Differences in the Perception of Emotion in Chimeric Faces between Left- and Right-Handed Individuals

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Abstract

When judging emotional facial expression, most right-handed individuals focus on the information in their left visual field, the perceived left side of the face. This left-field advantage is consistent with neurological findings of right-hemisphere superiority in processing emotions. Here we extend this finding to left-handed individuals to determine the extent of left-hemisphere emotional processing in this population. In order to create a more life-like setting than past research, photographs were used instead of cartoons; moreover, emotional quality was expanded. Fifty-five participants (30 right-handed, 25 left-handed) were given the Edinburgh [Handedness] Inventory to measure strength of handedness preference. Twelve stimuli were created as “chimeric” faces in which the left side of the face expressed one emotion and the right side expressed a different emotion. The chimeric faces were the following: Happy/Angry, Angry/Happy, Happy/Fear, Fear/Happy, Fear/Angry, and Angry/Fear. Each face was depicted by a male and female model, for a total of 12 chimeric faces. Participants viewed all twelve stimuli in random order. Each stimulus was preceded by a fixation point and presented for 200 milliseconds. These conditions minimized the possibility of eye movements, thus ensuring that each hemisphere “saw” a different emotion. For each stimulus, participants were asked to rate the strength and valence of the emotion they saw and to label the emotion as Happy, Anger, Fear(ful), or Sad. It was hypothesized that left-handed persons would perceive the emotion on the right side of the visual field more often than that on the left, revealing a reverse effect of hemispherical processing for left-handed individuals. Main effects were found for both handedness and emotional quality. Left-handed participants reported perceiving the emotional quality projected to the left visual cortex (right visual field) significantly more than right-handed participants. In addition, happiness was perceived significantly more often than any other emotion, independent of its location. These findings support the hypothesis.

Keywords: Perception of Emotion, Chimeric Faces, Left- and Right-Handed Individuals.

1. Introduction

When judging emotional facial expression, most right-handed individuals focus on the information in their Left Visual Field (LVF), which is the perceived left side of the face. This LVF advantage had led researchers to believe in Right Hemisphere (RH) dominance in the perception and of emotion, an idea known as the “Right Hemisphere Hypothesis.” This theory suggests that the RH is responsible for the processing of all emotions. Researchers have found much evidence of RH dominance in the recognition of emotion, supporting the Right Hemisphere Hypothesis. The RH was found superior in the perception and expression of emotion. This RH dominance was found not only for emotion present in the face but also in tone of voice. Furthermore, the left side of the face, controlled by the RH, was found to express more emotion than the right side of the face.

Others have argued that the RH is not dominant for all emotions. There is substantial research supporting a theory known as the “Valence Hypothesis,” where the Left Hemisphere (LH) is dominant in the perception of positive emotions, while the RH is dominant in the perception of negative emotions. A series of “Splitfield Studies” by Mandal and Singh support this theory. These studies found evidence that the identification of facial emotion was stronger for stimuli presented in the LVF; however, this RH advantage was weakest for happiness, a positive...
emotion. This finding suggests possible differential hemispherical processing of emotion, dependent on the valence of the emotion perceived.

It is important to note that most research on the perception of emotion in faces has used right-handed individuals as participants. Little research has been conducted on the perception of emotion in faces by left-handed individuals. One case study reported reverse hemispherical specialization in the processing of emotion of a left-handed brain damaged individual\textsuperscript{11}. Left-handers have been found to express emotion differently from right-handers; while right-handers express more emotion with the right side of their face, left-handers express more emotion with the left side of their face\textsuperscript{12}. Such asymmetry in expression may hint at a subsequent asymmetry in emotional processing. Opposite patterns in the perception of emotion were found for right-handed individuals and non-inverted left-handed individuals. One study separated left-handed participants on the basis of hand inversion (“hooking”) when writing\textsuperscript{13}. Here “hooked” left-handed writers were considered to be “strong” left-handers and non-hooked were considered “weak” left-handers. When viewing chimeric stimuli, both hooked and non-hooked left-handers favored the emotions in the Right Visual Field (RVF) significantly more than right-handers. This RVF preference was found true for both cartoon and photographic chimeric stimuli.

The purpose of the present study was to investigate the perception of emotion in faces by left-handers to determine the extent of LH processing of emotion. Previous research has not controlled for eye movements and therefore the possibility of bilateral hemispheric stimulation exists. It is hypothesized that, when eye movements are controlled for, left-handed participants will perceive the emotion in the RVF more often than that in the LVF, revealing a reverse effect of hemispherical processing for left-handed individuals.

2. Methodology

2.1 participants

Forty-seven participants were used in this study (13 male, 34 female). Twenty-six identified themselves as right-handed. Twenty-one identified themselves as left-handed. Handedness was confirmed through use of the Edinburgh Handedness Inventory\textsuperscript{14}.

2.2 materials

Adobe Photoshop version CS was used to create chimeric stimuli. Microsoft PowerPoint 2002 was used to present the stimuli in a timed slideshow format. Participants used a data sheet and a pen or pencil to record responses. Stimuli consisted of 12 chimeric faces (see Fig. 1 for example). Six faces were of a female model, six of a male. Each portrayed the following three emotions: Happy, Angry, and Fearful. Original images were spliced in half using the midpoint between the eyes, the upper lip, front teeth, and chin as points of reference. Chimeric faces were created such that different emotions appeared on the left and right side of the face. The stimuli included all possible combinations of emotion (Happy, Anger, and Fearful), side of face (Left, Right), and model (male, female) for a total of 12 chimeric stimuli.

Figure 1. On left, anger-fear stimulus; on right, anger-happy.
2.3 design and procedure

The purpose of the present study was to investigate the extent of LH emotional processing in left-handed individuals. Participants were ran one at a time. Each was brought to a quiet room with a computer and a chair. The participant was instructed to sit in front of the computer. Instructions on the screen explained the general purpose of the study. The participant was prompted to click to continue. Instructions on the screen prompted the participant that a small black dot would appear on the next screen. The participant was instructed to focus on the dot, and prompted to mouse click when ready to continue. A small black dot appeared on the screen. The dot was placed as a point of focus at the center of the chimeric face that would appear. The center was determined using the midpoint between the eyes and the middle of the upper lip as points of reference.

The participant focused on the fixation point for two seconds. After two seconds, the first chimeric stimulus appeared on the screen for 200 milliseconds, and then disappeared. The fixation point remained present throughout the trial. A new screen prompted the user to choose which emotion he/she perceived in the flashed chimeric stimulus and to record it on the provided data sheet. A four alternative (Happy, Anger, Fear, Sad) forced-choice procedure was used. After circling the perceived emotion, the participant rated the perceived strength and valence of the emotion using a Likert scale (1=very negative, 5-6=neutral, 10=very positive). These directions were displayed on both the answer sheet and the computer screen (See Fig. 2). The participant circled the chosen number on the scale provided. This process was repeated for twelve trials.

At the end of the session, the participant filled out an adaptation of the short form version of the Edinburgh Handedness Inventory. The participants were then debriefed, thanked, and dismissed.

3. Results

The results were analyzed by means of percentages and t-test analyses. Main effects were found for both handedness and emotional quality.

3.1 handedness

Recall that it was hypothesized that left-handed individuals would perceive the emotion in the RVF more than the LVF. The results confirmed the hypothesis. Left-handed participants reported perceiving the emotional quality projected to the RVF significantly more than the emotion projected to the LVF (t=2.13, df=22, p<.05). Left-handed individuals chose the emotion portrayed in the RVF 49.6% (n=252) of the time. The emotion portrayed in the LVF was chosen 29.4% of the time. An emotion that was not present in the stimulus, known as “Other,” was chosen 21.0% of the time (see Fig. 3).
Surprisingly, no significant preference was found for right-handed individuals. Right-handers chose the emotion projected to the LVF 38.78% (n=312) of the time. They chose the emotion projected to the RVF 38.46% of the time. An emotion that was not present in the stimulus (“Other”) was chosen 22.76% of the time.

A main effect was found for emotional quality. A subsequent analysis was performed using a subset of eight stimuli that consisted of positive-negative emotional pairing. Therefore, Angry-Fear(ful) combinations were removed. Using this analysis, right-handed participants showed the predicted LVF advantage at near significance (t=1.389, df=7, p<.12).

![Figure 3. Handedness and visual field preference comparison.](image)

**3.2 emotional valence and magnitude**

This subsequent analysis also revealed a relationship between valence, magnitude, and visual field. Emotions with a positive valence were rated as stronger when judged in the RVF while emotions with a negative valence were rated as stronger when judged in the LVF (t=2.434, df=5, p<.05). This was true regardless of handedness (see Fig. 4).

![Fig. 4. Strength and magnitude of emotions (left- left-handers; right- right-handers).](image)

Finally and importantly, when happiness was present, it was chosen significantly more than any other emotion. This was true for both left- and right-handed participants (See Table 1). Furthermore, sad was chosen more than anger, although sad was never present in the stimuli.
Table 1. Frequency of emotional quality perceived

<table>
<thead>
<tr>
<th></th>
<th>Count for Left-Handers</th>
<th>Count for Right-Handers</th>
<th>Overall % Perceived</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happy</td>
<td>45.24%</td>
<td>39.10%</td>
<td>42.07%</td>
</tr>
<tr>
<td>Angry</td>
<td>12.70%</td>
<td>15.06%</td>
<td>14.08%</td>
</tr>
<tr>
<td>Fear(ful)</td>
<td>26.59%</td>
<td>27.56%</td>
<td>27.27%</td>
</tr>
<tr>
<td>Sad</td>
<td>14.68%</td>
<td>17.95%</td>
<td>16.58%</td>
</tr>
</tbody>
</table>

4. Discussion

The purpose of the present study was to investigate the extent of LH emotional processing in left-handed individuals. This study was methodologically different from previous research on laterality and the perception of emotion in faces. First, chimeric photographs were used instead of chimeric cartoons. Past research often used cartoons or drawn faces to portray simple emotional affects. The present study used photographs in order to make the experiment more life-like, and to account for the complexities of human facial expression of emotion that are lost in the use of cartoons.

A brief presentation duration (200 ms) was used, in addition to a fixation point, in order to minimize the possibility of eye movements and maximize the extent to which each hemisphere received different information from the visual field. It may be argued that the results could be confounded by bilateral representation of the foveal visual field. This effect, if present, is minimal, as each chimeric face was approximately 12° of the visual field; therefore, the major facial features defining the emotions fall outside the fovea.

To the extent that bilateral representation did contribute, it added variability to the data, especially for the right-handed participants who are known to be more lateralized than the more heterogeneous left-handed group. This variability would partially account for the relatively weaker visual field preference effect in right-handers.

The final methodological difference in this study was the simultaneous rating of emotional quality and strength. There has been much debate in the literature over hemispheric involvement in the perception of emotion in faces. Many studies have found hemispheric involvement to be dependent on the valence of the emotion. For example, there is left hemisphere (RVF) superiority for the processing of the positive emotion of happiness. Other studies have found evidence of bilateral processing of emotions. The “right hemisphere hypothesis” asserts that the RH processes all emotions. Many advocates of this theory believe that while the RH processes both positive and negative, the LH is also involved in positive emotions.

This study used two different negative emotions (anger and fear). The chimeric stimuli did not simply consist of positive-negative valence combinations; happiness was placed with one of two different negative emotions. This factor allowed an examination of the importance of quality over valence which previous research has found important.

A main laterality effect was found for left-handed participants. It was hypothesized that left-handed participants would perceive the emotion in the RVF more often than that in the LVF, revealing a reverse effect of hemispherical processing for left-handed individuals. When emotion identification was measured, they showed a strong preference for emotions portrayed in the RVF, which projects to the LH. This LH preference was strongest for positive emotions but also true for negative emotions. These findings confirm the hypothesis, in terms of correct identification of emotion.

When the perceived strength of correctly-identified emotions was measured, the left-handers expected RVF preference was sustained. Emotions projected the RVF were considered stronger than those projected to the LVF. This RVF preference in strength of emotion was to a lesser extent than the RVF preference in identifying emotional quality.

Surprisingly, right-handed participants showed a smaller laterality effect of visual field in identification of emotional quality. There are several possible explanations for this lower visual field preference.

The chimeric faces in this study were constructed by splicing together the left and right sides of modeled male and female faces, expressing Happiness, Anger, or Fear. Research on the expression of emotion indicates asymmetrical expression of emotion. Right-handers express emotion more intensely on the left side of their face, which is controlled by the RH. Since both models were right-handed, it is possible that the left side of their faces (the participant’s RVF) expressed more emotion and that therefore the RVF emotions in the chimeric faces were stronger. This would be expected to reduce the LVF preference of right-handed participants.
Second, the preference for happiness may have decreased any present laterality effect. Both left-and right-handed individuals showed a preference for choosing happiness, regardless of location in the visual field. This happiness bias was much stronger for right-handed individuals and may partially account for the lack of visual field preference in identification of emotion.

It is important to note that in the valence analysis of emotional quality and strength, there was a definite LVF trend for right-handed individuals. This analysis removed negative-negative stimuli (i.e., anger-fear combinations) in order to investigate visual field preference in positive-negative emotion stimuli. In this analysis, right-handers showed the expected LVF trend. They preferred the emotion present in the LVF, which is projected to the RH. This LVF preference was also true for the magnitude of emotion perceived. Right-handed participants judged emotions as more positive when perceived in the RVF and more negative when perceived in the LVF, confirming the valence theory of laterality25.

Finally, an additional explanation for the reduced visual field preference in right-handers is that right-handed participants had much more incorrect emotional quality identifications than left-handed participants. Right-handers more frequently chose emotions that were not present in the stimuli. They misidentified anger as fear and vice versa. Furthermore, they chose “sad” much more than left-handed participants, even though this emotion never appeared in the stimuli. Such confusion in emotional quality is removed in the valence analysis, which indicates LVF preference for right-handed participants.

The processing of “happiness” is highly debated in the literature. Some researchers assert that the processing of happiness is a function of solely the LH26 while others argue that it is processed bilaterally27. [There is surprising support in the literature for the valence hypothesis, affirming unilateral processing of happiness.] The findings of the present study indicate a strong happiness bias. The results show that the presence of a positive emotion in a stimulus seems to be a factor of equal importance to handedness of participant and visual field location, or visual cortex stimulation. Participants preferred happiness over any other emotion, often regardless of location in visual field. This happiness bias was more predominant in right-handed participants, although significantly present in left-handed participants as well; it was more pronounced for RVF presentation although present for LVF as well. These findings allow for pleasant speculation on humanity. People appear to have a predisposition to perceive happiness, whenever present. Despite laterality, handedness, visual field location and subsequent visual cortex stimulation, people will perceive happiness over other emotions as often as possible!

5. Acknowledgements

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6. References

9. R.J. Davidson, “Affect, Cognition, and Hemispheric Specialization”