influence emotion recognition, one of which is the perceiver's emotional state. This study verifies the predictions of two theories concerning the influence of mood on emotion recognition. According to the affect-as-information theory, people in a positive mood are prone to a more global processing style and perceive emotional facial expressions more easily compared to those in a negative mood. The emotion congruence theory claims that people in a positive mood are more sensitive to positive expressions and people in a negative mood are more sensitive to negative expressions. These predictions were tested with the experimental paradigm using morphed faces developed by Jackson and Arlegui-Prieto. Study 1 used participants' natural moods; its findings failed to replicate the main results of the original study. Study 2 used laboratory mood induction and showed that participants in a negative mood are more sensitive to negative emotions compared to those in positive mood. These findings support the emotion congruence theory. However, this result was obtained only for the participants with the most effective mood induction. The observed effects of mood are weak and fragile. For more persuasive results, a study with greater statistical power using more effective mood induction procedures is needed.

JEL Classification: Z

Key words: mood, emotion recognition, mood induction, facial morphing task.

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# Introduction

The ability to recognize emotions from facial expressions is crucial for normal social functioning. The speed and accuracy of recognition play an important role in recognition, in order to respond in a suitable way. There are a number of factors that influence emotion recognition efficiency. This study focuses on the influence of emotional states and emotional traits on emotion recognition. Jackson and Arlegui-Prieto (2016) showed that emotion recognition can be affected by the current emotional state, however the results seem to be ambiguous. They developed a procedure that could clarify the influence of emotional states on emotional face perception and emotion recognition.

Changing the classical facial morphing task, Jackson and Arlegui-Prieto distinguished facial feature perception from emotion recognition and analyzed their correlation with the current emotional state of a participant. They distinguished two forms of sensitivity, perceptual and conceptual. Perceptual sensitivity is related to the ability to notice physical changes in expression; conceptual sensitivity is related to the ability to understand the meaning of expression. Two types of thresholds can be distinguished, perceptual and conceptual, correspondingly. This work tested the predictions of competing theories of the influence of emotional state on the cognitive processes. We considered two theories: affect-as-information theory (Schwarz & Clore, 2003) and emotion congruence theory (Bower,1981).

One version of affect-as-information theory proposes that the emotional state of a person influences perception (Schwarz & Clore, 2003). This influence is such that a positive emotional state leads to a more global level of processing whereas a negative emotional state leads to a narrower and more precise way of thinking. Emotion congruence theory (Bower, 1981) originally concerns the effects of congruence in memory. Bower's study showed that participants memorized and/or recalled events that share the same valence with their current emotional state more easily. This is called the emotion congruence effect. Bower explained this using the idea of an emotional semantic network. This explanation can be extrapolated to other cognitive processes such as emotion recognition.

The original study carries out by Jackson and Arlegui-Prieto (2016) hypothesized that according to the affect-as-information theory (Schwarz & Clore, 2003) participants in a positive emotional state would have a lower *conceptual* threshold in the recognition of all emotions, whereas participants in a negative emotional state would have a lower *perceptual* threshold in the recognition of all emotions. In contrast, according the emotion congruence theory (Bower,1981), the original study hypothesized that participants in a positive emotional state recognize positive emotions faster on both thresholds and participants in a negative emotional state recognize negative emotions faster on both thresholds.

The results were ambiguous. Negative mood scores had a significant positive correlation with the anger and sadness conceptual thresholds. Positive mood scores had a significant positive correlation with the anger and sadness perceptual thresholds and also had a positive correlation with the anger and sadness conceptual thresholds. Thus, any emotional state, regardless of its valence, raised recognition thresholds for anger and sadness. These findings provided no support to either of the two theories.

Considering that the sample included only healthy participants, it is questionable if the authors obtained enough variability in mood to observe the effects. It has been shown that healthy participants arrive at the experiment being in a mild positive emotional state (Lyusin, Kozhukhova & Suchkova, 2019). The same can be observed in the original study – the negative affect scores of the Positive Affect Negative Affect Schedule (PANAS; Watson, & Clark, 1994; Osin, 2012) are in the lower range of the Negative Affect (NA) scale.

In the current study, a different method was applied to test the hypotheses of the original study (Jackson & Arlegui-Prieto, 2016). This study examined the influence of emotional states on emotion recognition while the procedure allowed examining only correlations saying nothing about the causation. Our experiment, based on the ideas of the original study, checked if the results would be replicated in a Russian sample. Taking into account the effects of emotional traits on different cognitive processes (Levens & Gotlib, 2010; Pe, Koval & Kuppens, 2013) a number of emotional trait inventories were included.

Hypothesis 1 assumed that a positive emotional state would result in lower the conceptual thresholds, whereas a negative emotional state would result in lower the perceptual thresholds. Hypothesis 2 assumed that perceptual and conceptual thresholds would be lower if participants' emotional states match the presented emotional expression in valence.

# Experiment 1

## Method

### Participants

52 participants with normal or corrected to normal vision took part in the experiment in exchange for course credits. During data preparation, 5 participants were dropped from the analysis because they failed to follow the instructions; they did not respond to minimal change in face images (see the Procedure section for details). The final sample included 47 participants aged from 17 to 30 (*M* = 21.0; *SD* = 2.72): 33 females and 14 males. The study was approved by the Institutional Review Board of HSE University.

## Materials

*Facial morphing task*

To assess the efficiency of emotion recognition, a facial morphing task was used. The task and stimuli were taken from Jackson and Arlegui-Prieto (2016). In the facial morphing task, the faces of three actors expressing six emotions (happiness, sadness, anger, fear, surprise and disgust) taken from the Radboud Faces database (Langner et al., 2010), were presented in their morphed versions. The stimuli were mixed images, each of which was a combination of two face images, neutral and emotional. The stimuli were presented in sequence (see Figure 1). Each sequence included 51 unique images and 10 duplicated. The duplicates were inserted into the sequences randomly to prevent the effects of learning. Morphed images were made by Joormann and Gotlib (2006) with FantaMorph software (Abrosoft, Beijing, China). Every unique image in the sequence differed 2% from the previous one and was presented on the screen for 500 ms with no interval between the stimuli.

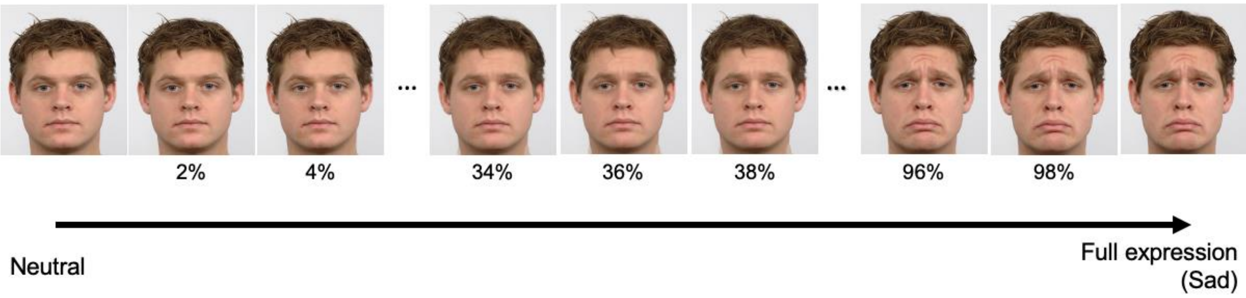


*Figure 1*. Sequence of morphed images from a neutral to sad emotional expression.

*Emotional state and emotional trait assessment*

The Russian adaptation of PANAS was used to measure participants' emotional state. Since the study was supplemented with the measurement of emotional traits, the levels of subjective well-being, trait anxiety and depression were assessed. The subjective well-being was assessed using the Russian adaptation of the Satisfaction With Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985; Leontiev & Osin, 2008) and the Subjective Happiness Scale (SHS; Lyubomirsky & Lepper, 1999; Leontiev & Osin, 2008). Trait anxiety was measured using the Russian adaptation of The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; Hanin, 1976). The level of depression was measured using the Russian adaptation of the Beck Depression Inventory (BDI; Beck et al., 1961; Tarabrina, 2001).

## Procedure

The study was run in a quiet and isolated room. PsychoPy v. 1.84.2. (Peirce, 2009) was used for stimuli presentation and response registration. At the beginning of the experiment, participants filled out a consent form and a Russian adaptation of the PANAS questionnaire (Watson & Clark, 1994; Osin, 2012). Following this, the practice session of the study began. In the practice session, 2 emotions – fear and disgust – were employed. The participants were presented with 30 practice trials, 15 for disgust and 15 for fear. 15 trials for each emotion consisted of 5 presentations of each emotion obtained from each of 3 actors. Similarly, in the main session of the study the participants were presented with 15 trials for each emotional expression, but since the emotions included happiness, sadness, anger and surprise, this resulted in 60 trials. The trials were presented in a random order. The structure of a trial was identical in the practice and in main sessions. Participants were presented with a sequence of morphed images from a completely neutral image to a completely emotional one. The participants were asked (1) to indicate when they saw a minimal change in face image (*perceptual sensitivity*), after this step the sequence continued; (2) to indicate, when they were able to name the emerging emotion (*conceptual sensitivity*), after this step the sequence terminated, and the participants were presented with a list of words naming emotions; (3) to choose from the list the emotion that was emerging in the face (*accuracy*). In the practice session, the list of emotions consisted of two items, fear and disgust; in the main session, the list of emotions consisted of four items, happiness, sadness, anger and surprise. After completing both sessions, the participants were asked to fill out the 4 emotional trait questionnaires mentioned above.

## Results

To check the comparability of the result of the current study with the original, the differences between the mean scores of both studies were tested for significance using Student's t-tests. Descriptive statistics are shown in Table 1. For most of the scores obtained in the original study and in the current study, differences are not significant, therefore, the results are comparable.

Table 1. Descriptive statistics and comparison of mean scores between studies with Bonferroni corrections.

| | Original study, n = 46<br>M (SD) | Our study, n = 47<br>M (SD) | Student's<br>*t* (91) | *p* |
|---|---|---|---|---|
| **Accuracy** | | | | |
| Anger | 88.85 (13.83) | 0.88 (0.12) | -0.335 | >.99 |
| Happiness | 98.57 (2.95) | 0.99 (0.04) | - 0.048 | >.99 |
| Sadness | 97.39 (5.65) | 0.94 (0.08) | -2.195 | .435 |
| Surprise | 97.70 (4.68) | 0.97 (0.05) | -0.299 | >.99 |
| *Overall* | 95.62 (8.83) | 0.95 (0.09) | - | - |

| | | | | |
|---|---|---|---|---|
| **Perceptual threshold** | | | | |
| Anger | 25.37 (10.05) | 27.81 (10.25) | 1.157 | >.99 |
| Happiness | 16.75 (4.79) | 19.02 (7.08) | 1.808 | >.99 |
| Sadness | 24.14 (8.71) | 27.77 (9.02) | 1.977 | .715 |
| Surprise | 16.64 (6.27) | 18.05 (6.22) | 1.089 | >.99 |
| *Overall* | 20.73 (8.68) | 23.16 (9.45) | - | - |
| **Conceptual threshold** | | | | |
| Anger | 37.31 (10.24) | 38.07 (12.12) | 0.155 | >.99 |
| Happiness | 22.96 (5.22) | 25.73 (9.59) | 1.736 | >.99 |
| Sadness | 34.11 (7.67) | 36.46 (9.86) | 1.284 | >.99 |
| Surprise | 25.98 (5.73) | 25.55 (7.79) | -0.308 | >.99 |
| *Overall* | 30.19 (9.52) | 31.45 (11.48) | - | - |
| **PANAS** | | | | |
| Positive mood score | 77.65 (15.51) | 88.92 (19.23) | 3.111 | .035 |
| Negative mood score | 48.41 (13.72) | 54.69 (19.95) | 1.774 | >.99 |

*Note: PANAS scores in the current study were multiplied by three in order to make results within the same range.*

To check the influence of the type of emotional expression on recognition efficiency, 3 separate analyses of variance (1x4) were performed, where *emotional expression* was a factor, and accuracy, perceptual threshold, and conceptual threshold were dependent variables.

*Accuracy*

For accuracy scores, a one-way repeated measures ANOVA (1x4) showed a significant influence of *emotional expression* ($F(3,123) = 15.62$, $p < .001$; $\eta_p^2 = 0.276$). Pairwise t-tests with Bonferroni corrections showed significant differences in accuracy between anger and happiness ($t(41) = -5.300$, $p <. 001$, $d = -1.085$), anger and sadness ($t(41)= -2.870$, $p = .039$, $d = -0.611$), anger and surprise ($t(41) = -5.021$, $p < .001$, $d = -1.125$). Differences between happiness and sadness ($t(41) = 2.571$, $p = .083$, $d = 0.564$); happiness and surprise ($t(41) = 0.240$, $p > .99$, $d = 0.054$); sadness and surprise ($t(41) = -2.682$, $p = .063$, $d = -0.542$) were not significant.

*Perceptual threshold*

For perceptual thresholds, a one-way repeated measures ANOVA (1x4) showed a significant influence of *emotional expression* ($F(3,123) = 74.495$, $p <. 001$, $\eta_p^2 = 0.645$). Pairwise t-tests with Bonferroni corrections showed significant differences between anger and happiness

($t$(41) = 8.117, $p$ < .001, $d$ = 0.904); anger and surprise ($t$(41) = 11.576, $p$ < .001, $d$ = 0.846), happiness and sadness ($t$(41) = -7.993, $p$ < .001, $d$ = -1.012); sadness and surprise ($t$(41) = 11.265, $p$ < .001, $d$ = 1.042). Differences between happiness and surprise: ($t$(41) = 1.553, $p$ = .767 $d$ = 0.151); anger and sadness: ($t$(41) = -0.831, $p$ >.99, $d$ = - 0.050) were not significant.

*Conceptual threshold*

For conceptual thresholds, a one-way repeated measures ANOVA (1x4) showed a significant influence of *emotional expression* ($F$(3,123) = 91.302, $p$ < .001, $\eta_p^2$ = 0.690). Pairwise t-tests with Bonferroni corrections showed significant difference between all but one pairs of emotional expressions types. Anger and happiness ($t$(41) = 9.657, $p$ <.001, $d$ = 1.244); anger and sadness: ($t$(41) = 3.587 , $p$ = .005, $d$ = 0.218); anger and surprise: ($t$(41) = 14.153, $p$ < .001, $d$ = 1.122); happiness and sadness ($t$(41) = -8.402, $p$ < .001, $d$ = -1.117); sadness and surprise ($t$(41) = 12.393, $p$ < .001, $d$ = 1.171) differed significantly, whereas happiness and surprise: ($t$(41) = 0.418, $p$ < .99, $d$ = 0.046) did not.

To examine the relations between emotion recognition efficiency and emotional states and traits, the Pearson's correlation coefficients were computed. After Bonferroni corrections all correlations were not significant.

## Discussion

No significant correlation between different parameters of emotion recognition efficiency and emotional state scores was obtained. Therefore, neither of the hypotheses were supported. No correlations between emotion recognition efficiency parameters and emotional trait scores were significant. However, we found the influence of emotional expression types on the efficiency of emotion recognition similar to the original study.

The findings failed to replicate the relationships between the emotional states and thresholds reported in the original study. This can be explained by the use of different questionnaire versions, since in the original study PANAS-X was applied, and in the current study it was PANAS. These two versions differ, as PANAS-X consists of 60 items, while PANAS consists of only 20 items. We used PANAS because PANAS-X is not available in the Russian language. The primary analysis performed on the mean scores of the current and original data showed a significant difference in the negative mood scores but not in the positive mood scores. The absence of a significant correlation for negative mood scores could be due to instrumental reasons, although this explanation does not hold for the positive mood scores. Another possible explanation is the use of the correction for multiple significance tests, as in the original study the authors did not apply this correction.

# Experiment 2

## Method

### Participants

65 participants took part in the experiment in exchange for course credits. The second study had a between-group design as only one out of two moods (happy or sad) was induced in each participant. The participants were divided into groups randomly. The group in which happiness was induced (happy group) consisted of 34 participants, the group in which sadness was induced (sad group) consisted of 31 participants. During data preparation 8 participants were removed from the analysis because they failed to follow the instructions; they did not respond to minimal change in face images (see the Procedure section for details). The final sample consisted of 57 participants. Happy group included 30 participants aged from 18 to 30 ($M$ = 20.47, $SD$ = 2.57): 25 females and 5 males. Sad group consisted of 27 participants aged from 18 to 23 ($M$ = 19.30, $SD$ = 1.03): 22 females and 5 males. The study was approved by the Institutional Review Board of HSE University.

### Materials and procedure

The materials and procedure did not differ from the first study with one exception: the second study included mood induction and a mood manipulation check. Videos were used to induce emotional state (for more details see Table 3). The videos were shown to participants three times during the main part of the experiment, at the beginning, after 20 trials, and after 40 trials. A neutral video was played during the practice session to "normalize" the baseline emotional state and make the participants familiar with the main procedure (Figure 2). The participants performed the experiment wearing headphones.

Table 3. Videos used to induce positive, negative and neutral emotional states, including description and reference to the study in which they were approbated or used.

| | Duration | Description | Approbation |
|---|---|---|---|
| *For neutral mood induction* | | | |
| Dolphins | 2’35” | Underwater world in which a flock of dolphins swim | Pankratova & Lyusin, 2018 |

*For sad mood induction*

| | | | |
|---|---|---|---|
| Father and Daughter | 6’43’’ | Father leaves daughter by the river. The daughter is waiting for him for several years. The cartoon ends with a scene where a grownup daughter finds her father's boat wrecked in the river. | Lyusin, Kozhukhova, Suchkova, 2019; Chentsova Dutton, Parrott, Lyusin, 2013 |
| My Girl (1991) | 2’28’’ | Young boy's funerals, the boy's friend does not understand her friend's death and cries | Gabert-Quillen, Bartolini, Abravanel & Sanislow, 2015 |
| Grandpa | 1’19” | German social advertising. An old man is left alone on Christmas eve | Pankratova & Lyusin, 2018 |

*For happy mood induction*

| | | | |
|---|---|---|---|
| Ormie 2010 | 2’57’’ | The pig is trying to get cookies from the top of the refrigerator. | - |
| Oktapodi 2007 | 2’02’’ | Octopus is trying to return its lover, who was taken out of their aquarium | Lyusin, Kozhukhova, Suchkova, 2019; Chentsova Dutton, Parrott, Lyusin, 2013 |
| Bruce Almighty 2003 | 0’36’’ | Man is singing and walking through the streets to the rhythm of the 90's song "I've got the Power." | Uhrig, et al., 2016 |

As mood induction was introduced into the experiment, the mood manipulation checks were added to both the practice and main sessions of the experiment and followed the blocks of trials. Measures for mood manipulation checks included two 7-point Likert scales, one for positive mood assessment and one for negative mood assessment. In the mood manipulation check, the participants were asked to assess their emotional state from 1 (not negative or positive at all) to 7 (completely negative or positive). The two scales were presented to each participant in order to check their mood after the practice session and then after every 20-trial block of the main session.

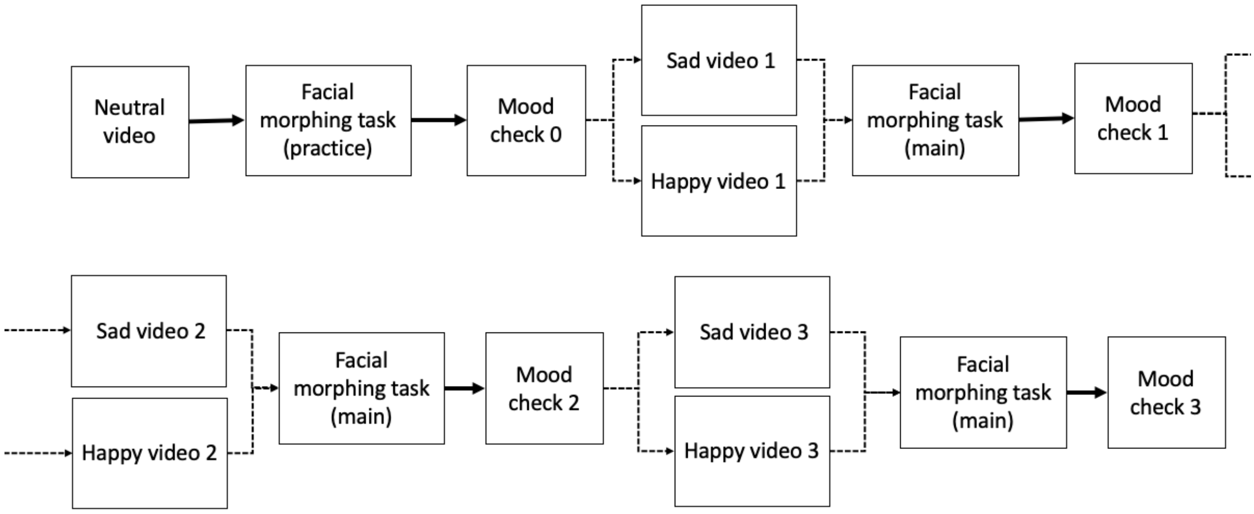


*Figure 2.* Procedure of the experiment. Dotted lines show different experimental paths for the sad and happy groups of participants.

## Results

*Effectiveness of mood induction*

2 two-way repeated measures ANOVAs (2x2) were performed on positive and negative mood scores to assess the overall effectiveness of mood induction, where the time of measurement (before or after mood induction) and mood (happy or sad) were taken as factors. Mean scores obtained in three mood manipulation checks were used as indicators of mood after mood induction. For positive mood scores, the results showed a significant influence of mood ($F(1,224) = 101.420$, $p < .001$, $\eta_p^2 = .31$) and the mood and the time of measurement interaction ($F(1,224) = 13.51$, $p < .001$, $\eta_p^2 = .06$). The effect of the time of measurement was not significant ($F(1, 224) < 1$).

For negative mood scores, the results showed a significant influence of mood ($F(1,224) = 5.86$, $p = .016$, $\eta_p^2 = .026$), though the influence of the time of measurement ($F(1, 224) < 1$) and their interaction ($F(1,224) < 1$) was not significant (Fig. 3). Descriptive statistics are shown in Table 4.

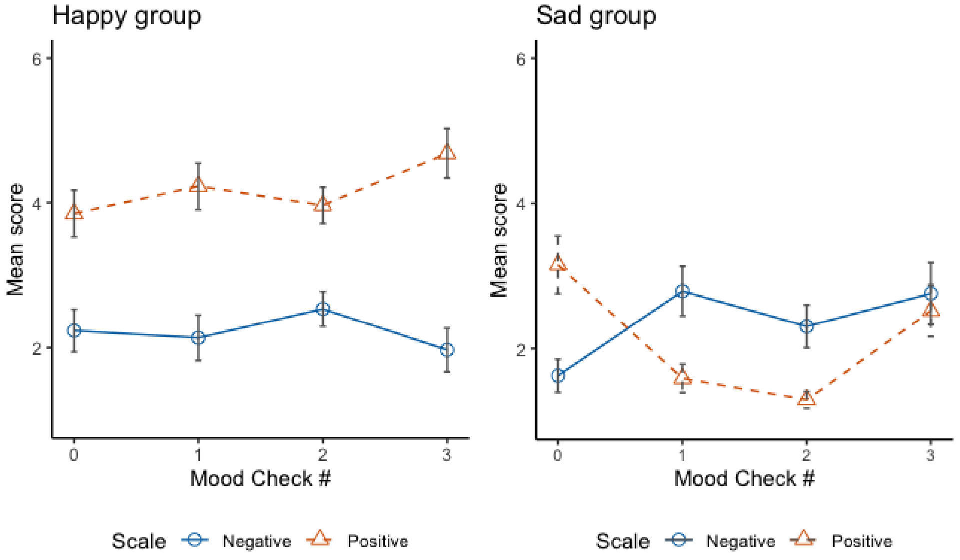


*Figure 3*. Change of positive and negative mood scores from 0 before the mood induction to 1, 2 and 3 after mood induction (after the 1st, 2nd, and 3rd video, respectively). The error bars show SEM.

Table 4. Mean scores and standard deviations of positive and negative mood scores before and after mood induction, and after each video, including t-tests with Bonferroni correction.

| | | Sad group (n = 27) M (SD) | Happy group (n = 30) M (SD) | Student's *t* (55) | *p* |
|---|---|---|---|---|---|
| Before induction | | | | | |
| | Positive scale | 3.30 (2.13) | 4.17 (1.84) | - 1.64 | .11 |
| | Negative scale | 1.63 (1.18) | 2.23 (1.61) | -1.62 | .11 |
| **After induction** | | | | | |
| | **Positive scale** | **2.02 (1.03)** | **4.98 (1.35)** | **9.041** | **<.001** |
| | **Negative scale** | **2.94 (1.43)** | **2.21 (1.35)** | **-1.968** | **.054** |
| After 1st video | | | | | |
| | Positive scale | 1.59 (1.01) | 4.97 (1.79) | - 8.87 | <.001 |
| | Negative scale | 3.26 (2.07) | 2.13 (1.72) | 2.22 | .03 |
| After 2nd video | | | | | |
| | Positive scale | 1.30 (0.61) | 4.17 (1.49) | - 9.71 | <.001 |
| | Negative scale | 2.48 (1.72) | 2.53 (1.31) | -0.13 | .90 |

| | | | | | |
|---|---|---|---|---|---|
| After 3rd video | | | | | |
| | Positive scale | 3.19 (2.25) | 5.53 (1.63) | - 4.46 | <.001 |
| | Negative scale | 3.07 (2.34) | 1.97 (1.65) | 2.05 | .05 |

Since the influence of the mood and time of measurement interaction for the negative mood scores was not significant, it can be concluded that mood induction was not effective. Nevertheless, for positive mood scores this interaction was significant and in the expected direction. Therefore, it was decided to analyze this data, keeping in mind the limitations of any potential conclusions.

*The influence of emotional state on emotion recognition*

Descriptive statistics for all emotion recognition indexes are shown in Table 5.

Table 5. Descriptive statistics for emotion recognition efficiency for happy and sad groups of participants.

| | | Happy group | Sad group | Overall |
|---|---|---|---|---|
| | | M (SD) | M (SD) | M (SD) |
| Accuracy | | | | |
| | Anger | 0.87 (0.10) | 0.86 (0.13) | 0.87 (0.12) |
| | Happiness | 0.99 (0.02) | 0.99 (0.03) | 0.99 (0.03) |
| | Sadness | 0.97 (0.06) | 0.97 (0.05) | 0.97 (0.05) |
| | Surprise | 0.98 (0.04) | 0.96 (0.06) | 0.97 (0.05) |
| | Overall | 0.95 (0.08) | 0.95 (0.09) | |
| Perceptual threshold | | | | |
| | Anger | 23.80 (9.97) | 26.42 (9.40) | 25.04 (9.71) |
| | Happiness | 15.64 (5.11) | 17.62 (5.81) | 16.58 (5.49) |
| | Sadness | 24.16 (7.68) | 26.49 (7.76) | 25.26 (7.74) |
| | Surprise | 14.74 (6.58) | 16.16 (5.78) | 15.42 (6.20) |
| | Overall | 19.59 (8.64) | 21.67 (8.67) | |
| Conceptual threshold | | | | |
| | Anger | 39.72 (11.38) | 40.82 (11.96) | 40.23 (11.56) |
| | Happiness | 23.76 (6.57) | 26.43 (8.68) | 25.Ω02 (7.69) |
| | Sadness | 35.33 (8.02) | 37.57 (9.63) | 36.39 (8.81) |

| | | | |
|---|---|---|---|
| Surprise | 25.39 (7.50) | 26.42 (8.94) | 25.88 (8.16) |
| Overall | 31.05 (10.76) | 32.74 (11.66) | |

*Accuracy*

A Two-way repeated measures ANOVA (2x4) was performed on accuracy scores with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results yielded a significant effect of *emotional expression* ($F(3,165) = 36.741$, $p < .001$, $\eta_p^2 = 0.400$). The effects of *mood* ($F(1, 55) < 1$), and the interaction ($F(3,165) < 1$) were not significant. Pairwise t-tests with Bonferroni corrections for emotional expression showed a significant difference in accuracy when recognizing anger and happiness ($t(56)= -8.768$, $p < .001$, $d = -1.261$); anger and sadness ($t(56) = -5.879$, $p <.001$, $d = -1.199$); anger and surprise ($t(56) = -5.801$, $p < .001$, $d= - 1.180$); happiness and sadness: ($t(56) = 2.944$, $p = .028$, $d = 0.441$); happiness and surprise ($t(56) = 2.780$, $p = .044$, $d= 0.537$). The difference in the accuracy of the recognition of sadness and surprise: ($t(56) = 0.259$, $p > .99$ , $d = 0.044$) was not significant.

*Perceptual threshold*

A two-way repeated measures ANOVA (2x4) was performed on the perceptual threshold with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results yielded a significant effect of *emotional expression* ($F(3,165) = 137.762$, $p < .001$, $\eta_p^2 = 0.715$). The effects of *mood* ($F(1, 55) = 1.324$, $p = .255$, $\eta_p^2 = 0.023$), and the interaction ($F(3, 165) < 1$) were not significant. Pairwise t-tests with Bonferroni corrections showed a significant difference between anger and happiness ($t(56) = 11.035$, $p <.001$, $d = 0.795$); anger and surprise: ($t(56) = 13.522$, $p <.001$, $d = 0.940$); happiness and sadness: ($t(56) = -13.513$, $p <.001$, $d = -1.179$); happiness and surprise: ($t(56) = 2.970$, $p = .026$, $d = 0.194$); sadness and surprise ($t(56) = 15.456$, $p <.001$, $d = 1.346$). The difference between anger and sadness: ($t(56) = -0.361$, $p > .99$, $d = -0.022$) was not significant.

*Conceptual threshold*

A two-way repeated measures ANOVA (2x4) was performed on the conceptual threshold with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results showed a significant influence of *emotional expression* ($F(3,165) = 137.986$, p< .001, $\eta_p^2$= 0.715). The influence of *mood* ($F(1,55) < 1$) and the interaction ($F(3, 165) < 1$) was not significant. Pairwise t-tests with Bonferroni corrections showed a significant difference for anger and happiness: ($t(56) = 15.529$, $p < .001$, $d = 1.395$); anger and sadness ($t(56) = 4.171$, $p <.001$, $d = 0.354$); anger and surprise: ($t(56) = 13.49$, $p < .001$, $d = 1.354$); happiness and sadness ($t(56) = -13.659$, $p < .001$, $d = -1.359$); sadness and surprise: ($t(56) = 10.879$, $p < .001$, $d = 1.235$), but not for happiness and surprise ($t(56) = -1.354$, $p < .99$, $d = - 0.107$).

**Analysis of the data from the subsample with effective mood induction**

Mood induction was not fully effective, because one out of the two mood scales did not show the influence of the interaction between mood and the time of measurement. For this reason, it was decided to analyze the subsample comprising only participants with effective mood induction. Mood induction was considered to be effective at the individual level if, after induction, the mood changed in the expected direction or stayed unchanged. For the happy group, the participants were included in the subsample with effective mood induction if their positive mood scores after mood induction were not lower than that before mood induction and negative mood scores after mood induction were not larger than that before the mood induction. For the sad group, the participants were included in the subsample with effective mood induction if their positive mood scores after mood induction were not larger than that before mood induction and negative mood scores after mood induction were not lower than that before the mood induction.

The subsample included 26 participants, a sad group with 16 people aged from 18 to 23 ($M = 19.31$; $SD = 1.14$), including 13 females and 3 males and a happy group with 10 people aged from 19 to 22 ($M = 19.70$; $SD = 1.06$), all females.

*Effectiveness of mood induction*

2 two-way repeated measures ANOVAs (2x2) were performed on positive and negative mood manipulation check scores in order to assess the overall effectiveness of mood induction, where the *time of measurement* (before or after mood induction) and the *mood* of participants (happy or sad) were chosen as factors. Mean scores obtained in the three mood manipulation checks were used as scores of after mood induction. For the positive mood scores, the results showed a significant influence of the *time of measurement* ($F(1,24) = 8.911$, $p = .006$, $\eta_p^2 = .27$) and the interaction ($F(1,24) = 32.149$, $p < .001$, $\eta_p^2 = .57$). The effect of *mood* was not significant ($F(1, 24) = 4.231$, $p = .051$, $\eta_p^2 = .15$). For the negative mood scores the results showed a significant influence of the interaction ($F(1,24) = 21.934$, $p <.001$, $\eta_p^2 = .48$), although the influence of the *time of measurement* ($F(1, 24) = 3.842$, $p =.06$, $\eta_p^2 = .14$) and *mood* ($F(1,24) < 1$) were not significant. Descriptive statistics are shown in Table 6, also see Fig.4.

Table 6. Mean scores and standard deviations of positive and negative mood scores before and after mood induction, and after each video.

| | | Sad group (n = 16) M (SD) | Happy group (n = 10) M (SD) |
|---|---|---|---|
| Before induction | | | |
| | Positive scale | 4.06 (2.17) | 3.3 (1.42) |
| | Negative scale | 1.19 (0.54) | 2.6 (1.58) |
| **After induction** | | | |
| | **Positive scale** | **1.62 (1.28)** | **4.67 (1.81)** |
| | **Negative scale** | **2.85 (2.08)** | **1.43 (0.82)** |
| After 1st video | | | |
| | Positive scale | 1.19 (0.40) | 4.6 (1.84) |
| | Negative scale | 3.44 (2.31) | 1.4 (0.70) |
| After 2nd video | | | |
| | Positive scale | 1.12 (0.34) | 4.2 (1.75) |
| | Negative scale | 2.38 (1.78) | 1.6 (1.07) |
| After 3rd video | | | |
| | Positive scale | 2.56 (1.86) | 5.2 (1.87) |
| | Negative scale | 2.75 (2.11) | 1.3 (0.67) |

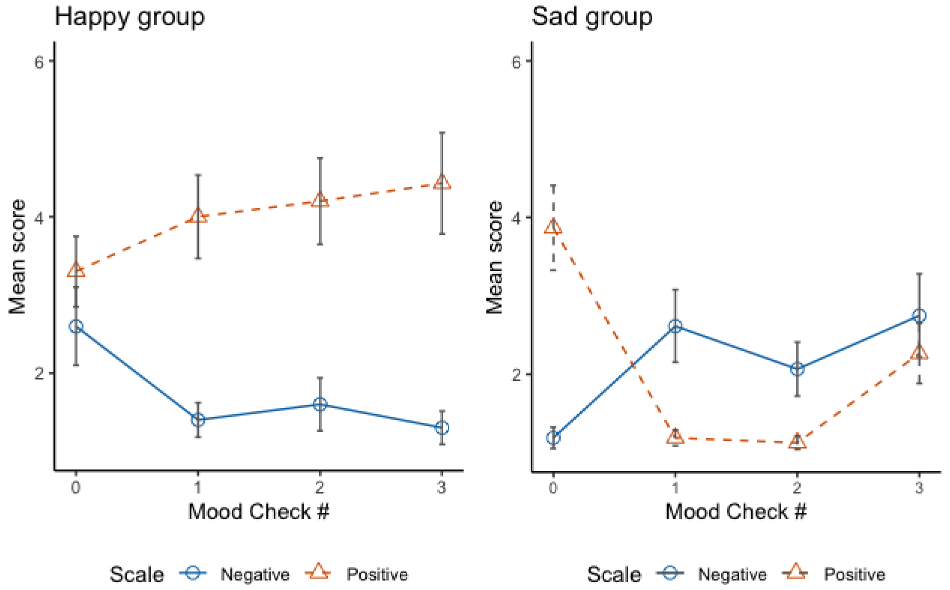


*Figure 4.* Change of positive and negative mood scores from 0 – before the mood induction, to 1, 2 and 3 – after mood induction (after 1st,2nd, and 3rd video, respectively). The error bars show SEM.

In the subsample with effective mood induction the time and *mood* interaction for both positive and negative mood scores was significant. In general, in the subsample with effective mood induction, the effectiveness of mood induction is confirmed. Therefore, it becomes possible to perform the same analysis knowing that the mood induction is effective.

*Accuracy*

A two-way repeated measures ANOVA (2x4) was performed on accuracy scores with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results yielded a significant effect of *emotional expression* ($F(3, 69) = 12.241$, $p <.001$, $\eta_p^2 = 0.35$). The effects of *mood* ($F(1, 23) < 1$) and the interaction ($F(3,69) < 1$) were not significant.

*Perceptual threshold*

A two-way repeated measures ANOVA (2x4) was performed on the perceptual threshold, with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results yielded significant effects of *emotional expression* ($F(3,69) = 76.51$, $p < .001$, $\eta_p^2 = 0.77$), and the interaction between *emotional expression* and *mood* ($F(3, 69) = 4.67$, $p = .005$, $\eta_p^2 = 0.17$). The effect of *mood* ($F(1, 23) = 1.825$, $p = 0.19$, $\eta_p^2 = 0.07$) was not significant (Fig. 5).

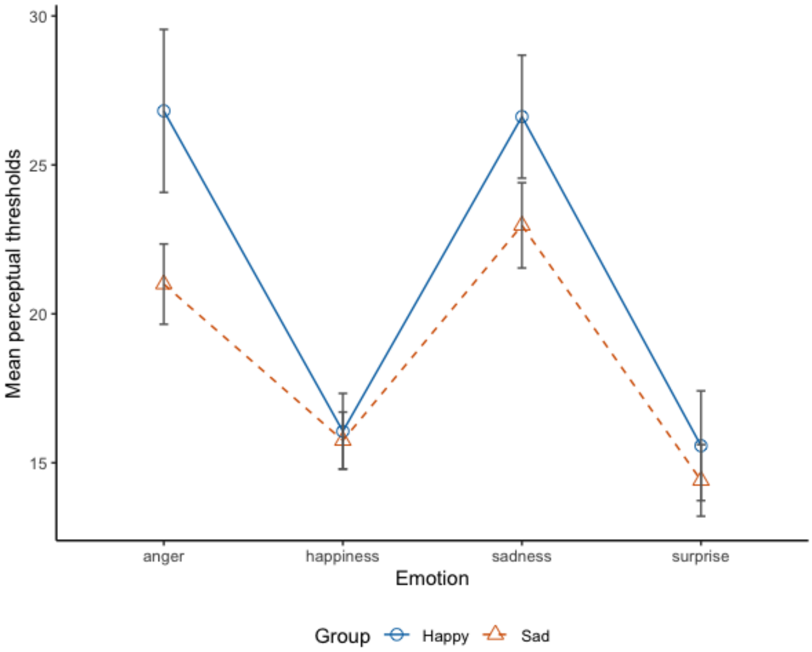


*Figure 5.* Perceptual threshold in happy and sad group of participants for whom mood induction was effective for each of four emotional expressions. The error bars show SEM.

*Conceptual threshold*

A two-way repeated measures ANOVA (2x4) was performed on the conceptual threshold, with *mood* (happy or sad) as a between factor, and *emotional expression* (happy, sad, angry or surprised) as a within factor. The results show the significant influence of *emotional expression* ($F$(3,69) = 49.542, $p$ < .001, $\eta_p^2$= 0.68). The influence of *mood* ($F$(1,23) = 1.874, $p$ = .18, $\eta_p^2$= 0.08) and the interaction ($F$(3, 69) = 1.509, $p$ = .22, $\eta_p^2$= 0.06) were not significant.

## Discussion

In the second study, happy and sad emotional states were induced in two groups of participants. The results showed the influence of the type of emotional expression on emotion recognition—similar to our first study and to the original one. In general, mood induction was not effective, so a subsample of participants with effective mood induction was formed, and the same analysis was then performed on this subsample.

No effect of mood on emotion recognition thresholds was found, therefore Hypothesis 1 was not supported. The interaction between the mood of the participant and emotional expression for the perceptual threshold was significant but only for the participants with effective mood induction. The happy group had higher perceptual thresholds than the sad group, for anger and sadness these differences were significant. An effect of congruence in its partial version can be observed. This effect appears in the fact that emotions of the opposite valence are processed with lower efficiency than emotions of the same valence as the participants' emotional state.

## General discussion

In the two studies described in this paper, a significant influence of emotional state on emotion recognition was obtained only in the second for the subsample with effective mood induction. This demonstrates that the effects of emotional states are small or unstable. The specific influence of the emotional state is observed in the recognition of anger and sadness, but not in the recognition of happiness and surprise. These effects are only observed for the perceptual threshold. The results support Hypothesis 2, which is based on emotion congruence theory, as in this particular case emotions of the opposite valence are processed with lower efficiency than the ones of the same valence. The discrepancy between the results of the original study and ours can be explained by differences in statistical analysis. If we apply the correction for multiple significance testing to the original data, few correlations will remain significant. Hence, it can be concluded that the influence of emotional states on emotion recognition would be better assessed under stricter experimental conditions or in larger samples. Both options would allow us to find the effect given a larger variance in mood from larger and more diverse samples or using an elicitation procedure that would increase mood variance.

The influence of the type of emotional expression on emotion recognition efficiency is observed in both studies and in the original article (Jackson & Arlegui-Prieto, 2016). Anger has the lowest accuracy scores and the highest perceptual and conceptual thresholds compared to other emotional expressions. Further analysis showed that anger is often confused with sadness, and most of these confusions concern a particular face. This effect, in other words, could be caused by stimuli specificity.

Interestingly, in our Study 2 a general increase in negative moods was observed in both groups of participants. This could explain the mood induction inefficiency in most participants of the happy group. The reason for this increase in negative moods could be participant fatigue.

Future studies should be performed using larger samples and taking into account the small effect of mood on emotion recognition. Special attention should also be paid to the mood induction procedure. In the present study, the induction was generally considered ineffective, and this may be due to inappropriate material for mood induction. In future studies, extra attention should be paid to the selection and validation of stimuli for effective mood induction.

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