

## NOTE

### DIFFERENTIAL CONTRIBUTIONS OF THE TWO CEREBRAL HEMISPHERES TO THE PERCEPTION OF HAPPY AND SAD FACES\*

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**Abstract**—Emotional and neutral facial expressions of the same individual were presented simultaneously, one to each visual field, and subjects were required to identify the side containing the affective face. Reaction time was faster to right vs left visual field presentations when the expression was happy and vice versa when it was sad. The data support the hypothesis of differential hemispheric specialization for positive and negative emotion.

FUNCTIONAL competencies of the hemispheres in the cognitive realm have been well documented over the past decade [1-3]. However, differences between the hemispheres in the perception of affective information and in the production of affective behavior are not well understood. A variety of recent findings are consistent with the hypothesis of differential hemispheric specialization for certain positive and negative affects [4-15]. Specifically, the left hemisphere has been implicated as more actively involved in the control of positive affect while the right hemisphere has been associated with the control of negative affect. Most of these findings have focused upon affective experience and expression. While a large body of literature is available on hemispheric specialization for the perception and processing of affect [16-20], few of the studies were explicitly concerned with differential hemispheric involvement in the perception of positive vs negative affect [10, 13, 20] and none has assessed hemispheric asymmetries in the perception of happy and sad human faces. The purpose of the present experiment was to explicitly examine visual field differences in an affective face discrimination task as a function of the nature of the affective expression.

## METHOD

### *Subjects*

Twenty-eight young adults between the ages of 18 and 27 were recruited to be subjects in an experiment on the perception of faces. All subjects were right-handed as assessed through a handedness questionnaire [21]. Two hand conditions were randomized among subjects. One group responded with their right hand only. The other group responded with their right hand if they chose the RVF and their left hand if they chose the LVF. An equal number of subjects were assigned to each group. Since the groups were not found to differ in any condition on either of the measures, the data were pooled.

### *Stimuli*

Faces expressing sadness, happiness, anger and disgust, were used as stimuli and subjects were naive concerning the emotions to which they were exposed. The slides were obtained from Paul Ekman and had been empirically tested for their affective content. The slides that received the highest ratings in each of the four affect categories were selected as stimuli. Slides of six different people, three male and three female expressing each of the four emotions and a neutral pose were used.

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The stimulus set included 24 pairs of faces, one neutral and one emotional in each pair. Each pair (constituting a single trial) was presented a total of four times, with the emotional face being projected twice to each hemifield, giving a total of 96 trials. The slide set was counterbalanced for emotion and sex of the expressor.

#### *Apparatus*

Stimuli were presented by means of a three field projecting tachistoscope focused on a rear projection screen. The screen was covered by a mask, which had three windows through which the stimuli were projected. The central window was a size  $11 \times 11$  cm and 4 cm away on either side were two smaller windows with a size of  $4.4 \times 5.7$  cm. When the subject was seated 104 cm from the screen the nasion edge of the images projected through each of the outer windows was  $5.5^\circ$  from the central fixation point. This positioning insured that the faces presented through these windows would project exclusively to the right and left hemifields.

An eye tracking system was created so that trials associated with eye shift could be eliminated. This was necessary since the mean stimulus duration was longer than a saccade. Beckman miniature electrodes were placed on the external canthus of each eye. EOG was recorded with a Grass Model 7B polygraph, using a wide band AC pre-amplifier (Model 7P5). The output of the EOG channel was led into two Schmidt triggers which were set to fire when the eyes deviated from the fixation point by  $1.5^\circ$  or more in either direction. This would cause a tone to sound, providing feedback to the subjects which would allow them to regulate their eye movement. When eye movements exceeded this criteria of  $1.5^\circ$  during stimulus presentation, the trial was excluded from the data set.

#### *Procedure*

Each participant was accompanied to the subject room and seated in a chair opposite the viewing screen. The EOG electrodes were applied, the eye tracking sensitivity was set and a response box was placed on a table that was situated directly between the subject and the screen. The subjects were instructed to focus on the point whenever it appeared on the screen and approximately 2 sec following its onset the stimulus pair was exposed for a brief duration, one face on either side of the central point. The subjects were told that both pictures were of the same person; however in one picture the person was expressing an emotion while in the other the expression was neutral. Subjects were asked to identify the side which contained the emotional face. They indicated their choice of side by pressing either the right or left key on the response box in front of them. Reaction time (RT) from slide offset to subjects' button press was obtained and printed automatically along with their response, for each trial. Stimuli were exposed for a duration that was individually determined and was set so that each subject was performing the task at an accuracy level of approximately 75% correct. Prior to beginning the actual experiment each subject was run in a pre-experimental session in which they performed the same discrimination task that would be performed during the experiment. Slides which had not been selected for the actual experiment served as stimuli. Exposure time was adjusted according to the subject's performance until a consistent level of approximately 75% was obtained. The mean exposure duration was 328 msec, with a standard deviation of 65 msec.

#### *Control experiments*

(A) Following the completion of the experiment we learned that the sad, anger and disgust expressions were posed, while the happy expressions were spontaneous. A separate control experiment was run in order to evaluate whether the posed expressions could be distinguished from the spontaneous expressions since these differences may have confounded any differential emotion effects found in the main study.

To a new group of 20 right-handed subjects each of the slides used in the main experiment was randomly exposed foveally for 3 sec. When these subjects were asked to make a forced choice judging whether each expression was posed or spontaneous, 70.6% of the happy faces, across subjects, were judged to be spontaneous and similarly 63.2% of the sad faces were judged spontaneous, while only 27.6% and 37.6% of the disgust and anger faces respectively were judged as spontaneous. An overview of research on the recognition of emotion in others [22] indicates that posed expressions of anger and disgust have been associated with the least accuracy. The obviously posed nature of these expressions in the present study may have accentuated the difficulty inherent in the discrimination task, and obscured lateralized effects that might have emerged. On the basis of this control study, only data in response to the happy and sad expressions are presented.

(B) A second control experiment was then conducted to assess specifically the intensity differences between the happy and sad faces. The happy and sad expressions of the six posers used in the experiment were presented to a new group of 29 subjects. Each slide was presented once for a period of 10 sec following which subjects rated the face on a seven point scale for perceived emotional intensity. A Newman-Keuls comparison revealed that for two of the six posers the happy expressions were rated as significantly ( $P < 0.05$ ) more intense than the sad expressions. Intensity ratings for the remaining four posers revealed no systematic difference between happy vs sad faces. The intensity data are presented in Table 1 and indicate that for two of the posers, happy faces are rated as more intense than sad faces, while for the remaining two posers, the reverse trend was observed. None of the differences are significant. The analyses in this paper are restricted to data in response to the four posers whose happy and sad facial expressions did not differ in intensity.

Table 1. Means and standard deviations for ratings on intensity on a 1-7 scale, separately for each poser. Data are for Control Study B,  $N = 29$

		Poser			
		1	2	3	4
Happy	$\bar{X}$	3.45	5.07	4.03	4.66
	SD	1.27	1.51	1.24	1.32
Sad	$\bar{X}$	3.83	4.55	3.79	5.07
	SD	1.36	1.38	1.40	1.36

## RESULTS

For each subject percent correct scores were obtained by dividing the number of correct responses by the total number of presentations for each of the four emotion-hemifield combinations. An analysis of variance (ANOVA) on percent correct scores revealed a significant main effect for Hemifield [ $F(1, 27) = 4.18, P = 0.05$ ] indicating an overall RVF superiority ( $\bar{X}$  for RVF = 73%,  $\bar{X}$  for LVF = 64%). The main effect for Emotion was not significant ( $F < 1$ ).

The mean percent correct for RVF presentations was greater in response to happy versus sad faces ( $\bar{X} = 74.8, \bar{X} = 70.3\%$  respectively), while for LVF presentations, percent correct was greater in response to sad compared with happy faces ( $\bar{X} = 66.3, \bar{X} = 61.3\%$  respectively). However, the Emotion  $\times$  Hemifield interaction for this variable did not reach significance [ $F(1, 26) = 1.66, P = 0.22$ ].

A two-way ANOVA on reaction time revealed no significant main effects. However a striking Emotion  $\times$  Hemifield interaction was found for this variable [ $F(1, 25) = 12.74, P = 0.002$ ]. As can be seen from Fig. 1, happy faces presented to the RVF are associated with faster RT than sad faces to the RVF ( $t = 3.01, df = 27, P = 0.006$ ) while in the LVF there is a mirror reversal of this pattern. When presented to the LVF, sad faces are responded to more quickly compared with happy faces ( $t = 2.10, df = 27, P = 0.04$ ).

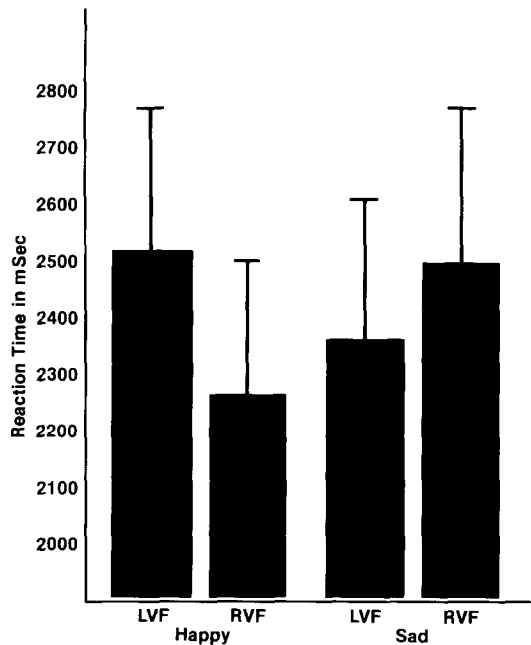


FIG. 1. Mean reaction time for Happy and Sad stimulus presentations, separately for each visual field (bars indicate standard errors).

In addition, subjects showed a visual field difference in response to happy faces with RVF presentations associated with faster RT compared with LVF presentations ( $t = 3.27$ ,  $df = 2$ ,  $P = 0.003$ ). The visual field difference in response to sad faces was opposite in direction and marginally significant ( $t = 1.84$ ,  $df = 27$ ,  $P = 0.076$ ).

## DISCUSSION

The reaction time data indicate robust differences between the visual fields in the processing of happy versus sad faces. When presented initially to the left hemisphere (i.e. RVF), happy faces are perceived more quickly compared with sad faces. The opposite pattern emerged when the faces were initially presented to the right hemisphere (i.e. LVF). Although the interaction was not significant, the accuracy findings revealed a similar trend. Happy faces were associated with greater accuracy compared with sad faces when presented to the RVF, while the opposite pattern was found in response to LVF presentations. The present set of findings demonstrate that the hemispheres may be differentially specialized for the perception of different emotions and therefore call into question the hypothesis of right hemisphere specialization for all emotion.

In light of the data discussed in the introduction which suggest that mechanisms involved in the production of positive and negative emotion are differentially lateralized, a motor theory of perception may be tentatively invoked in the interpretation of the results from the present study. There is a growing body of cognitive and psycholinguistic evidence highlighting the role of motoric and productive processes in the act of perceiving [23-25]. According to this theoretical perspective the analysis of information is a constructive process through which perceptual information is understood. GOMBRICH [26] has hypothesized that the interpretation and encoding of facial expressions is done not so much in visual as in motor terms. Through the process of unconscious imitation meaning can be derived from the perception of facial expressions and from this, empathic understanding can arise.

Through considering perception as a productive process we might explain that the RVF superiority for happy faces is associated with the left hemisphere's specialized role in the generation and experience of positive affect. An additional and not mutually exclusive possibility concerns the role of the left hemisphere in the generation of certain motor processes such as fine manual dexterity [27-29] which may in turn be associated with approach behavior and positive affect.

The above interpretation is speculative and we are currently investigating the veracity of this model. At present the results from this study provide further support for the asymmetrical organization of the human brain and suggest that the right and left hemispheres contribute differentially to the regulation of emotional processes in the intact human.

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Résumé :

On a présenté simultanément à des sujets des expressions émotionnelles et neutres sur des représentations du même individu en leur demandant d'identifier le côté de la face avec modification affective. Les temps de réaction étaient plus courts pour les présentations dans l'hémichamp droit lorsque l'expression traduisait la joie et vice-versa lorsqu'elle traduisait la tristesse. Ces données sont en faveur de l'hypothèse selon laquelle il existe une spécialisation hémisphérique préférentielle pour les émotions positives et négatives.

Zusammenfassung:

Gefühlsbetonter und neutraler Gesichtsausdruck der verschiedenen Art eines Individuums wurden gleichzeitig dargeboten, und die Versuchspersonen sollten die Seite identifizieren, welche den gefühlsbeladenen Gesichtsausdruck trug. Die Reaktionszeit war schneller von Darbietungen im rechten zum linken Gesichtsfeld, wenn der Gesichtsausdruck glücklich war und umgekehrt, wenn er traurig war. Diese Ergebnisse unterstützen die Hypothese einer differentiellen hemisphärischen Spezialisierung für positive und negative Emotionen.