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# The McGill Face Database: validation and insights into the recognition of facial expressions of complex mental states

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## Abstract

Current databases of facial expressions represent only a small subset of expressions, usually the basic emotions (fear, disgust, surprise, happiness, sadness, anger). To overcome these limitations, we introduce a database of pictures of facial expressions reflecting the richness of mental states. 93 expressions of mental states were interpreted by two professional actors and high-quality pictures were taken under controlled conditions in front and side view. The database was validated in two experiments. Firstly, a 4 AFC paradigm was employed to test the ability to select a term associated with each expression. Secondly, the task was to locate each face within a 2D space of valence and arousal. Results from both experiments demonstrate that subjects can reliably recognize a great diversity of emotional states from facial expressions. While subjects' performance was better for front view images, the advantage over the side view was not dramatic. This is the first demonstration of the high degree of accuracy human viewers exhibit when identifying complex mental states from only partially visible facial features. The McGill Face Database provides a wide range of facial expressions that can be linked to mental state terms and can be accurately characterized in terms of arousal and valence.

*Keywords:* Faces, Face Database, Emotions, Mental States, Theory of

Mind

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## 1. Introduction

Faces represent a special, very complex class of visual stimuli and have been extensively studied in a wide range of research areas. In particular, facial expressions are among the most important sources of information about the mental states of others. The capacity to make mental state inferences, whether from faces or other sources, is known as Theory of Mind (ToM), and it is widely agreed that this capacity is essential to human social behavior. There is also substantial evidence that a ToM deficit may be associated with a variety of clinical conditions, notably autism (Baron-Cohen et al., 1997, 2001) and schizophrenia (Bora et al., 2009; Brüne, 2005; Harrington et al., 2005; Sprong et al., 2007). Hence, the assessment of ToM is important for the exploration of social cognition in healthy individuals as well as in some patients. It may also be useful to measure a change in the social capacities of patients in psychotherapy. The “Reading the Mind in the Eyes” Test (Baron-Cohen et al., 1997, 2001) is a common ToM test in which participants have to choose a mental state term that best characterizes the expression in a picture of someone’s eyes. However, only a small proportion of possible mental states are tested, and the stimuli themselves are of inconsistent quality with respect to image resolution, luminance and perspective. Most other comparable databases of facial expressions of mental states typically only include a small subset of expressions, typically the basic emotions proposed by Paul Ekman (e.g. Ekman, 1992): fear, disgust, surprise, happiness, sadness, and anger) – the emotional expressions that are considered universal. However, multiple secondary emotions where two or more primary emotions are mixed (e.g. hatred being a mix of anger and disgust, are highly under-represented in the databases available. One exception is the “Mind Reading” database (DVD, Baron-Cohen et al., 2004) that contains a much wider range of mental states. The Mind Reading DVD is computer-based platform developed to help individuals diagnosed along the autism spectrum to recognize facial expressions. It contains 412 mental state concepts, each assigned to one of 24 mental state classes. However, it is designed for commercial and clinical use and specifically

Table 1: Summary of face databases (n.s.: not specified)

Database	Reference	No. Images	Expressions
The Yale Face Database	<a href="#">Belhumeur et al. (1996)</a>	165	happy, sad, winking, sleepy, surprised
AR Face Database	<a href="#">Martínez (1998)</a>	3000	n. s.
Karolinska Directed Emotional Faces (KDEF)	<a href="#">Lundqvist et al. (1998)</a>	4900	anger, happiness, surprise, disgust, sadness, fear, neutral
	<a href="#">Gooleven et al. (2008)</a>	490	angry, fearful, disgusted, happy, sad, surprised
Japanese Female Facial Expression (JAFFE)	<a href="#">Lyons et al. (1998)</a>	219	anger, happiness, surprise, disgust, sadness, fear, neutral
Yale Face Database B+	<a href="#">Georghiades et al. (2000)</a>	4050	n. s.
Palermo & Coltheart Faces	<a href="#">Palermo &amp; Coltheart (2004)</a>	336	anger/disgust, fear, happiness, neutrality, sadness, surprise
MMI	<a href="#">Pantic et al. (2005)</a>	1588	79, n. s.
BU-3DFE Database	<a href="#">Yin et al. (2006)</a>	2500	anger, disgust, fear, happy, sad, surprise, neutral
The Bosphorus Database	<a href="#">Alyüz et al. (2008)</a>	4666	n. s.
Multi-PIE	<a href="#">Gross et al. (2010)</a>	750000+	neutral, smile, surprise, squint, disgust, scream
Genki-4K	<a href="#">Whitehill et al. (2009)</a>	63,000	smiling or non-smiling
The MUG Face Database	<a href="#">Aifanti et al. (2010)</a>	70645	Anger, fear, happiness, sadness, surprise
FACES	<a href="#">Ebner et al. (2010)</a>	2052	neutral, sadness, disgust, fear, anger, happiness
Radboud Faces	<a href="#">Langner et al. (2010)</a>	5880	angry, contemptuous, disgusted, fearful, happy, sad, surprised, neutral
Cohn-Kanade CK+	<a href="#">Lucey et al. (2010)</a>	593 recordings, 10708 frames	anger, contempt, disgust, fear, happy, sadness, surprise
Indian Movie Face database (IMFDB)	<a href="#">Setty et al. (2013)</a>	34512	anger, happiness, surprise, disgust, sadness, fear
DynEmo	<a href="#">Tcherkassof et al. (2013)</a>	358 videos	n. s.
KinectFaceDB	<a href="#">Min et al. (2014)</a>	156 images, 52 videos	neutral, smile

31 targets patients with autism spectrum disorder and Asperger syndrome. A list  
 32 of popular face stimuli databases is shown in Table 1. Most databases only  
 33 represent a very small subset of emotions encountered in daily life and often  
 34 in exaggerated form. To overcome these limitations, we have developed and  
 35 validated a large new database of pictures of facial expressions – the McGill  
 36 Face Database – that reflects some of the richness of human mental states. The  
 37 database contains high-resolution pictures of 93 expressions of mental states  
 38 that were interpreted by two professional actors (one male and one female) in  
 39 front and side view – 372 images in total. In this paper, we present two different  
 40 experiments to investigate subjects’ ability to recognize the facial expressions  
 41 in the Database. In experiment 1, we employ a four-alternative forced choice  
 42 paradigm, based on previous studies ([Baron-Cohen et al., 1997, 2001](#)). The task  
 43 for the observer in this experiment was to choose, out of four terms, the one  
 44 that best identifies the mental state expressed. Given that a particular “correct”  
 45 term is only a representation of the actors’ interpretations of the mental state,  
 46 a second validation experiment (experiment 2) was carried out, which did not  
 47 rely on the semantics of the mental state terms. Instead, the observers located  
 48 each face within a two-dimensional space of valence and arousal (mental state  
 49 – space) employing a “point-and-click” paradigm ([Jennings et al., 2017](#)).

## 50 **2. Database**

### 51 *2.1. Actor Recruitment*

52 Five male and five female professional native English-speaking actors were  
53 invited to take part in an audition. The actors' performance was judged by a  
54 panel of two of the authors and a theater-experienced Professor of Drama and  
55 Theatre in the McGill Department of English. During the audition, one male  
56 and one female actor engaged in various improvisation exercises. The "best  
57 actors" were those who exhibited the most precise, nuanced, and yet read-  
58 able range of emotional expression in their faces, i.e. that clarity of emotional  
59 expression - as captured by the camera - was paramount. Some actors were  
60 better able to convey different emotions through subtle recalibration of facial  
61 expression while others either got "stuck in look" or fell into exaggerated or  
62 melodramatic countenances. The two best-performing actors (male, age 29, fe-  
63 male, age 23) were chosen to take part in a photo shoot based on a majority  
64 vote. The actors gave informed consent and signed an agreement allowing for  
65 the pictures to be used for research and other non-commercial purposes. The  
66 actors were compensated for their work.

### 67 *2.2. Images*

#### 68 *2.2.1. Equipment*

69 The pictures were taken by a professional photographer with a Canon 70D  
70 digital camera mounted on a tripod at a distance of 1.5 m from the actor. The  
71 optic was a Canon 85 mm, f1.8 with a shutter speed of 1/60th and an aperture  
72 of f5.6 and a sensitivity of ISO 100. Two separate flashes—a Canon 580 EX and  
73 a Canon 430 EXII (both set with exposure compensation at +1) were placed at  
74 the appropriate distance. One of the flashes had a reflector umbrella.

#### 75 *2.2.2. Image Acquisition*

76 The pictures were taken in two separate sessions at a studio specifically  
77 prepared for that purpose. During the sessions, the actor was positioned in  
78 front of a white screen. The instructor provided the mental state term and

79 read the corresponding short explication provided in the Glossary in Appendix  
80 B of [Baron-Cohen et al. \(2001\)](#). The actor was given as much time as needed  
81 to prepare the interpretation for the relevant expression. When the actor gave  
82 a hand signal to the photographer, a single picture was taken in front view.  
83 Importantly, in order to guarantee a natural interpretation of a given expression,  
84 we did not restrict the head tilt. The actor then immediately turned to face  
85 a mark  $30^\circ$  from the camera, and a second picture was taken. This procedure  
86 was repeated three to four times for each of 93 mental state terms used in the  
87 Reading the Mind in the Eyes Test ([Baron-Cohen et al., 2001](#)) (Table 2 in the  
88 Appendix).

### 89 *2.2.3. Image Selection*

90 A focus group, consisting of six referees (four females and two males) were  
91 presented with the different images for a given expression and asked to compare  
92 their quality and expressivity of mental state. Four out of six referees had to  
93 agree on a picture for it to be selected for inclusion in the database. The full  
94 database can be downloaded at: [McGill Face Database](#).

### 95 *2.2.4. Image Specificities*

96 The database contains 372 jpegimage files with a resolution of 5472 x 3648  
97 pixel (colour space profile: sRGB IEC61966-2.1). The size of each image is 7.3  
98 MB. The image files have not been post-processed. Raw image files are available  
99 upon request from the first author.

## 100 **3. Experiment 1**

### 101 *3.1. Methods*

#### 102 *3.1.1. Subjects*

103 All participants were recruited via the McGill Psychology Human Partici-  
104 pant Pool or via public advertisements. 33 individuals (7 males, 26 females,  
105 mean age 21 years,  $\pm 2.96$  SD) participated in Experiment 1. All subjects were  
106 native English speakers and were naïve as to the purpose of the study. Subjects

107 had normal or corrected-to-normal visual acuity. Informed consent was obtained  
108 from each observer. All experiments were approved by the McGill University  
109 Ethics committee and were conducted in accordance with the original Declara-  
110 tion of Helsinki.

### 111 *3.1.2. Apparatus*

112 The face stimuli were presented using MATLAB (MATLAB R 2016b, Math-  
113 Works) on either a CRT monitor running with a resolution of 1600 x 1200 pixel  
114 and a frame rate of 60 Hz (mean luminance  $40 \frac{cd}{m^2}$ ) under the control of an PC  
115 (3.2GHz) or on a MacBook Pro (2015, 3.1 GHz) with a monitor resolution of  
116 2560 x 1600 pixel. The viewing distance was adjusted to guarantee an equal  
117 image size of  $20.91^\circ \times 13.95^\circ$  on both systems. Experiments were performed in  
118 a dimly illuminated room. Routines from the Psychtoolbox-3 were employed to  
119 present the stimuli (Brainard, 1997).

### 120 *3.1.3. Procedure*

121 A four-alternative forced choice paradigm was employed to test the ability  
122 of participants to correctly select the term associated with each picture in the  
123 database. All 372 pictures (93 male front view, 93 male side view, 93 female  
124 front view, 93 female side view) were tested in one experimental block. The im-  
125 ages were presented in random order, different for every observer. Stimuli were  
126 presented for 1 s. This presentation time was based on previous results, where  
127 identification accuracy for the same face stimuli was measured as a function  
128 of presentation time (Schmidtman et al., 2016). The presentation of the face  
129 image was followed by the presentation of the target (correct) term as well as  
130 three distractor terms. Importantly, in order to minimize a decision bias caused  
131 by specific terms, the distractor terms were randomly selected from the remain-  
132 ing 92 terms shown in Table 2. In other words, each observer was presented  
133 with different distractor terms for each face. The terms were presented on a  
134 mid-grey screen in a diamond-like arrangement (see Figure 1), corresponding to  
135 the cursor keys on a computer keyboard, which were used to by the observers



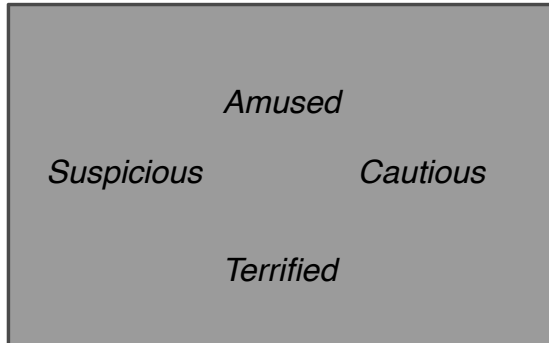


Figure 1: Experiment 1: Experimental Paradigm

136 to make their choice. The target term could occur in one out of four locations,  
137 which was randomly determined. The task for the observer was to choose the  
138 term most appropriate to the expression in the picture. Participants were given  
139 a break after each group of 93 presentations, i.e. three breaks in total.

### 140 3.2. Results

141 Table 4 summarizes the performance (percent correct) across 33 subjects.  
142 The guess rate in a four-alternative forced choice paradigm is 25%.  $\chi^2$  -Tests  
143 with a Yates correction for continuity ( $p > .05$ ) were performed to determine  
144 whether performances were significantly different from chance level for a given  
145 term (Yates, 1934). Performances not significantly better than chance are shown  
146 by the grey shading in Table 3 in the Appendix and by the lines in Figures 2 and  
147 3 showing the sorted percent correct performances for the actors in front and  
148 side view as bar plots. Results show that for the pictures of the female actor,  
149 subjects performed significantly better than chance in 78 of 93 images (84%) for  
150 the front view condition and 74 of 93 images (80%) of the side view pictures.  
151 For the male actor, subjects performed significantly better than chance in 67  
152 of 93 images (72%) in front view and 61 of 93 images (66%) in side view. The  
153 non-significant terms are summarized in Table 4. Interestingly, 13 of these 52  
154 non-significant cases occur in judgements of both the female and male actor.  
155 Furthermore, in 8 of these 52 terms subjects performed no better than chance

156 for three or four of the images. These terms are indicated by the grey-shaded  
157 cells in Table 4.

158 In addition, we conducted parametric Pearson correlation between each com-  
159 bination of the stimuli tested in experiment 1. Results show statistically sig-  
160 nificant correlations between results for the female faces in front and side view  
161 ( $r = .555, p < .001, n = 93$ ), male faces in front and side view ( $r = .598, p <$   
162  $.001, n = 93$ ), and female and male faces in front view ( $r = .336, p = .001, n =$   
163  $93$ ). All other correlations are presented in Table A1.

## 164 4. Experiment 2

### 165 4.1. Methods

#### 166 4.1.1. Subjects

167 32 subjects participated in Experiment 2 (10 males, 22 females, mean age  
168 22 years,  $\pm 4.13$  SD).

#### 169 4.1.2. Procedure

170 We employed a “point-and-click” task that did not rely on any semantic  
171 information being presented to observers during trials (Jennings et al., 2017).  
172 The complete set of images (372) was presented in a random order. Each image  
173 was displayed for 1 s followed by the two-dimensional mental state-space (Rus-  
174 sell, 1980), presented until the observer submitted a response (Figure 4 shows  
175 the 2-dimensional space). Once the two-dimensional space was displayed, the  
176 observers’ task was to click a computer mouse on the point within the space  
177 deemed most appropriate to the facial expression displayed in the image. The  
178 horizontal direction represented a rating of valence (pleasant vs. unpleasant)  
179 and the vertical direction a rating of arousal (low vs. high). Example emotions  
180 corresponding to different regions of the space are illustrated by the red text  
181 (not visible during testing) in Figure 4. The axes as well as the example mental  
182 states (red) were used to instruct the observer during training. In order to eval-  
183 uate whether participants tended to locate facial expressions in similar regions

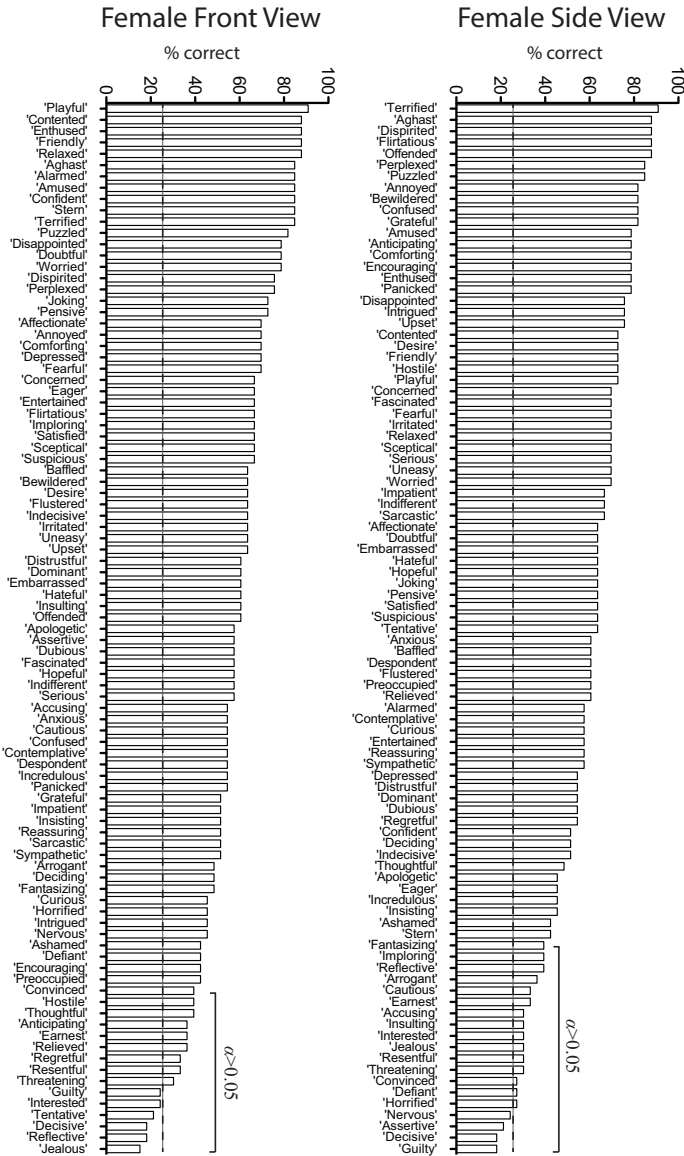


Figure 2: Bar plots showing percent correct for the 93 terms in the database for the female actor in both views. The dashed line represents the guessing rate (25 %). Performances which are statistically not better than chance ( $\chi^2$  - Yates correction for continuity;  $\alpha > .05$ ) are indicated by the solid lines in each graph.

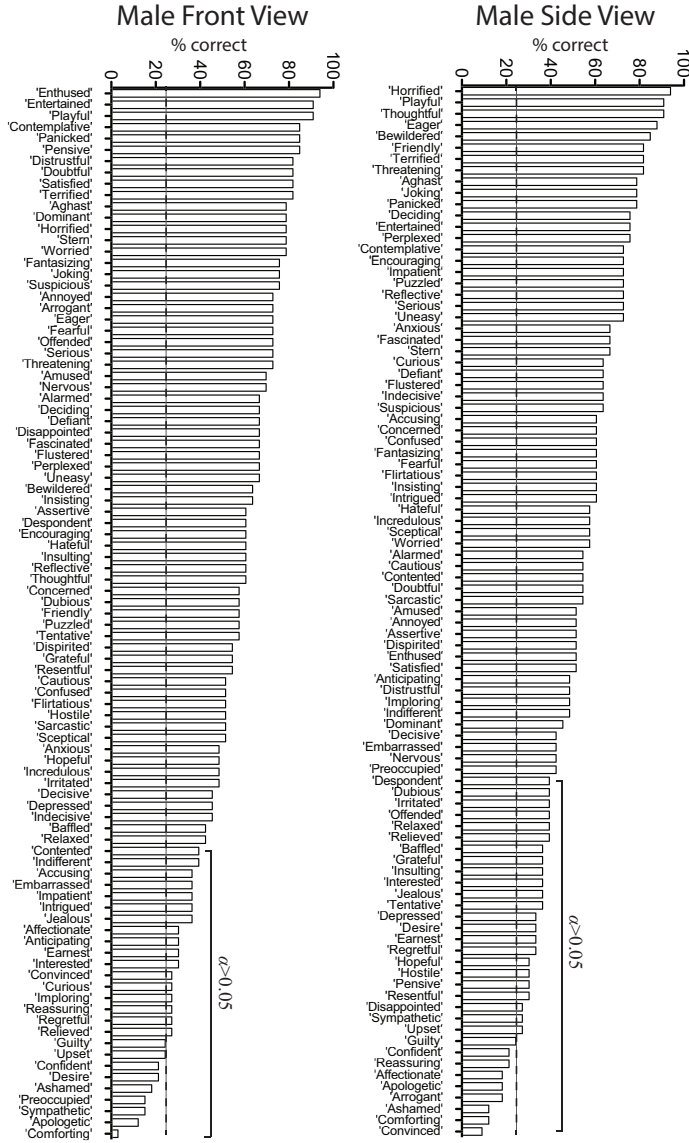


Figure 3: Bar plots showing percent correct for the 93 terms in the database for the male actor in both views. The dashed line represents the guessing rate (25 %). Performances which are statistically not better than chance ( $\chi^2$  - Yates correction for continuity;  $\alpha > .05$ ) are indicated by the solid lines in each graph.

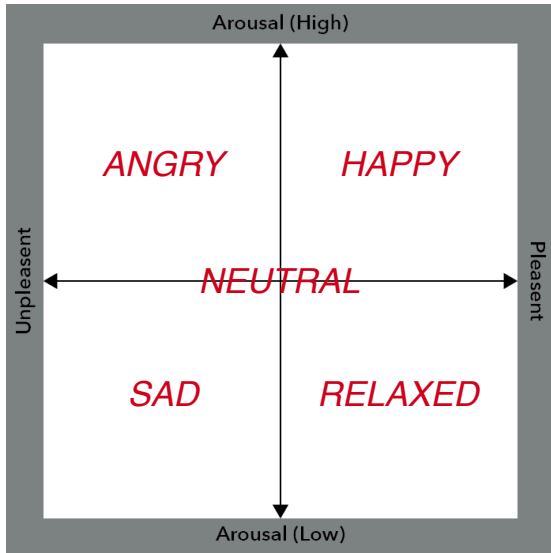


Figure 4: Experiment 2: The image was presented for 1 s, followed by the presentation of a valence-arousal space, extending from low to high arousal in one dimension and pleasant to unpleasant in the other dimension. Note: The red terms provide illustrations of the appropriate location of mental state terms used (the red text was not visible during testing).

184 of the two-dimensional space, we calculated an agreement score ( $\eta_{agreement}$ ) for  
 185 each image among 32 observers in the following way.

186 First, the mean arousal ( $A_{mean}$ ) and valence ( $V_{mean}$ ) coordinates were calcu-  
 187 lated across all observer responses for a given condition. Second, the Euclidian  
 188 distance ( $r$ ) for each of the observers' response, and hence the mean rmean  
 189 (see Eq. 1) was determined. Finally, these values were normalized (based on  
 190 the highest mean value,  $r_{max}$ ) and shifted according to the lowest value ( $r_{min}$ ,  
 191 see Eq. 2). This transformation produced agreement scores ( $\eta_{agreement}$ ) so  
 192 that, a score of 1 corresponds to the greatest agreement between subjects and  
 193 as the scores decrease the agreement between subjects' decreases, i.e., emotion  
 194 ratings were less tightly clustered around the mean location (see Eq. 3). Fig-  
 195 ure 5 illustrates the procedure for four hypothetical data points located within

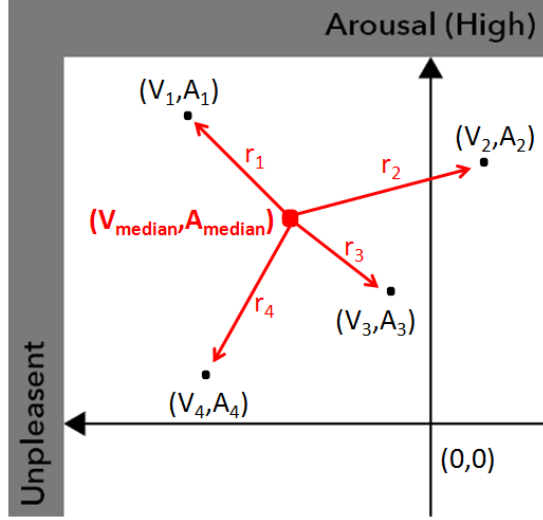


Figure 5: A subsection of the valence-arousal space showing four hypothetical responses (black dots); the red dot represents the mean valence ( $V_{median}$ ) and arousal ( $A_{median}$ ). The agreement score ( $\eta_{agreement}$ ) is determined by the mean Euclidian distance  $r$ .

196 a subsection of the arousal-valence space.

$$r_{mean} = \frac{1}{n} \sum_1^{i=n} \sqrt{(V_{median} - V_i)^2 + (A_{median} - A_i)^2} \quad (1)$$

$$r_{mean} = \frac{1}{n} \sum_1^{i=n} r_i \quad (2)$$

$$\eta_{agreement} = 1 - \frac{r_{mean}}{r_{max}} + r_{min} \quad (3)$$

#### 197 4.2. Results

198 Tables 5 and 6 summarize the agreement scores ( $\eta_{agreement}$ ), for the female  
 199 and male face stimuli, respectively. To visualize the magnitude of the agreement  
 200 scores within the mental state-space three examples are illustrated in Figure 6.  
 201 The circles are rendered with a radius equal to the values produced by Eq. 1  
 202 and the corresponding agreement values are stated for comparison. The results  
 203 for each of the 93 terms can be downloaded here: [McGill Face Database](#).

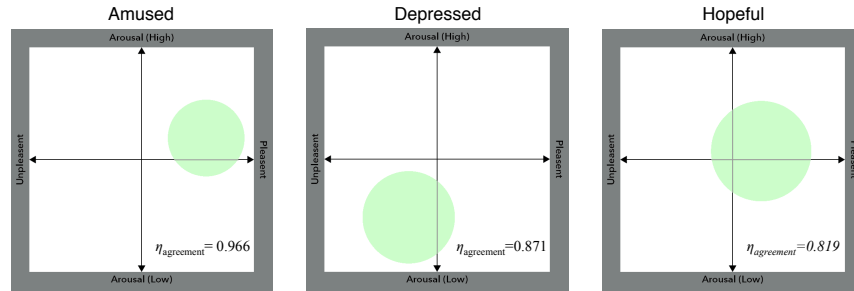


Figure 6: A subsection of the valence-arousal space showing four hypothetical responses (black dots); the red dot represents the mean valence ( $V_{mean}$ ) and arousal ( $A_{mean}$ ). The agreement score ( $\eta_{agreement}$ ) is determined by the mean Euclidian distance  $r$ .

#### 204 4.3. Correlations between Experiment 1 and Experiment 2

205 In a final analysis, parametric Pearson correlation tests were conducted be-  
 206 tween the percent correct performance for each stimulus in experiment 1 and  
 207 the agreement score  $\eta_{agreement}$  for each stimulus in experiment 2. This analy-  
 208 sis showed statically significant correlations between the results for male faces  
 209 in front view in experiment 1 and male faces in front view in experiment 2  
 210 ( $r = -.302$ ,  $p = .003$ ,  $n = 93$ ), for male faces in front view in experiment 1  
 211 and female faces in front view in experiment 2 ( $r = -.216$ ,  $p = .038$ ,  $n = 93$ )  
 212 and for male faces in side view in experiment 1 and male faces in front view in  
 213 experiment 2 ( $r = -.311$ ,  $p = .002$ ,  $n = 93$ ) (see Table 7).

## 214 5. Discussion

215 Most currently available image databases of facial expressions of mental  
 216 states include only a very small range of possible mental states. With the  
 217 exception of the “Mind Reading” platform (Baron-Cohen et al., 2004), the vast  
 218 majority of free databases employ the basic emotions proposed by Paul Ekman  
 219 (e.g. Ekman (1992): fear, disgust, surprise, happiness, sadness, and anger; see  
 220 Table 1.) Even the full set of emotions, however, constitute only one category of  
 221 mental state to which ToM is directed. In order to investigate ToM comprehen-  
 222 sively, a more expansive set of stimuli is desirable. The aim of the current study

223 was to develop and to validate a new database of such stimuli reflecting a greater  
224 variety of mental states. The McGill Face Database includes 4 representations  
225 of 93 mental state terms. The pictures are unmodified but can be altered if  
226 users wish to do so. In order to determine the usefulness of the database, two  
227 validation experiments were carried out. These experiments revealed consider-  
228 able agreement among participants regarding the mental state expressed by the  
229 faces. Results from experiment 1 demonstrate that subjects can reliably select  
230 the correct term associated with a particular mental state despite the semantic  
231 complexity of the terms denoting them. Subjects performed significantly better  
232 than chance in 78 of 93 front view images and 74 of 93 side view images of the  
233 female actor, and they performed significantly better than chance in 67 of 93  
234 front view and 61 of 93 side view images of the male actor. Results from this  
235 experiment also show that subjects performed better with images of the female  
236 actor, most likely because she was more expressive than the male actor. It is  
237 noteworthy that while subjects' performance was better for front view images,  
238 the advantage over the side view was not dramatic (female: 84% vs. 80% ; male:  
239 72% vs. 66% ). To our knowledge, this is the first demonstration of the high de-  
240 gree of accuracy human viewers exhibit when identifying complex mental states  
241 from only partially visible facial features. The Pearson correlation analyses for  
242 experiment 1 show a highly significant correlation between the two views of the  
243 same face as well as between front views of the male and female faces. The  
244 slightly more difficult side view task together with differences across the male  
245 and female faces presumably accounts for the absence of the full complement of  
246 correlations. The aim of the validation in experiment 2 was to develop a task  
247 that is independent of the complex vocabulary used in experiment 1. This ap-  
248 proach has a number of advantages. First, some of the mental state terms may  
249 be more likely to be chosen just in virtue of their meanings. These biases would  
250 distort subjects' performance. Secondly, the facial expressions produced by the  
251 actors are interpretations of mental state terms and some interpretations may  
252 be more easily associated with a target term than others. In this respect, the  
253 relationship between the facial expressions and the mental state terms explored



254 in experiment 1 is distinctly different from the relationship between the basic  
255 emotions and the facial expressions to which they correspond. Whereas it is  
256 widely agreed that each basic emotion is represented by a single characteristic  
257 expression, many facial expressions might be thought to correspond to the men-  
258 tal state terms. Finally, it is of particular importance to be able to carry out  
259 ToM experiments without difficult vocabulary if one wants to study individuals  
260 with intellectual disabilities, or those suffering from conditions associated with  
261 impaired linguistic ability. The “point-and-click” paradigm in which subjects  
262 had to indicate the location of a given facial expression in a logical space ([Russell, 1980](#)), along the dimensions of valence and arousal, makes this possible  
263 ([Jennings et al., 2017](#)). Results from this experiment show that there is sub-  
264 stantial agreement across individuals about how to characterize faces along these  
265 dimensions. In addition, there is a high correlation between the face stimuli be-  
266 tween perspectives and gender. The imperfect correlation between performance  
267 in the two experiments can be attributed to the presence of linguistic items in  
268 the first experiment and their absence in the second, as well as the difference  
269 in the specificity of the judgements required; the 2-dimensional space used in  
270 experiment 2 is a much coarser framework for classifying facial expressions than  
271 is the method of assigning a quite specific term to each face. The McGill Face  
272 Database thus provides a wide range of facial expressions of mental states that  
273 can be linked to mental state terms as well as accurately characterized in terms  
274 of arousal and valence independently of any such terms.

276

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## 377 8. Appendix

Table 2: Summary of terms in the McGill Face Database

	English		English
1	Accusing	48	Grateful
2	Affectionate	49	Guilty
3	Aghast	50	Hateful
4	Alarmed	51	Hopeful
5	Amused	52	Horrified
6	Annoyed	53	Hostile
7	Anticipating	54	Impatient
8	Anxious	55	Imploring
9	Apologetic	56	Incredulous
10	Arrogant	57	Indecisive
11	Ashamed	58	Indifferent
12	Assertive	59	Insisting
13	Baffled	60	Insulting
14	Bewildered	61	Interested
15	Cautious	62	Intrigued
16	Comforting	63	Irritated
17	Concerned	64	Jealous
18	Confident	65	Joking
19	Confused	66	Nervous
20	Contemplative	67	Offended
21	Contented	68	Panicked
22	Convinced	69	Pensive
23	Curious	70	Perplexed
24	Deciding	71	Playful
25	Decisive	72	Preoccupied
26	Defiant	73	Puzzled
27	Depressed	74	Reassuring
28	Desire	75	Reflective
29	Despondent	76	Regretful
30	Disappointed	77	Relaxed
31	Dispirited	78	Relieved
32	Distrustful	79	Resentful
33	Dominant	80	Sarcastic
34	Doubtful	81	Satisfied
35	Dubious	82	Serious
36	Eager	83	Skeptical
37	Earnest	84	Stern
38	Embarrassed	85	Suspicious
39	Encouraging	86	Sympathetic
40	Entertained	87	Tentative
41	Enthused	88	Terrified
42	Fantasizing	89	Thoughtful
43	Fascinated	90	Threatening
44	Fearful	91	Uneasy
45	Flirtatious	92	Upset
46	Flustered	93	Worried
47	Friendly		

Table 3: Percent correct for the images averaged across 32 subjects. The guess rate is 25%. Performances which are statistically not better than chance ( $\chi^2$  – Yates correction for continuity; ( $\alpha > .05$ ) are indicated by the \*.

		Male		Female				Male		Female	
		Front	Side	Front	Side			Front	Side	Front	Side
1	accusing	36.36*	60.61	54.55	30.3*	48	grateful	54.55	36.36*	51.52	81.82
2	affectionate	30.3*	18.18*	69.7	63.64	49	guilty	24.24*	24.24*	24.24*	18.18*
3	aghast	78.79	78.79	84.85	87.88	50	hateful	60.61	57.58	60.61	63.64
4	alarmed	66.67	54.55	84.85	57.58	51	hopeful	48.48	30.3*	57.58	63.64
5	amused	69.7	51.52	84.85	78.79	52	horrified	78.79	93.94	45.45	27.27*
6	annoyed	72.73	51.52	69.7	81.82	53	hostile	51.52	30.3*	39.39	72.73
7	anticipating	30.3*	48.48	36.36*	78.79	54	impatient	36.36*	72.73	51.52	66.67
8	anxious	48.48	66.67	54.55	60.61	55	imploing	27.27	48.48	66.67	39.39
9	apologetic	12.12*	18.18*	57.58	45.45	56	incredulous	48.48	57.58	54.55	45.45
10	arrogant	72.73	18.18*	48.48	36.36*	57	indecisive	45.45	63.64	63.64	51.52
11	ashamed	18.18*	12.12*	42.42	42.42	58	indifferent	39.39	48.48	57.58	66.67
12	assertive	60.61	51.52	57.58	21.21	59	insisting	63.64	60.61	51.52	45.45
13	baffled	42.42	36.36*	63.64	60.61	60	insulting	60.61	36.36*	60.61	30.3*
14	bewildered	63.64	84.85	63.64	81.82	61	interested	30.3*	36.36*	24.24	30.3*
15	cautious	51.52	54.55	54.55	33.33*	62	intrigued	36.36	60.61	45.45	75.76
16	comforting	3.03*	12.12*	69.7	78.79	63	irritated	48.48	39.39	63.64	69.7
17	concerned	57.58	60.61	66.67	69.7	64	jealous	36.36*	36.36*	15.15*	30.3*
18	confident	21.21*	21.21*	84.85	51.52	65	joking	75.76	78.79	72.73	63.64
19	confused	51.52	60.61	54.55	81.82	66	nervous	69.7	42.42	45.45	24.24
20	contemplative	84.85	72.73	54.55	57.58	67	offended	72.73	39.39	60.61	87.88
21	contented	39.39	54.55	87.88	72.73	68	panicked	84.85	78.79	54.55	78.79
22	convinced	27.27	9.09*	39.39	27.27	69	pensive	84.85	30.3*	72.73	63.64
23	curious	27.27*	63.64	45.45	57.58	70	perplexed	66.67	75.76	75.76	84.85
24	deciding	66.67	75.76	48.48	51.52	71	playful	90.91	90.91	90.91	72.73
25	decisive	45.45	42.42	18.18*	18.18*	72	preoccupied	15.15	42.42	42.42	60.61
26	defiant	66.67	63.64	42.42	27.27*	73	puzzled	57.58	72.73	81.82	84.85
27	depressed	45.45	33.33*	69.7	54.55	74	reassuring	27.27*	21.21*	51.52	57.58
28	desire	21.21*	33.33*	63.64	72.73	75	reflective	60.61	72.73	18.18*	39.39
29	dispondent	60.61	39.39	54.55	60.61	76	regretful	27.27*	33.33*	33.33*	54.55
30	disappointed	66.67	27.27*	78.79	75.76	77	relaxed	42.42	39.39	87.88	69.7
31	dispirited	54.55	51.52	75.76	87.88	78	relieved	27.27*	39.39	36.36*	60.61
32	distrustful	81.82	48.48	60.61	54.55	79	resentful	54.55	30.3*	33.33*	30.3*
33	dominant	78.79	45.45	60.61	54.55	80	sarcastic	51.52	54.55	51.52	66.67
34	doubtful	81.82	54.55	78.79	63.64	81	satisfied	81.82	51.52	66.67	63.64
35	dubious	57.58	39.39	57.58	54.55	82	skeptical	51.52	57.58	66.67	69.7
36	eager	72.73	87.88	66.67	45.45	83	serious	72.73	72.73	57.58	69.7
37	earnest	30.3*	33.33*	36.36*	33.33*	84	stern	78.79	66.67	84.85	42.42
38	embarrassed	36.36*	42.42	60.61	63.64	85	suspicious	75.76	63.64	66.67	63.64
39	encouraging	60.61	72.73	42.42	78.79	86	sympathetic	15.15*	27.27*	51.52	57.58
40	entertained	90.91	75.76	66.67	57.58	87	tentative	57.58	36.36*	21.21*	63.64
41	enthused	93.94	51.52	87.88	78.79	88	terrified	81.82	81.82	84.85	90.91
42	fantasizing	75.76	60.61	48.48	39.39	89	thoughtful	60.61	90.91	39.39	48.48
43	fascinated	66.67	66.67	57.58	69.7	90	threatening	72.73	81.82	30.3*	30.3*
44	fearful	72.73	60.61	69.7	69.7	91	uneasy	66.67	72.73	63.64	69.7
45	flirtatious	51.52	60.61	66.67	87.88	92	upset	24.24*	27.27*	63.64	75.76
46	flustered	66.67	63.64	63.64	60.61	93	worried	78.79	57.58	78.79	69.7
47	friendly	57.58	81.82	87.88	72.73						

Table 4: A summary of terms (sorted alphabetically) in which participants' performances were not significantly better than chance. The cases which were not significant in three or more conditions are indicated by the \*.

	Female				Male					
	Front	Side	Front	Side	Front	Side	Front	Side		
1	accusing		30.3	36.36		27	hopeful		30.3	
2	affectionate			30.3	18.18	28	horrified		27.27	
3	anticipating	36.36		30.3		29	hostile	39.39	30.3	
4	apologetic			12.12	18.18	30	impatient		36.36	
5	arrogant		36.36		18.18	31	imploring	39.39	27.27	
6	ashamed			18.18	12.12	32	indifferent		39.39	
7	assertive		21.21			33	insulting	30.3	36.36	
8	baffled				36.36	34	interested*	24.24	30.3	36.36
9	cautious		33.33			35	intrigued		36.36	
10	comforting			3.03	12.12	36	irritated		39.39	
11	confident			21.21	21.21	37	jealous*	15.15	36.36	36.36
12	contented			39.39		38	nervous		24.24	
13	convinced*	39.39	27.27	27.27	9.09	39	offended		39.39	
14	curious			27.27		40	pensive		30.3	
15	decisive	18.18	18.18			41	preoccupied		15.15	
16	defiant		27.27			42	reassuring		27.27	21.21
17	depressed				33.33	43	reflective	18.18	39.39	
18	desire			21.21	33.33	44	regretful*	33.33	27.27	33.33
19	despondent				39.39	45	relaxed		39.39	
20	disappointed				27.27	46	relieved*	36.36	27.27	39.39
21	dubious				39.39	47	resentful*	33.33	30.3	30.3
22	earnest*	36.36	33.33	30.3	33.33	48	sympathetic		15.15	27.27
23	embarrassed			36.36		49	tentative	21.21		36.36
24	fantasizing		39.39			50	thoughtful	39.39		
25	grateful				36.36	51	threatening	30.3	30.3	
26	guilty*	24.24	18.18	24.24	24.24	52	upset		24.24	27.27



Table 5: Agreement scores ( $\eta_{agreement}$ ) for the female in front and side view. Terms are sorted from high to low scores in each view.

Female												
	Front			Side			Front			Side		
1	Concerned	0.99	Enthused	0.982	48	Arrogant	0.834	Relaxed	0.844			
2	Relieved	0.98	Eager	0.969	49	Resentful	0.834	Ashamed	0.844			
3	Amused	0.966	Upset	0.961	50	Despondent	0.831	Sceptical	0.842			
4	Playful	0.964	Relieved	0.96	51	Annoyed	0.829	Distrustful	0.84			
5	Cautious	0.945	Guilty	0.954	52	Jealous	0.829	Resentful	0.84			
6	Satisfied	0.939	Tentative	0.945	53	Joking	0.827	Contemplative	0.838			
7	Friendly	0.934	Reassuring	0.943	54	Anxious	0.826	Reflective	0.836			
8	Indecisive	0.925	Jealous	0.941	55	Thoughtful	0.821	Nervous	0.834			
9	Accusing	0.921	Amused	0.941	56	Hopeful	0.819	Comforting	0.833			
10	Relaxed	0.916	Playful	0.937	57	Puzzled	0.815	Incredulous	0.827			
11	Confident	0.915	Impatient	0.933	58	Stern	0.813	Sympathetic	0.825			
12	Fantasizing	0.912	Disappointed	0.905	59	Intrigued	0.812	Deciding	0.824			
13	Comforting	0.909	Concerned	0.903	60	Reflective	0.811	Indifferent	0.823			
14	Encouraging	0.897	Pensive	0.901	61	Indifferent	0.81	Encouraging	0.818			
15	Reassuring	0.897	Cautious	0.9	62	Eager	0.802	Threatening	0.815			
16	Tentative	0.896	Depressed	0.896	63	Earnest	0.8	Intrigued	0.815			
17	Interested	0.891	Friendly	0.895	64	Guilty	0.8	Decisive	0.815			
18	Assertive	0.89	Dubious	0.893	65	Threatening	0.799	Fascinated	0.805			
19	Upset	0.886	Preoccupied	0.891	66	Desire	0.793	Desire	0.804			
20	Defiant	0.885	Indecisive	0.891	67	Serious	0.78	Affectionate	0.803			
21	Sarcastic	0.884	Regretful	0.89	68	Convinced	0.778	Hopeful	0.802			
22	Regretful	0.883	Joking	0.888	69	Anticipating	0.777	Worried	0.799			
23	Ashamed	0.881	Puzzled	0.887	70	Sympathetic	0.777	Fantasizing	0.798			
24	Contented	0.879	Anxious	0.881	71	Imploring	0.776	Assertive	0.786			
25	Disappointed	0.872	Flustered	0.876	72	Dominant	0.763	Bewildered	0.786			
26	Entertained	0.871	Alarmed	0.876	73	Baffled	0.761	Entertained	0.783			
27	Pensive	0.871	Suspicious	0.874	74	Insisting	0.76	Curious	0.782			
28	Depressed	0.871	Flirtatious	0.874	75	Fascinated	0.759	Contented	0.782			
29	Dispirited	0.87	Thoughtful	0.873	76	Incredulous	0.757	Embarrassed	0.775			
30	Hostile	0.869	Imploring	0.869	77	Embarrassed	0.756	Sarcastic	0.775			
31	Contemplative	0.866	Earnest	0.869	78	Affectionate	0.755	Confident	0.771			
32	Irritated	0.865	Insisting	0.868	79	Insulting	0.742	Serious	0.771			
33	Flirtatious	0.862	Convinced	0.867	80	Uneasy	0.735	Fearful	0.764			
34	Preoccupied	0.862	Hostile	0.866	81	Horrified	0.734	Accusing	0.764			
35	Enthused	0.86	Uneasy	0.865	82	Perplexed	0.724	Defiant	0.758			
36	Decisive	0.86	Perplexed	0.864	83	Fearful	0.718	Annoyed	0.74			
37	Nervous	0.857	Baffled	0.86	84	Bewildered	0.711	Insulting	0.735			
38	Impatient	0.856	Interested	0.86	85	Dubious	0.707	Stern	0.734			
39	Apologetic	0.855	Doubtful	0.859	86	Hateful	0.704	Anticipating	0.734			
40	Confused	0.854	Grateful	0.853	87	Worried	0.7	Horrified	0.732			
41	Distrustful	0.846	Irritated	0.85	88	Sceptical	0.699	Apologetic	0.727			
42	Flustered	0.842	Confused	0.849	89	Alarmed	0.655	Hateful	0.712			
43	Curious	0.841	Satisfied	0.849	90	Aghast	0.651	Panicked	0.679			
44	Grateful	0.841	Dominant	0.847	91	Panicked	0.649	Terrified	0.672			
45	Deciding	0.839	Dispirited	0.847	92	Terrified	0.57	Offended	0.66			
46	Suspicious	0.835	Arrogant	0.846	93	Offended	0.532	Aghast	0.648			
47	Doubtful	0.834	Despondent	0.846								

Table 6: Agreement scores ( $\eta_{agreement}$ ) for the male actor in front and side view Terms are sorted from high to low scores in each view.

Male												
	Front			Side			Front			Side		
1	Suspicious	0.989	Reflective	1	48	Defiant	0.829	Anxious	0.846			
2	Intrigued	0.968	Baffled	0.975	49	Hostile	0.829	Cautious	0.845			
3	Encouraging	0.961	Jealous	0.961	50	Regretful	0.826	Confused	0.845			
4	Depressed	0.937	Puzzled	0.943	51	Relieved	0.826	Friendly	0.844			
5	Despondent	0.934	Sarcastic	0.94	52	Curious	0.824	Decisive	0.843			
6	Confident	0.934	Ashamed	0.925	53	Nervous	0.823	Concerned	0.842			
7	Concerned	0.931	Stern	0.916	54	Reassuring	0.823	Comforting	0.84			
8	Incredulous	0.926	Eager	0.915	55	Pensive	0.821	Earnest	0.838			
9	Disappointed	0.906	Irritated	0.914	56	Hopeful	0.818	Arrogant	0.835			
10	Sympathetic	0.905	Contemplative	0.913	57	Offended	0.815	Resentful	0.833			
11	Convinced	0.902	Distrustful	0.909	58	Distrustful	0.813	Convinced	0.829			
12	Indecisive	0.897	Suspicious	0.908	59	Indifferent	0.812	Uneasy	0.828			
13	Dubious	0.896	Joking	0.904	60	Thoughtful	0.809	Deciding	0.827			
14	Contented	0.893	Defiant	0.902	61	Playful	0.808	Perplexed	0.827			
15	Eager	0.891	Confident	0.901	62	Dominant	0.799	Assertive	0.827			
16	Friendly	0.891	Annoyed	0.9	63	Interested	0.796	Pensive	0.826			
17	Cautious	0.89	Offended	0.897	64	Assertive	0.796	Embarrassed	0.825			
18	Apologetic	0.888	Despondent	0.894	65	Perplexed	0.793	Accusing	0.824			
19	Preoccupied	0.884	Intrigued	0.891	66	Doubtful	0.792	Insisting	0.822			
20	Amused	0.883	Encouraging	0.891	67	Relaxed	0.791	Relaxed	0.82			
21	Resentful	0.881	Affectionate	0.888	68	Insisting	0.784	Threatening	0.819			
22	Jealous	0.881	Thoughtful	0.888	69	Guilty	0.769	Dominant	0.819			
23	Sarcastic	0.88	Playful	0.885	70	Sceptical	0.762	Curious	0.814			
24	Joking	0.88	Enthused	0.879	71	Fearful	0.761	Impatient	0.81			
25	Alarmed	0.876	Preoccupied	0.879	72	Threatening	0.757	Imploring	0.809			
26	Tentative	0.871	Worried	0.877	73	Flustered	0.749	Contented	0.809			
27	Upset	0.871	Depressed	0.876	74	Desire	0.746	Indifferent	0.802			
28	Earnest	0.868	Regretful	0.876	75	Fantasizing	0.744	Upset	0.801			
29	Anticipating	0.866	Hostile	0.874	76	Dispirited	0.726	Insulting	0.801			
30	Annoyed	0.864	Fascinated	0.874	77	Puzzled	0.723	Doubtful	0.794			
31	Serious	0.858	Serious	0.873	78	Accusing	0.713	Guilty	0.793			
32	Affectionate	0.857	Sympathetic	0.867	79	Arrogant	0.71	Apologetic	0.791			
33	Deciding	0.854	Dispirited	0.866	80	Horrified	0.709	Bewildered	0.79			
34	Decisive	0.853	Amused	0.866	81	Anxious	0.707	Fearful	0.785			
35	Comforting	0.853	Entertained	0.862	82	Confused	0.705	Incredulous	0.779			
36	Enthused	0.852	Anticipating	0.86	83	Impatient	0.705	Indecisive	0.77			
37	Ashamed	0.851	Dubious	0.858	84	Bewildered	0.701	Alarmed	0.769			
38	Entertained	0.844	Relieved	0.856	85	Uneasy	0.693	Hopeful	0.75			
39	Baffled	0.84	Desire	0.853	86	Fascinated	0.693	Fantasizing	0.736			
40	Stern	0.837	Grateful	0.853	87	Insulting	0.681	Flirtatious	0.732			
41	Contemplative	0.836	Nervous	0.853	88	Worried	0.678	Aghast	0.685			
42	Embarrassed	0.833	Interested	0.853	89	Satisfied	0.658	Reassuring	0.665			
43	Imploring	0.831	Tentative	0.852	90	Aghast	0.617	Flustered	0.647			
44	Flirtatious	0.831	Disappointed	0.852	91	Panicked	0.605	Horrified	0.614			
45	Irritated	0.831	Sceptical	0.849	92	Hateful	0.6	Panicked	0.483			
46	Grateful	0.83	Satisfied	0.848	93	Terrified	0.443	Terrified	0.471			
47	Reflective	0.83	Hateful	0.848								

Table 7: Parametric Pearson correlations / \*. Correlation is significant at the 0.05 level (2-tailed). / \*\*. Correlation is significant at the 0.01 level (2-tailed).

	Exp_1_female_front	Exp_1_female_side	Exp_1_male_front	Exp_1_male_side	Exp_2_female_front	Exp_2_female_side	Exp_2_male_front	Exp_2_male_side
<b>Exp_1_female_front</b>	1	.555**	.336**	0.201	-0.087	-0.09	-0.123	-0.131
Sig. (2-tailed)		0	0.001	0.053	0.408	0.389	0.239	0.211
N	93	93	93	93	93	93	93	93
<b>Exp_1_female_side</b>	.555**	1	0.157	0.193	-0.168	-0.078	-0.145	-0.089
Sig. (2-tailed)		0	0.133	0.064	0.107	0.46	0.167	0.397
N	93	93	93	93	93	93	93	93
<b>Exp_1_male_front</b>	.336**	0.157	1	.598**	-.216*	-0.145	-.302**	-0.125
Sig. (2-tailed)		0.001	0.133	0	0.038	0.167	0.003	0.232
N	93	93	93	93	93	93	93	93
<b>Exp_1_male_side</b>	0.201	0.193	.598**	1	-0.175	-0.163	-.311**	-0.178
Sig. (2-tailed)		0.053	0.064	0	0.093	0.119	0.002	0.089
N	93	93	93	93	93	93	93	93
<b>Exp_2_female_front</b>	-0.087	-0.168	-.216*	-0.175	1	.520**	.436**	.321**
Sig. (2-tailed)		0.408	0.107	0.038	0.093	0	0	0.002
N	93	93	93	93	93	93	93	93
<b>Exp_2_female_side</b>	-0.09	-0.078	-0.145	-0.145	-0.163	.520**	1	.391**
Sig. (2-tailed)		0.389	0.46	0.167	0.119	0	0	0.004
N	93	93	93	93	93	93	93	93
<b>Exp_2_male_front</b>	-0.123	-0.145	-.302**	-.311**	.436**	.391**	1	.519**
Sig. (2-tailed)		0.239	0.167	0.003	0.002	0	0	0
N	93	93	93	93	93	93	93	93
<b>Exp_2_male_side</b>	-0.131	-0.089	-0.125	-0.178	.321**	.297**	.519**	1
Sig. (2-tailed)		0.211	0.397	0.232	0.089	0.002	0.004	0
N	93	93	93	93	93	93	93	93