100 Peers: An open set of controlled emotional facial expressions for use in psychology
and neuroscience experiments

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Abstract

Human faces are a ubiquitous stimulus category in experimental psychology and neuroscience, routinely applied in many research domains including perception, emotion, social cognition, and memory. Here, we present a set of portrait photographs of 100 identities with each identity making 9 emotional expressions (anger, calm, contempt, disgust, fear, happiness, sadness, surprise, and neutral), amounting to 900 total photographs. Unlike many existing face databases, these photographs are highly controlled for perceptual features, in that (1) they were taken in a laboratory setting with identical professional lighting, (2) all participants are wearing the exact same neutral clothing (a black t-shirt), (3) all faces have been manually adjusted such that the eyes are approximately at the center of a square without cropping any part of the face from the photograph, and (4) the background has been colored to be exactly the same gray hue in all photographs with no shadows. Given their highly controlled nature, these faces are optimal for experiments aiming to homogenize non-face properties, such as lighting or clothing. We are making the face set open for the benefit of the broader research community, and request that in turn, data collected in response to the faces be made open and linked to the original face database (*please cite this technical report*). This report presents a high-level summary of the faces using behavioral data (free-response descriptions and emotion categorizations), but these data do not necessarily capture the scope of potential research designs that the stimuli could support. If authors collect relevant pilot data on these stimuli for specific research questions, our hope is that such data can be collaboratively linked to the face set for the community to utilize.

Human faces are an important stimulus category across many domains of psychology and neuroscience research. Infants show a preference for face-like stimuli as early as six weeks (e.g., Mondloch, Lewis, Budreau, Maurer, Danemiller, Stephens, et al., 1999), identifiable brain networks are dedicated to processing information about faces (e.g., Haxby, Hoffman, & Gobbini, 2000), and faces are a key source of information about emotional states (e.g., Ekman & Oster, 1979) and personality traits (e.g., Naumann, Vazire, Rentfrow, & Gosling, 2009). Due to the importance and ubiquity of faces across domains, many experiments require a large number of controlled facial stimuli. Here, we present a database of portrait photographs of 100 individuals (66% female, 34% male) with a range of racial diversity (56% non-Hispanic/white, 10% Hispanic/white, 19% Asian, 6% African American, 9% mixed race), each expressing 9 emotion categories (anger, calm, contempt, disgust, fear, happiness, sadness, surprise, and neutral). Our photo-taking procedure and post-processing of the photos ensure a level of control that is required for many psychology and neuroscience experiments. We present an example dataset of responses to a subset of the faces, and our hope is that as the research community validates the faces for particular experimental contexts, data about these face stimuli will accumulate in a collaborative way.

Method

Participants (Models). The one hundred participants volunteering to have their picture taken for the set included undergraduate students, graduate students, and staff at Dartmouth College (66 women; age range = 18-33 years old). Models were recruited through (1) participation in Dartmouth extracurricular activities (e.g., sports teams,

artistic/performance activities, social houses, or residence halls), (2) the introductory psychology class participant pool, or (3) enrollment in the graduate program in the psychology department. All models were compensated for their participation either through monetary payment or course credit. Prior to each experiment session, models gave written and informed consent in accordance with the Dartmouth Committee for the Protection of Human Subjects. Models also signed an additional waiver, giving permission for their photographs to be used for research purposes. Although not included in the open dataset for confidentiality purposes, most models were asked to complete a series of behavioral scales after the photo-taking session, measuring depression (Beck's Depression Inventory (BDI); Beck, Ward, & Mendelson, 1961), state and trait anxiety (State-Trait Anxiety Inventory (STAI); Spielberger, Gorsuch, & Lushene, 1988), social anxiety (Social Interaction Anxiety Scale (SIAS) & Social Phobia Scale (SPS); Mattick & Clarke, 1998), empathy (Empathy Quotient (EQ); Baron-Cohen & Wheelwright, 2004), and expressivity (Berkeley Expressivity Questionnaire (BEQ); Gross & John, 1997).

Photo-taking procedure. After giving informed consent, the models were asked to change into a black crew neck T-shirt, remove all hair accessories, and remove all visible jewelry. Nine "warm-up" photographs were taken, in which the model made no expression, or smiled without teeth with various face angles. The forward-facing photograph with no expression was used as the models' 'neutral' facial expression, and the forward-facing photograph in which the model smiled without showing teeth was used as their 'calm' facial expression. Note that the 'neutral' and 'calm' photographs were taken before the model had been primed to make any other facial expressions.

Models were then told that they would be photographed making emotional expressions, and they were given a folder with exemplar photographs of the six following labeled expressions: surprise, anger, disgust, sadness, fear, and happiness. Two exemplars of each facial expression (one male, one female) with a high rate of categorization accuracy ($> 90\%$) were chosen from the NimStim face database (Tottenham, Tanaka, Leon, McCarry, Nurse, Hare et al., 2009). These standardized facial expression photographs allowed the participants to see an example of what the expression should look like. In other words, the model's task was to mimic these expressions for the camera. The surprised face exemplars that were chosen had a relatively ambiguous valence, in the sense that they were rated as negative by approximately half of observers and as positive by the other half in a separate study (Mattek, Berkowitz, Whalen, & Freeman, 2016). Prior to posing the emotion category photos, models were given five minutes to practice the expressions privately in a mirror. After practicing, models were not given any context for the facial expressions and were only told to make and hold a given facial expression on the count of three (i.e., for each expression the experimenter would say "make a happy face on the count of three: one...two...three," and then would snap a series of photographs). Images were taken rapidly using the "series" setting on the camera, which allowed several pictures to be taken per second. At least four pictures were taken per expression, and choice of which photo would be included in the final set was determined by agreement of independent choices by two of the authors (AM and JB; disagreements were decided via discussion).

Surprise was the first expression each model was asked to make. The valence of surprise is ambiguous, so we did not want the valence of the other expressions (overall

negative) to impact the surprised face. The models then posed the remainder of the categories in the following order: anger, disgust, sadness, fear, happiness, contempt. Because “contempt” is not an emotion category included in the NimStim, the following situation¹ was given to models to cue this expression: “Imagine that you worked on a group project, and you overheard one of the group members blatantly taking credit for work that you did. What is the facial expression you would make in this situation?”

If a model noticeably struggled to pose a particular expression, occasionally the experimenter would ask them to re-observe the exemplar photos and re-take photos for that expression at the end (after the “contempt” photo). However, rather than forcing participants to make a perfectly accurate expression, we opted to allow for some natural individual differences in the ability to pose particular expressions, with the thought that these differences might be important markers of personality or other traits. For example, if an individual can easily pose an angry face, but has difficulty posing a sad face, this might indicate natural differences in the frequency with which an individual experiences or communicates a particular emotional state, and these individual differences might be important for broader psychological research questions.

Post-processing of photos. Each of the 900 photos (100 individuals making 9 expressions each) were edited using Adobe Photoshop software. A template that centered the eyes within a square boundary was imposed on each photograph. In some cases, it was not possible to exactly center the eyes, for example, if the participants face was

¹In a pilot set of photo-taking sessions, we attempted to cue all of the emotions by providing an emotion-evoking situation, rather than asking them to simply mimic an exemplar emotion expression. We found that participants were confused by this procedure, and the majority of the photographs taken using this method were relatively “neutral”, whereas the mimicking instructions were easier for the participants to follow and resulted in more readily identifiable emotion categories by observers.

tilted. In the unedited photos, the white-sheet background varied in color, as the camera automatically adjusted the shading of white relative to the skin color of the participant. This contrast effect was corrected for, and the background was filled in with a uniform gray background. Figure 1 shows 6 example identities making all 9 expressions.

Figure 1. A subset of the 100 model identities making all 9 expressions.

Descriptive data.

This face database was created in a way that we thought would be generally useful to the broader research community. As stated above, the goal was not merely to generate perfectly contrived categorical facial expressions, but also to preserve individual differences in the ability to express particular emotion categories. In this sense, no single

task could appropriately “validate” these photographs along all psychological dimensions that might be considered for general experimental use. Nonetheless, we ran a simple “validation” experiment on a subset of the expressions in order to generate a high-level description of the faces, by collecting some standard responses to a subset of the faces (free response and emotion category label). More generally, our hope is that as these faces become utilized by the broader research community, relevant validation data will accumulate in a collaborative fashion.

Face stimuli subset. A representative subset of the face stimuli (315) was selected, which consisted of 45 identities, each making 7 facial expressions (6 “basic” emotions [angry, disgusted, fearful, happy, sad, surprise] + neutral).

Participants. Participants (N=113, 70% women) were recruited through the introductory psychology course at Dartmouth College. All participants gave informed consent according to the Committee for the Protection of Human Subjects and were compensated with course credit.

Procedure. The experimental task took place on a computer in a laboratory setting. Participants completed 2 blocks of 45 experimental trials. In the first block, participants were asked to respond in 40 characters or less how they interpreted the meaning of the facial expression (without being primed with any possible category terms). In the second block, participants were asked to categorize the faces into one of seven emotion categories (Afraid, Angry, Disgusted, Happy, Sad, Surprised, No Expression) using the keyboard. For each trial, a single face was presented. Participants saw each identity once in each block (3 times across all three blocks), and in each block a given identity was making one of the seven possible facial expressions, such that (a)

every trial for a given participant had a unique photograph, and (b) across all trials, there was approximately a uniform distribution across the different emotion categories. Identity and emotion of the stimuli were divided into 14 pseudorandom orders to ensure that all items were rated in both task blocks (free response, emotion category) by an approximately equal subset of participants. On each trial, instructions appeared above the face: “Please describe how you interpret this facial expression in 40 characters or less” in the first block, and “Please select the category that best describes the facial expression” in the second block, with the key code mapping listed below the face.

Descriptive statistics. Responses across both blocks yielded consistent information about each of the emotion categories. First, data from the emotion categorization block are summarized in Figure 2, which shows the confusion of emotion assignments. Consistent with previous work, happy faces are the most accurately classified emotion category, followed by surprise; and surprise and fear are more likely to be confused with each other compared to other categories, whereas anger and disgust are more likely to be confused with each other compared to other categories (e.g., Ekman, Friesen, O'Sullivan, Chan, Diacoyanni-Tarlatzis, Heider, et al., 1987; Russell, 1994). Also consistent with prior work, fear is the most difficult to classify (Tottenham et al., 2009), or perhaps the most difficult to pose, with the a preponderance of fear faces being classified as surprise in this stimulus set. Previous work has also shown that the emotion of fear is reported to be the least commonly observed expression in everyday life compared to other facial expressions of emotion (Sommerville & Whalen, 2006), perhaps explaining part of the difficulty in posing and classifying fearful expressions.

Figure 2. Confusion matrix for classifications of 7 facial expression categories.

Furthermore, our free response data, which were collected prior to participants being primed with any category terms, are summarized with word clouds in Figure 3 (word clouds were created using wordle.net). At a gross level, it is clear that the modal term used to spontaneously describe the expressions fits with the instructed category, except for fear, which, consistent with the emotion category rating data, was most often described as surprise.

Here we present a large set of controlled facial expressions for the broader scientific community to use for research purposes. We present response data to a representative subset of the faces to create a high-level summary. We hope that as researchers use these faces for various research questions, normative data along various behavioral dimensions will accumulate in a collaborative fashion. *We kindly request that people cite this technical report when using any of the faces in their research.*

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Contributions.

Contributed to conception and design: AMM, JLB, SNC, MIG

Acquisition of data: JLB, AMM

Analysis and interpretation of the data: AMM, SNC, RSC

Drafting the article: AMM, JLB, SNC, RSC

Acknowledgments.

We would like to thank Michael M. Meyer for assisting with collecting responses to the faces and Tracey d'Arboloff for assisting with a portion of the Photoshop work.

Importantly, we would like to thank each and every one of our participants for offering their beautiful faces for our research project!

Funding information.

This work was supported by the National Institutes of Mental Health of the National Institutes of Health under Award Number R01MH080716. The content of the reported research is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflicts of interest.

The authors declare no conflicts of interest with respect to their authorship or the publication of this article.

Data accessibility statement.

All face photographs and behavioral responses associated with the faces are available online through the Open Science Framework, must request permission to access [add URL here].