ANGLE OF REGARD: THE EFFECT OF VERTICAL VIEWING ANGLE ON THE PERCEPTION OF FACIAL EXPRESSIONS

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ABSTRACT: Two studies were conducted using video records of real faces and three-dimensional schematic faces to investigate the perceptual distortions introduced by viewing faces at a vertical angle and their influence on the attribution of emotional expressions and attitudes. The results indicate that faces seen from below were perceived as more *positive* and less *negative*, while faces seen from above appeared more *negative* and less *positive*. This effect seems to be moderated by interindividual differences in facial morphology, and perhaps by differences in dynamic aspects of expressions. The second study investigated the respective contribution of the upper half and the lower half of the face to the perceptual distortion found. In general, judges based their attributions of emotional state more on cues from the upper half of the face.

In the last two decades faces and facial expressions have been the focus of study in many different contexts. As Young and Ellis (1989) summarize in the introduction to their *Handbook of research on face processing*: "The high degree of scientific interest in face processing is readily understandable, since people's faces provide such a wealth of social information. We use facial cues to recognize friends and acquaintances, to infer people's moods and feelings, to attribute social characteristics to them, and even to assist in the comprehension of what they are saying" (p. v).

While there are a large number of studies on different aspects of the perception of facial expressions, there is a remarkable homogeneity in the type of stimuli being used. Usually, photographs or schematic drawings of faces are presented and subjects are asked to identify or judge them on one or more dimensions. These photographs or drawings generally depict Caucasian targets[1] shown in a full face view with the exception of a few studies

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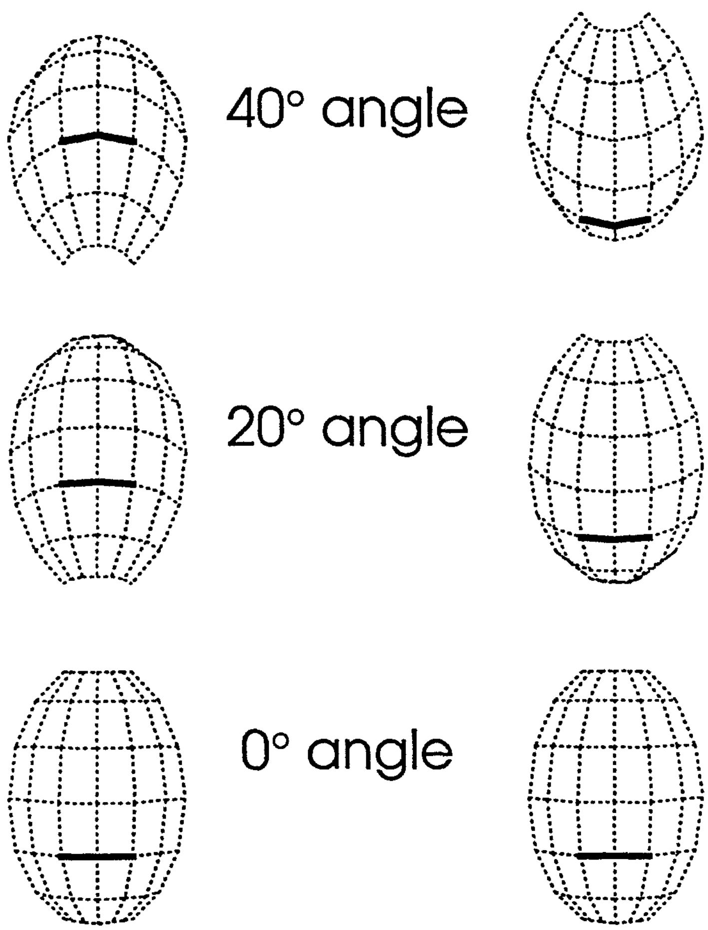
using profiles as stimuli (e.g., Mendolia & Kleck, 1991). Thus, much of the research on facial expression follows essentially a pre-Gibsonian point of view, ignoring the fact that the objects we perceive exist in space and time and are perceived as such (Sergent, 1989). Faces are three dimensional objects, and we perceive them as richly structured textures from many different angles. While there have been a few recent studies on the perception of the dynamics of emotional expressions (see, Hess, Kappas, McHugo, Kleck, & Lanzetta, 1989; Oster, Daily, & Goldenthal, 1989), little is known regarding the effect of changes in perspective with the exception of seeing faces in profile (e.g., Mendolia & Kleck, 1991; Hojo, 1987,1988) or three-quarter view (e.g., Baddeley & Woodhead, 1983). Specifically, we know of no study that examined the impact of vertical viewing angle on the perception of facial expressions. This is particularly astonishing, because (1) specific and relevant distortions can be predicted as a function of the vertical viewing angle, and (2) the vertical viewing angle may play an important role in interactions, such as those between adults and children, or between a speaker on a raised platform and the audience.[2]

Most of the facial components relevant for the expression of emotion (lips, eyelids, eyebrows, etc.) are horizontally oriented on the face, which is not flat, but can be approximated by the shape shown in Figure 1.

A flat line on a round surface will be distorted systematically as the object rotates vertically (that is, around the horizontal axis *x*; see Figure 2), or if the viewer changes her relative position. Seen from above the line will apparently curve up, seen from below the line will apparently curve down.

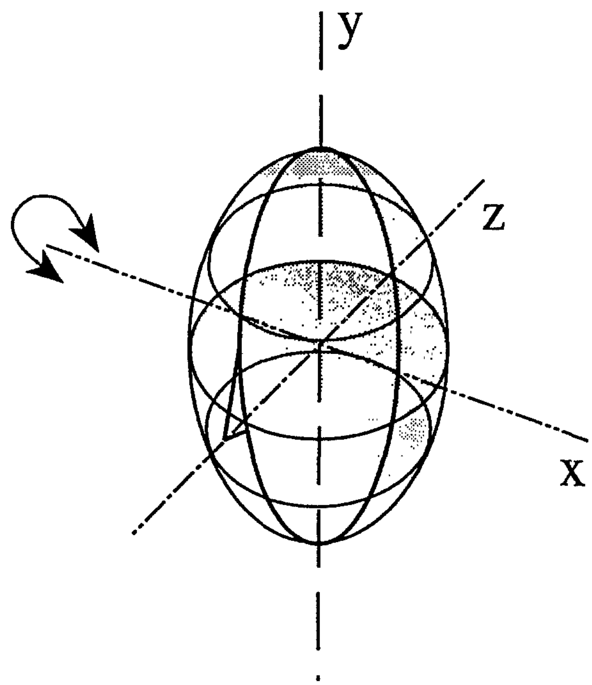
The mouth on a real face will be distorted in a way similar to the lines in Figure 1.[3] Consequently, we predict that the comers of the mouth will appear to be pulled up when seen from above, and appear to be curved down when seen from below. These distortions mimic changes in facial appearance that have been reliably shown to elicit judgments of happiness or sadness, respectively (e.g., Wiggers, 1982). Similar distortions can be observed for other parts of the face. The distance between eyes and eyebrows, for example, appears to be smaller when the face is seen from above (as in a frown) while it seems to be larger when the face is seen from below (as when the brows are raised). Previous findings lead to the assumption that not all regions contribute equally to the communication of emotional state; specifically, Boucher and Ekman (1975) concluded that the mouth is the most relevant part of the face for the emotion recognition process. Consequently, we predicted that *neutral* faces when seen from above will be perceived as expressing more happiness than faces seen from below. Conversely, the same faces seen from below will be perceived as expressing more sadness than when seen from above.

Figure 1. Effect of variation in vertical viewing angle of a straight line shown on a rounded surface straight on, seen from above, and seen from below.



The primary purpose of the present study was to assess the biasing effect of vertical viewing angle on the perception of neutral faces. However, in human interaction faces rarely show neutral expressions. More typically, our faces will reflect our emotional reactions to the ongoing conversation. Emotional facial expressions have dynamic movement patterns that interact with the distortions described above. We therefore decided to include two emotional facial expressions in our study. For this exploratory experiment we chose the expressions of happiness and disgust since both

Figure 2. Seeing the face from three vertical angles corresponds to a rotation around the *x*-axis.



expressions are easily posed[4] and involve both upper and lower face appearance changes. As mentioned above, facial expressions are dynamic by nature. We therefore chose to present judges with short video clips of the expressions. The distorting effects of vertical viewing angle on dynamic emotional expressions are likely complex and, lacking a simulation model, we did not attempt to make predictions for these expressions.

Moreover, it is obvious that vertical viewing angle might not only influence attributions of emotional states, but also expressions of attitudes towards the interactant, such as dominance. Specifically, we predict that a person filmed from a clearly perceptible vertical viewing angle will be perceived as more dominant when seen from below (and seeming to look up) while a person filmed from above (and seeming to look down) will be perceived as more submissive (see Ellyson & Dovidio, 1985). In a related study Mandell and Shaw (1973) found a significant influence of vertical viewing angle on judgments of *potency* and *activity* of a newscaster filmed from three angles.[5] It is important to note, that, while there are no established facial expressions of attitude, the expression of a specific emotion in an interaction can be interpreted as consistent with a particular attitude that the sender has towards the object of the conversation, or towards the receiver (Hess, Kappas, & Scherer, 1988).

Experiment 1

Method

Stimuli

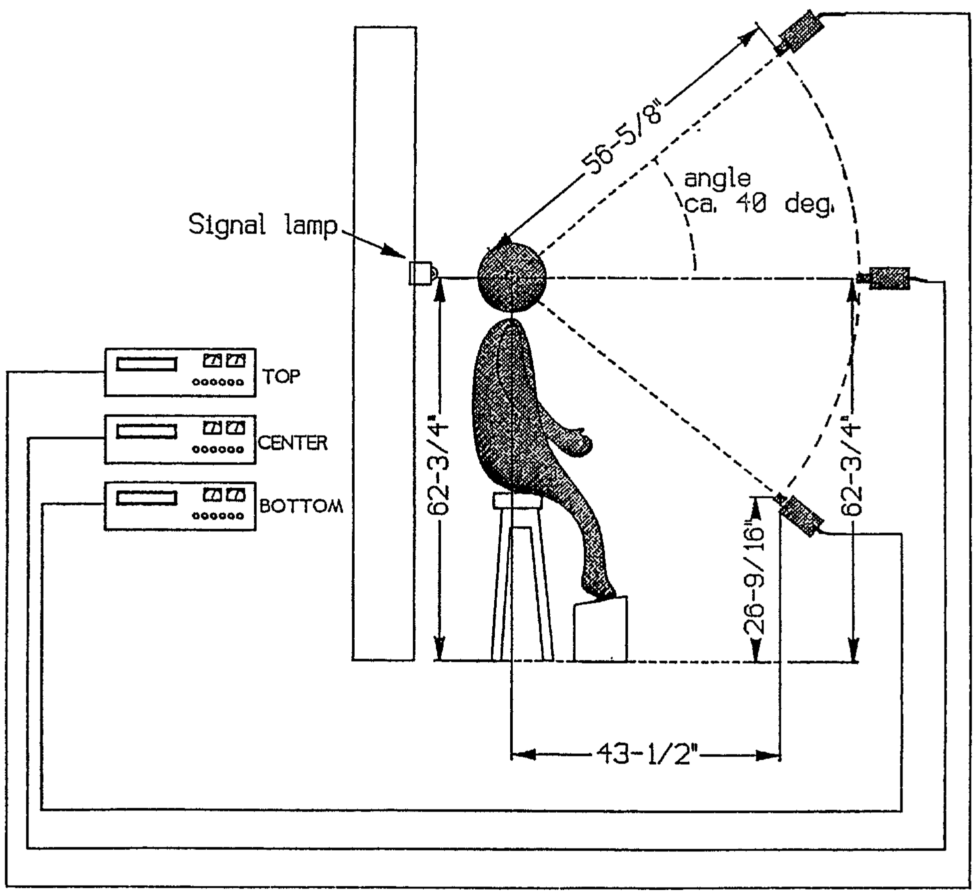
Two male and two female actors were filmed with three video cameras (40° from below, straight on, 40° from above) while displaying a neutral face, as well as a happy and a disgusted facial expression (see Figure 3). For the poses of the emotional facial expressions, actors were asked to try to imagine a situation where they felt the emotion and to produce a facial expression congruent with the situation. For the neutral expressions actors were asked to keep a neutral face for about 20 s.

Three video cameras were positioned at the same distance from the face of the actor. A counter was visible on all three viewing angles to allow the identification of corresponding episodes. To select the stimuli, a coder trained and certified in using the Facial Action Coding System (FACS; Ekman & Friesen, 1978) identified two happy, two disgusted, and two neutral facial episodes each from the *straight on* recording for each of the four stimulus persons. The patterns chosen have been shown to be consistently perceived as expressing the intended emotion (Wiggers, 1982). These episodes as well as the corresponding episodes from the *above* and *below* recordings were copied to three stimulus tapes. The resulting 72 (4 actors $\times$ 3 emotion expressions $\times$ 3 angles $\times$ 2 repetitions) stimuli were counterbalanced within tapes regarding actor, viewing angle, and emotion displayed. The order of presentation of the tapes was counterbalanced over subjects. Each stimulus was 7 seconds in length. The interstimulus interval was at least 15 seconds, or until all judges had finished filling out the rating forms for the respective stimulus.

Subjects

Eight male and eight female undergraduates at Dartmouth College participated for extra course credit. One to four subjects participated in each of two sessions,[6] one for judging attitudes and one for judging emotions.

Figure 3. Camera placement for Experiment 1.



Dependent Measures

The 72 facial expressions were rated on seven unipolar emotion scales (0 = not at all, 5 = very much): anger, contempt, disgust, fear, happiness, sadness, and "other." Perceived attitudes were judged on six bipolar attitude scales (-3 to $+3$): submissive/dominant, self-effacing/arrogant, warm/cold, unfriendly/friendly, rejecting/accepting, and passive/active.

Results

The emotion and the attitude ratings were analyzed separately. With regard to the perceived emotional state, we predicted that neutral facial expressions, when seen from above, would appear more happy/positive than when seen straight on, while when seen from below would appear more sad/negative. A 4 (actor) × 3 (angle) doubly multivariate analysis of variance was conducted for the neutral facial expressions on the scales *sadness* and *happiness*. The analysis was conducted separately for the two repetitions. Since the pattern of significant results was the same for both analyses only one will be reported. In addition, multivariate repeated measures analyses of variance with the actor and angle factors were conducted separately for the scales anger, disgust, fear, and contempt. Initial analyses included the factor sex of rater; however, since no main effect or consistent pattern of interaction was found for this factor it was dropped.

Regarding the doubly multivariate analysis of variance, the following effects emerged. For the scales *sadness* and *happiness*, main effects for angle ($F(4, 12) = 5.54$, $p < .01$; *sadness*, $F(2, 30) = 8.49$, $p < .001$; *happiness*, $F(2, 30) = 7.02$, $p < .01$); main effects for actor ($F(6, 10) = 7.89$, $p < .01$; *sadness* $F(3, 45) = 3.68$, $p < .05$; *happiness* $F(3, 45) = 2.58$, $p = .065$); and Angle × Actor interactions ($F(12, 180) = 2.62$, $p < .01$; *sadness* $F(6, 90) = 1.95$, $p = .085$; *happiness* $F(6, 90) = 2.58$, $p < .001$).

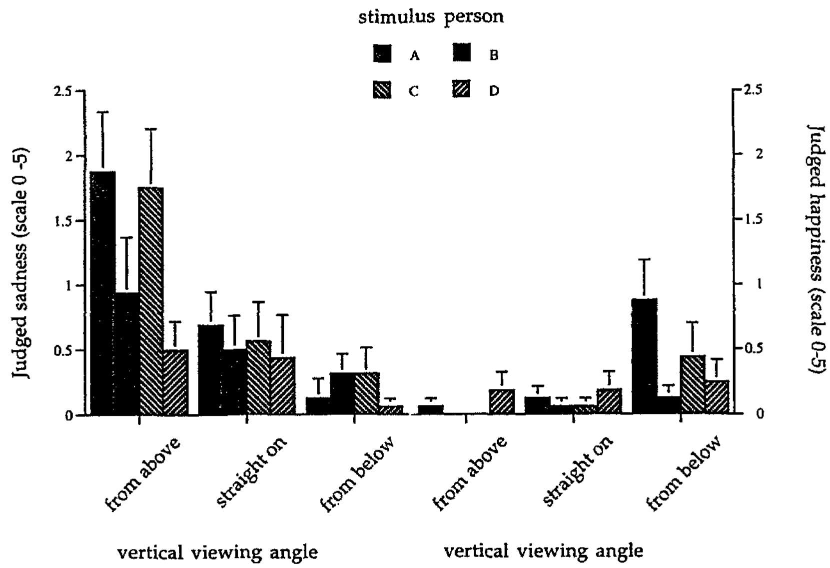
For the remaining emotion scales, significant main effects for angle emerged for the scales *disgust*, $F(2, 14) = 8.62$, $p < .01$, and *anger*, $F(2, 14) = 4.99$, $p < .05$, as well as marginally significant main effects of actor for the scales *anger*, $F(3, 13) = 3.28$, $p = .056$, *disgust*, $F(3, 13) = 3.19$, $p = .060$, and *fear*, $F(3, 13) = 2.66$, $p = .092$. A significant Actor × Angle interaction emerged for *contempt*, $F(6, 10) = 4.57$, $p < .05$.

Inspection of the means shows that, in general, and contrary to our predictions, expressions filmed from below were perceived as more positive and less negative than expressions filmed from above. Figure 4 shows the means for the scales *sadness* and *happiness*.

In addition to the neutral facial expressions, raters judged emotional facial expressions of happiness and disgust presented from three angles. A multivariate repeated measures [4 (actor) × 3 (angle) × 2 (emotional expression)] analysis of variance was conducted for each of the emotion scales separately. Main effects of angle emerged for the scales *happiness*, $F(2, 14) = 5.67$, $p < .05$, and *sadness*, $F(2, 14) = 3.16$, $p = .074$.

Highly significant main effects of emotion were found for all scales

Figure 4. Means and standard error of perceived sadness and happiness for four stimulus persons seen from three different angles.



indicating that the facial expression manipulation was successful. In addition, main effects of actor emerged for all scales as well as Emotion × Actor interactions, indicating that the judged emotional state was perceived to be differentially strong for different actors. Emotion × Angle interactions emerged for the scales *disgust, fear,* and *happiness* while the Actor × Angle interaction was significant only for *fear.* A significant three-way interaction emerged for the scales *disgust* and *fear.*

In summary, vertical viewing angle was found to influence the judgment of emotional facial expressions such that facial expressions of happiness were judged as less happy when seen from above than when seen from below. Similarly, facial expressions of disgust were judged to be more disgusted when seen from above than seen from below. However, both effects were qualified by the effect of actor.

For the attitude scales, a multivariate mixed model analysis of variance was conducted. The within-subject factors were actor (4), angle (above, straight on, below), repetition (2), and emotional expression (disgust, neutral, happy) and the between-subjects factor was sex of rater (2). Significant and marginally significant main effects for actor and emotion along with interactions emerged. However, no significant main effect of angle emerged for any of the scales. Since the focus of this experiment was on the influence of the angle of regard on the attribution of attitudes to the sender and no consistent effects of angles were found, the results of these analyses will be presented only in summary form.

Main effects of actor were found for the scales *submissive/dominant*, $F(3, 11) = 3.31$, $p = .061$, *unfriendly/friendly*, $F(3, 11) = 2.81$, $p = .089$, and *passive/active*, $F(3, 11) = 4.27$, $p < .05$. Main effects of emotion were found for the scales *self-effacing/arrogant*, $F(2, 12) = 4.79$, $p < .05$, *unfriendly/friendly*, $F(2, 12) = 53.16$, $p < .001$, *rejecting/accepting*, $F(2, 12) = 43.39$, $p < .001$, and *passive/active*, $F(2, 12) = 14.83$, $p < .001$. These results suggest that the attribution of attitudes (e.g., friendly, cold, and dominant) is influenced by the emotional expression shown. Furthermore, the presence of main effects of actor can be seen as evidence for the influence of facial demeanor on the perceived attitude of the stimulus person. Only for the scale *unfriendly/friendly* did a marginally significant main effect of angle emerge, $F(2, 12) = 3.22$, $p = .076$ in a direction consistent with the other findings. In addition two-way, three-way, and four-way interactions involving angle were found for all scales. No main effect of sex of rater was found.

Discussion

The findings support the notion that emotional facial expressions influence the perceived attitude of the actor. However, the notion that vertical viewing angle would have an influence on the perceived dominance/submissiveness of the actor was not supported.

The data do support the notion that viewing angle introduces a perceptual bias in the attribution of emotions to a stimulus person. Specifically, and contrary to our predictions, we found that subjects' expressions were perceived as more *positive* and less *negative* when filmed from below and as more *negative* and less *positive* when filmed from above.

How can this finding be explained? First, since a within-subjects design was employed, it is possible that subjects became aware of the distortion introduced by the vertical viewing angle and tried to compensate for these distortions, "overshooting" in the process. Yet, a closer inspection of the appearance of the stimuli suggests a second explanation. As mentioned above, vertical viewing angle changes the appearance of all parts of the face. Our predictions were based on the perceptual changes in the lower part of the face; specifically, the corners of the mouth when seen from above appear to be drawn upwards, and when seen from below seem to be drawn down. However, the vertical viewing angle also influences the appearance of the brow region—the eyebrows appear to be lowered when seen from above, as they are in anger (e.g., Wiggers, 1982), and raised when seen from below. Consequently, a neutral face seen from above combines a mouth that appears curved upwards (as in happiness) with eyebrows that appear lowered. Little is known about how observers resolve discordant information from different areas of the face. Observers may either prefer to base emotion attributions on a particular part of the face, or the facial appearance of the actors may draw attention to one half of the face rather than the other. Hess et al. (1988) suggested a weighted average model to explain the judgments of raters confronted with inconsistent face and vocal emotional expressions. Further research might provide evidence relevant for a model of the processing of discordant information contained within a given facial expression.

Similarly, the interactions involving the factor of actor are of special importance since they suggest that raters did indeed base their ratings more or less on the upper part of the face depending on the prominence of the actors' eye region. That is, depending on the facial morphology of the stimulus person the ratio of perceived changes in the upper and the lower half of the face as a function of vertical viewing angle should change. Specifically, the depth of the eye socket must affect the magnitude of perceived brow lowering.

In summary, two hypotheses emerged from our findings. First, facial morphology interacts with vertical viewing angle and emotion display regarding the attribution of emotional states to a stimulus person. Second, vertical viewing angle affects the upper and the lower half of the face differentially, and the contradictory information will be resolved according to a preference of the rater to rely on the information from one half of the face rather than on the information from the other half.

For an adequate test of the first hypothesis synthetic three dimensional faces with known morphological characteristics that are capable of displaying different emotions would have to be created, allowing the independent variation of viewing angle, morphology, and emotion display. While such faces can be produced using modern computer image technology (e.g., Yamada, Chiba, Tsuda, Maiya, & Harashima, 1992), the creation of such stimuli is extremely expensive and currently not within our reach. We therefore restricted ourselves to the testing of the second hypothesis.

To eliminate the influence of both actor and emotional facial expression, a schematic face showing a neutral expression, which could be easily rotated using a computer, was employed. Further, following our reasoning concerning the integration of information contained in the upper half and lower half of the face, subjects were asked to rate not only the full face but also the top half and the bottom half separately.

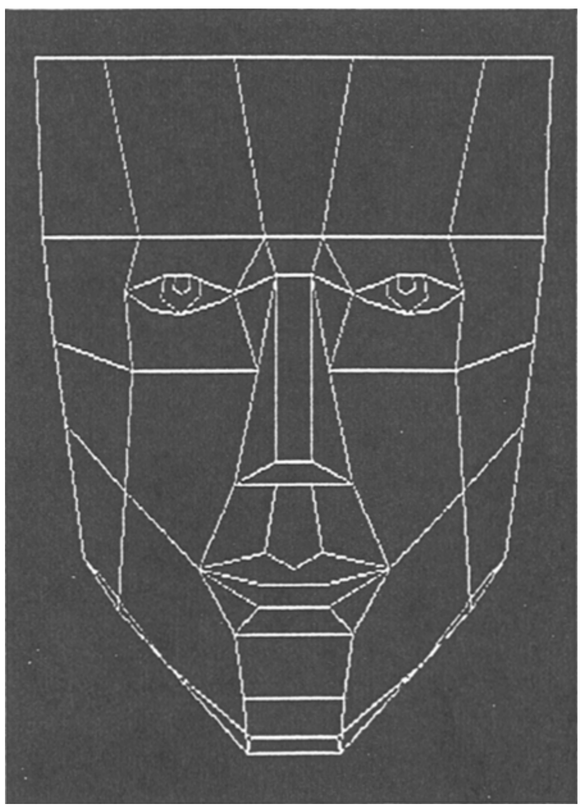
Experiment 2

Method

Stimuli

Using the program AcroSpin 1.1 (Acrobits) on a Compaq 386 MS-DOS computer, a three-dimensional line drawing depicting a face[7] with a neutral facial expression (see Figure 5) was rotated around the horizontal axis (the x axis in Figure 2) in six positive angles and six negative angles (in

Figure 5. Schematic face with neutral facial expression; straight-on perspective.



steps of 5° from −30° to 30°). The resulting 12 drawings and the straight-on drawing (0°) were printed. In addition, two sets of drawings showing only the upper or lower half of the face were prepared. The division into upper and lower halves was made following the cheekbone line. This resulted in three sets of thirteen drawings each. The drawings were assembled in two random orders for each set. The subjects rated all three sets in group sessions. At the beginning of the session, each subject received a small photo album containing one of the three sets and a stapled booklet of response sheets. After all subjects finished rating the first set, stimulus books were exchanged and they proceeded with the second set and then the third set. The order of stimulus sets was counterbalanced over subjects.

Subjects

Sixteen female and three male raters, undergraduates at the University of Geneva, participated in groups of up to three. Since in Experiment 1 no systematic effects of gender were found, no effort was made to equate the number of male and female raters.

Dependent Measures

Subjects were asked to describe the emotion expressed by each partial or full face on six 6-point Likert scales (0 = not at all, 5 = very much): anger, contempt, disgust, fear, happiness, and sadness.

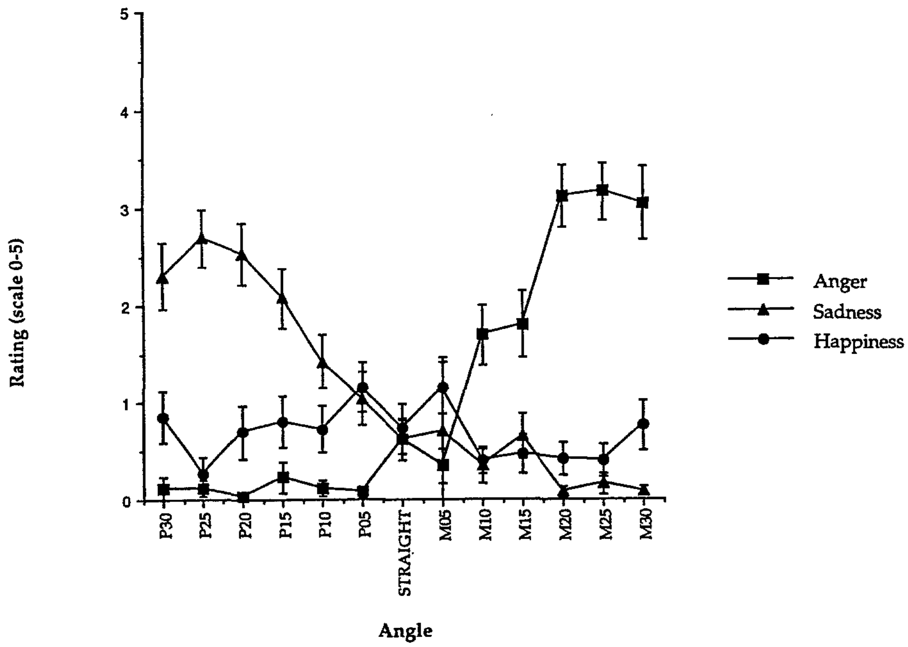
Results

A doubly multivariate analysis of variance with the factors angle (13 levels, −30° to +30°) and view (full face, upper half face, lower half face) was conducted for the negative emotions. A repeated measures analysis of variance with the same factors was conducted for happiness.

Negative Emotions

Significant main effects for both angle, $F(21, 347.2) = 15.03$, $p < .001$, and view, $F(10, 8) = 28.22$, $p < .001$, as well as an Angle × View interaction, $F(42, 704) = 4.56$, $p < .001$, emerged. In the univariate analyses a significant main effect of angle emerged for all negative emotions. Regarding view, the effect was univariately significant for all the negative emotions except for disgust, for which it was marginally significant. The

Figure 6. Perceived anger, sadness, and happiness as a function of viewing angle for the full face; P30-P05 = positive rotation angles in degrees (corresponds to face seen from below); M05-M30 = negative rotation angles in degrees (corresponds to face seen from above).

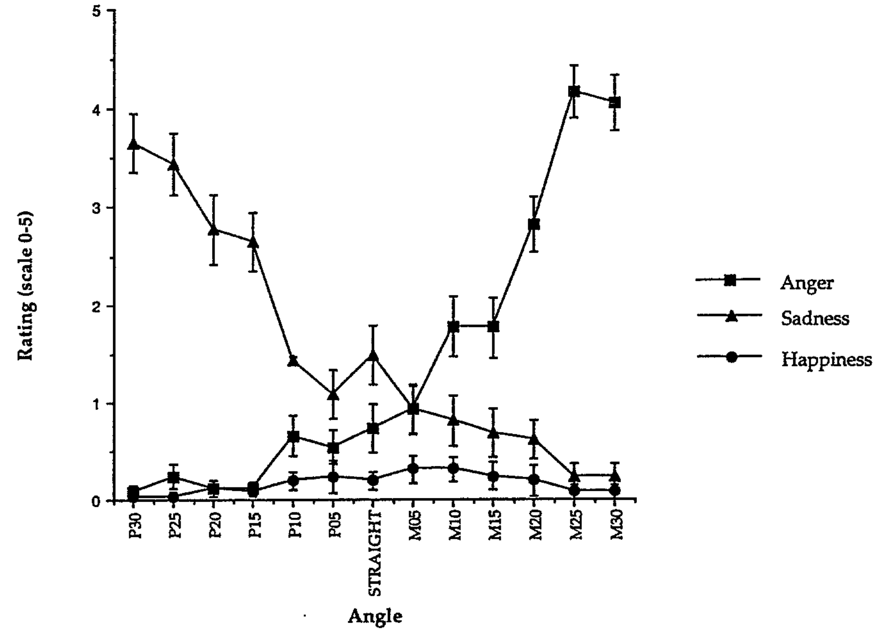


Angle × View interaction was univariately significant for all negative emotions except fear, for which a trend emerged. Inspection of the means indicates that both the full face and the upper half face were perceived as more sad when seen from below (positive angle) and as more angry when seen from above (negative angle). Ratings for the lower half face were not influenced by vertical viewing angle (see Figures 6 to 8).

Happiness

For happiness a significant Angle × View interaction $F(2, 36) = 21.39$, $p < .001$, as well as a main effect for view, $F(24, 432) = 3.84$, $p < .001$, emerged. Inspection of the means suggests that the lower face only was perceived as more happy when seen from above. Happiness ratings for the full face and the upper half face were not influenced by vertical viewing angle.

Figure 7. Perceived anger, sadness, and happiness as a function of viewing angle for the upper face only; P30-P05 = positive rotation angles in degrees (corresponds to face seen from below); M05-M30 = negative rotation angles in degrees (corresponds to face seen from above).

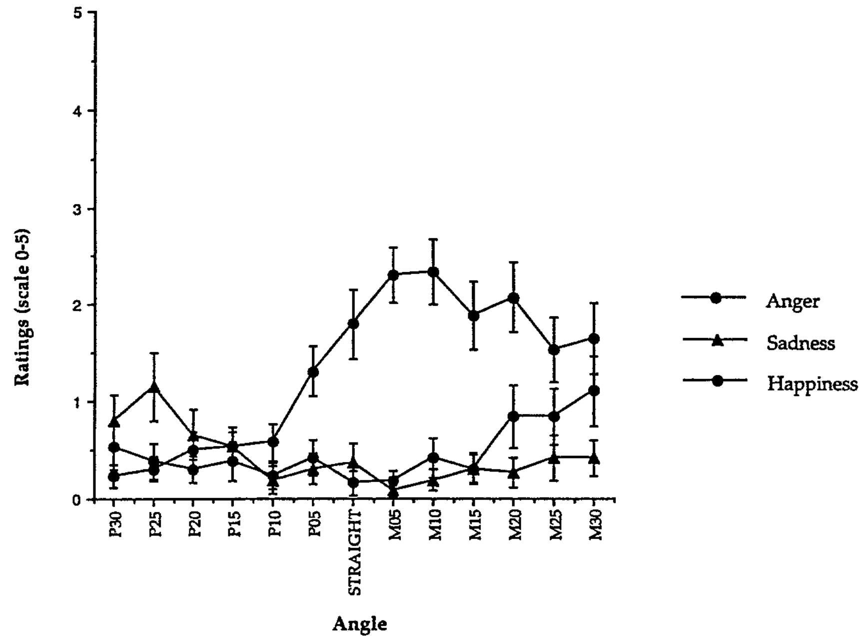


In summary, these results are in accordance with the prediction that raters will base their assessment of facial expressions preferentially on information on one half of the face rather than the other. Specifically, the assessment was based largely on the information from the upper half of the face. The contradictory information from the lower half of the face influenced raters only when they did not have access to information from the upper half. Only in this latter case did the apparent curving up of the corners of the mouth for negative angles (i.e., stimulus person seen from above) lead to a rating of happiness.

Discussion

The results of Experiment 2 confirm the effects of vertical viewing angle on the attribution of emotional state found in Experiment 1. Further, separate judgments for upper and lower face revealed (a) that the vertical viewing

Figure 8. Perceived anger, sadness, and happiness as a function of viewing angle for the lower face only; P30-P05 = positive rotation angles in degrees (corresponds to face seen from below); M05-M30 = negative rotation angles in degrees (corresponds to face seen from above).



angle introduces different perceptual distortions for the two halves of the face when shown alone, and (b) that raters based their attributions largely on information from the upper half of the face. Previous research (Bassili, 1979) indicates that ratings of happiness and disgust are largely based on information from the lower face while ratings of anger and fear are based on information from the upper face. The present research demonstrates that when contradictory information is displayed in the two halves of the face one half may dominate over the other. This may be because raters prefer information from the upper half of the face over information from the lower half. However, it is also possible that any information relating to a possible threat, such as an anger display on the part of an interaction partner, dominates over contradictory signals. This notion is in accordance with findings that anger displays are prepotent stimuli for the perception of threat (see Lanzetta & Orr, 1981). However, this explanation does not account for the preference for sadness information from the upper face over the happiness information from the lower.

General Discussion

Using two very different kinds of stimuli—real, moving faces and static schematic representations—we established an effect of vertical viewing angle on the perception of emotion. This effect has not been demonstrated before and calls for a further systematic investigation of this robust phenomenon.

The differences in judgments for the four stimulus persons in Experiment 1 calls for the study of the effects of facial morphology on perceptual distortions. In our opinion this needs to be done using photo-realistic computer generated (3D) faces allowing the systematic variation of individual features as well as of different expressions. In addition, the effect of facial movement could be tested using animations of these faces, as there are likely not only inter-individual differences in facial morphology, but also differences regarding dynamic aspects of facial activity. Using more realistic stimuli would also permit validation of the effects we found in Experiment 2 concerning the importance of upper and lower face in the context of vertical viewing angle.

While the effect of vertical viewing angle has been demonstrated here both with videotaped dynamic representations of real faces and with static schematic faces, we do not yet know the strength of the effect in "real-life" situations. For example, interactions between children and adults are often repeated over long periods of time, so it might well be that the perceptual distortions introduced by the vertical viewing angle will be compensated through experience and exposure. Yet, given the frequency with which we are exposed briefly to faces at different viewing angles, particularly in the mass media (see Mandell & Shaw, 1973) and new forms of telecommunications (where the camera is often positioned above a viewing screen or computer monitor and not in the line of gaze), the importance in further investigation of the effect becomes evident.

Our findings are not only of interest to applied areas, such as communications, but have implications for our knowledge regarding the processing of information conveyed in facial movement in general. We know little about the transformations necessary to interpret facial expressions that not only are dynamic in nature themselves, but are part of an entity (the head of another human being) that moves in three-dimensional space and rotates around three axes. For example, is the long-term memory representation of facial expressions independent or separate from the viewing angle (see Baddeley, 1994)? Are there specific facial actions that are particularly vulnerable to effects of vertical (or horizontal) angle? To answer these questions, we must move beyond research strategies that employ black and white, two-dimensional, and static photos and illustrations as stimuli and deal with the complexities of a moving, three-dimensional world.

Notes

1. One exception are Matsumoto and colleagues who conducted studies with both Caucasian and Japanese encoders and decoders (e.g., Matsumoto & Ekman, 1989).
2. Most human interactions, even among adults, imply the viewing of the interaction partner at an angle since people tend to differ in height. However, distortions due to vertical viewing angle differences can only be expected to be visible at more extreme angles. Smaller size differences such as can typically be found between males and females should not lead to significant distortions.
3. Due to morphological differences in appearance the mouth may not necessarily approximate a flat line for all faces; however, a flat line is a reasonable approximation for most cases.
4. We have used expressions of happiness and disgust in previous research and have found that subjects were not only well able to pose both emotions, but that these poses were judged as genuine as those expressions which were elicited by external stimuli provoking corresponding changes in subjective feeling (e.g., Hess & Kleck, 1994).
5. Mandell and Shaw (1973) used $-12°$,$0°$, and $+12°$ degree angle shots that included the torso of the news presenter from the knees up. Thus, body cues and facial cues were confounded in their study. While they did not include emotion scales per se they found no effects of vertical viewing angle on an *evaluation* scale.
6. In all cases subjects completed their judgment tasks in visually isolated booths.
7. The face used for this study was contained in the AcroSpin package (FACE.FIL).

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