

INFORMATION TO USERS

This reproduction was made from a copy of a manuscript sent to us for publication and microfilming. While the most advanced technology has been used to photograph and reproduce this manuscript, the quality of the reproduction is heavily dependent upon the quality of the material submitted. Pages in any manuscript may have indistinct print. In all cases the best available copy has been filmed.

The following explanation of techniques is provided to help clarify notations which may appear on this reproduction.

1. Manuscripts may not always be complete. When it is not possible to obtain missing pages, a note appears to indicate this.
2. When copyrighted materials are removed from the manuscript, a note appears to indicate this.
3. Oversize materials (maps, drawings, and charts) are photographed by sectioning the original, beginning at the upper left hand corner and continuing from left to right in equal sections with small overlaps. Each oversize page is also filmed as one exposure and is available, for an additional charge, as a standard 35mm slide or in black and white paper format.*
4. Most photographs reproduce acceptably on positive microfilm or microfiche but lack clarity on xerographic copies made from the microfilm. For an additional charge, all photographs are available in black and white standard 35mm slide format.*

***For more information about black and white slides or enlarged paper reproductions, please contact the Dissertations Customer Services Department.**

UMI University
Microfilms
International

8601709

Zeidler, Denise Karen

THE ROLE OF HEMISPHERIC SPECIALIZATION IN THE PERCEPTION AND
PRODUCTION OF FACIAL AFFECT

City University of New York

PH.D. 1985

**University
Microfilms
International**

300 N. Zeeb Road, Ann Arbor, MI 48106

Copyright 1985

by

Zeidler, Denise Karen

All Rights Reserved

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark .

1. Glossy photographs or pages _____
2. Colored illustrations, paper or print _____
3. Photographs with dark background _____
4. Illustrations are poor copy _____
5. Pages with black marks, not original copy
6. Print shows through as there is text on both sides of page _____
7. Indistinct, broken or small print on several pages
8. Print exceeds margin requirements _____
9. Tightly bound copy with print lost in spine _____
10. Computer printout pages with indistinct print _____
11. Page(s) _____ lacking when material received, and not available from school or author.
12. Page(s) _____ seem to be missing in numbering only as text follows.
13. Two pages numbered _____. Text follows.
14. Curling and wrinkled pages _____
15. Dissertation contains pages with print at a slant, filmed as received _____
16. Other _____

University
Microfilms
International

THE ROLE OF HEMISPHERIC SPECIALIZATION IN THE PERCEPTION
AND PRODUCTION OF FACIAL AFFECT

by

DENISE KAREN ZEIDLER

A dissertation submitted to the Graduate Faculty in Psychology
in partial fulfillment of the requirement for the degree of
Doctor of Philosophy, The City University of New York

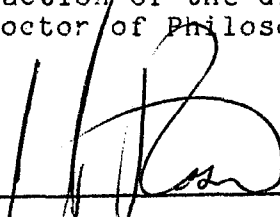
1985

COPYRIGHT BY
DENISE KAREN ZEIDLER
1985

This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy

5/24/85


date



Jeffrey J. Rosen, Ph.D.
Chairman of Examining Committee

May 24 1985

date



H. D. Saltzstein, Ph.D.
Executive Officer

Jeffrey J. Rosen, Ph.D.
Louis J. Gerstman, Ph.D.
Stephen Thayer, Ph.D.

Supervisory Committee

Abstract

THE ROLE OF HEMISPHERIC SPECIALIZATION IN THE PERCEPTION AND
PRODUCTION OF FACIAL AFFECT

by

Denise Karen Zeidler

Advisor: Prof. Jeffrey J. Rosen

The hemispheric specialization literature suggests that the perception of faces, of emotional facial expressions and the production of facial expressions are processes which are preferentially dependent on right hemispheric mechanisms. A series of experiments were conducted in order to explore asymmetries associated with these processes with a particular interest in the effect of emotional salience on perceptual asymmetries and the relationship of perceptual and expressive asymmetries within the individual.

Thirteen right-handed subjects posed happy, sad and neutral expressions. Normal orientation and mirror-reversed prints were cut down the midline and like-sided halves joined to create left and right composite photographs. These composites served as stimuli in an intensity rating task and in two tachistoscopic tasks. Thirty-two additional subjects plus nine of the 13 posers participated in three tasks. One task involved rating the emotional intensity of the composite photographs. Measures of "expressive asymmetry" for the 13 posers were derived from the ratings

elicited by the left and right composites. In the facial recognition task pairs of faces were successively presented and subjects were required to respond manually if the faces were the same. A similar procedure was used for expression recognition but the discrimination was made on the expression displayed by the face rather than for the identity of the face.

The results were as follows: Left-face effects, presumably reflecting right hemispheric mechanisms, were obtained for sad and neutral expressions under some procedures. Methodological and theoretical issues that may have affected asymmetries were discussed. In the facial recognition an overall LVF effect was found but this effect was not consistent across stimulus faces. In the expression recognition task an overall LVF effect was found with the magnitude of the effect greatest for neutral expressions. Emotional salience did not effect asymmetries in either perceptual task. The results were discussed in terms of how stimulus characteristics may have affected relative hemispheric superiorities. A subset of subjects showed a positive relationship in the direction and degree of asymmetry for the two perceptual tasks while a subset of subjects showed contrasting patterns. However there was no relationship between direction or degree of expressive and perceptual asymmetry.

ACKNOWLEDGMENTS

This research was funded by Predoctoral Grant #1F31 MH08597.

I would like to thank my husband Steven for all his help with hours of number and word crunching on our home computer. Most of all I want to thank him for his support and encouragement with my graduate studies.

This work is dedicated to the memory of my beloved mother, Sophia Weissman Karen.

TABLE OF CONTENTS

Title page	i
Copyright page	ii
Approval page	iii
Abstract	iv
Acknowledgments	vi
Table of contents	vii
List of Tables	viii
List of Figures	x
INTRODUCTION	1
Hemispheric Specialization	5
Laterality and facial recognition	12
Laterality and affect	29
Perception of facial expression	44
Production of facial expression	52
Hypotheses	60
METHOD	
General method	63
Intensity judgements	66
Facial discrimination	67
Expression discrimination	69
RESULTS and DISCUSSION	
Intensity judgements	
Results	72
Discussion	92
Facial Discrimination	
Results	100
Discussion	103
Expression discrimination	
Results	111
Discussion	120
Facial and expression discrimination	
Results & Discussion	126
Relationship between expressive and perceptual asymmetry	
Results & Discussion	129
TABLES	132
FIGURES	154
REFERENCE NOTES	189
REFERENCES	190

LIST OF TABLES

- Table 1 The percentage of positive, negative or neutral ratings for each poser and composite within an emotion category
- Table 2 The percentage of positive, negative or neutral ratings for each composite type within an emotion category
- Table 3 The percentage of cases rating all 13 instances of a composite type as negative, positive or neutral
- Table 4 Summary of the results of the ANOVAs conducted on the SAD ratings for each poser
- Table 5 Summary of the results of the ANOVAs conducted on the HAPPY ratings for each poser.
- Table 6 Summary of the results of the ANOVAs conducted on the NEUTRAL ratings for each poser
- Table 7 Number of cases showing left/right preference summed over all posers
- Table 8 The frequency of cases showing left/right preferences elicited by each poser
- Table 9 Errors for Person Discrimination as a function of sex of subject and stimulus face
- Table 10 Summary table of the ANOVA results for Person Discrimination RT
- Table 11 Mean RT for each of the five stimulus faces in Person Discrimination
- Table 12 Summary table of the ANOVA results for Emotion Discrimination
- Table 13 Overall mean RT for the five stimulus faces in Expression Discrimination
- Table 14 Poser by emotion interaction for Expression Discrimination RT
- Table 15 Emotion by composite interaction for Expression Discrimination RT

- Table 16 Poser by composite interaction for Expression Discrimination RT
- Table 17 Summary table of ANOVA results for each emotional expression separately
- Table 18 The relationship between emotional saliency and visual field asymmetry for the five stimulus faces in Expression Discrimination
- Table 19 The direction and degree of asymmetry demonstrated for perceptual and expressive tasks
- Table 20 The relationship between the magnitude of expressed emotion and visual field asymmetry for Expression Discrimination

LIST OF FIGURES

- Figure 1 Mean intensity rating for each poser
- Figure 2 Mean sad ratings for each poser as a function of sex of rater
- Figure 3 Mean sad ratings for each poser as a function of rating session
- Figure 4 Mean sad ratings for each poser as a function of rating sequence
- Figure 5 Mean sad ratings of the left and right composite sad expression for each poser
- Figure 6 Sex by rating session interaction for sad ratings (Posers 4 & 10)
- Figure 7 Sequence by rating session interaction for sad ratings (Poser 5)
- Figure 8 Sex of rater by composite interaction for sad ratings (Poser 6)
- Figure 9 Composite by sequence interaction for sad ratings (Posers 6,3,9 & 12)
- Figure 10 Composite by rating session interaction for sad ratings (Poser 7)
- Figure 11 Sequence by sex by composite interaction for sad ratings (Poser 9)
- Figure 12 Mean happy ratings for each poser as a function of sex of rater
- Figure 13 Mean happy ratings for each poser as a function of sequence
- Figure 14 Mean happy ratings for each poser as a function of rating session
- Figure 15 Mean happy ratings for left and right composites for each poser
- Figure 16 Sequence by rating session interaction for happy ratings (Poser 12)

- Figure 17 Composite by rating session interaction for happy ratings (Poser 13)
- Figure 18 Sequence by composite interaction for happy ratings (Posers 2,7,11,12 & 13)
- Figure 19 Sequence by sex by composite interaction for happy ratings (Posers 2 & 12)
- Figure 20 Mean neutral ratings for each poser as a function of rating session
- Figure 21 Mean neutral ratings for each poser as a function of sequence
- Figure 22 Mean neutral ratings for each poser as a function of sex of rater
- Figure 23 Mean neutral ratings for left and right composites for each poser
- Figure 24 Sex by rating session interaction for neutral ratings (Poser 12)
- Figure 25 Sequence by rating session interaction for neutral ratings (Poser 5)
- Figure 26 Sequence by composite interaction for neutral ratings (Posers 7 & 10)
- Figure 27 Sex by composite interaction for neutral ratings (Poser 6)
- Figure 28 Rating session by composite interaction for neutral ratings (Posers 13 & 3)
- Figure 29 Sequence by composite by rating session interaction for neutral ratings (Poser 3)
- Figure 30 Sex by sequence by composite by rating session interaction for neutral ratings (Poser 12)
- Figure 31 Visual field by stimulus face interaction for Person Discrimination RT

- Figure 32 Comparison of right visual field and left visual field RT for stimulus faces showing different patterns of asymmetry
- Figure 33 Visual field asymmetry as a function of intensity rating for the five stimuli faces in Person Discrimination
- Figure 34 Visual field asymmetry for Person Discrimination as a function of intensity rating for the 32 raters
- Figure 35 Visual field asymmetry as a function of intensity rating for neutral expressions
- Figure 36 Visual field asymmetry as a function of intensity rating for happy expressions
- Figure 37 Visual field asymmetry as a function of intensity rating for sad expressions

This dissertation consists of a series of studies designed to explore the nature of cerebral hemispheric asymmetries associated with various processes concerning the face and affect. Specifically, the processes of interest include: (a) the perception of facial identity, (b) the perception of facial displays of affect, and (c) the expression of facial displays of affect.

The perception of facial identity, more commonly known as facial recognition, refers to recognizing a particular face. This ability has been assessed in many different ways. For example, it has been studied by requiring subjects to find a target face in a broader display, to make same/ different discriminations between two faces, etc. Whatever the procedure used, the task always involves recognizing a particular face regardless of the expression displayed on the face. In contrast, the perception of facial displays of affect involves recognizing particular facial expressions. In assessing this skill, for example, subjects might be asked to discriminate whether two faces are showing the same facial expression, to select all the happy (or sad or angry, etc.) expressions when presented with various expressions, etc. Again, although the method of assessment may vary, the commonality is that the subject

is required to recognize an expression regardless of the individual displaying the expression. Finally, the expression of facial displays of affect refers to the production of emotional expressions.

In the investigation of cerebral asymmetries associated with these processes, the special relationship between the face and affect needs to be addressed. Common knowledge and every day experience tells us that the face is an important vehicle of affective communication. Not only are there facial expressions of major emotional states like happiness, sadness, anger, fear, disgust and surprise, which appear to be universal (Ekman, 1973; Izard, 1971) but the face also expresses more subtle affect and often is emotionally toned.

These considerations underscore the unique relationship between the face and affect and suggest the following:

1. Since faces are emotionally-toned, the perception of facial identity may involve the appreciation of affective information and affective processing may play a role in facial perception.

2. The perception of facial identity and expression identity are intimately related as the face is the locus of both and both processes involve extracting information from

the face.

3. Perceptual and productive aspects of affect communication center about the face.

The present set of studies were designed to explore these issues in terms of their relationship to hemispheric asymmetries. More specifically, it was hypothesized that:

1. If emotional processing is involved in facial perception then stimuli that differ in terms of the degree of affect expressed may be associated with different patterns of asymmetry depending upon the sensitivity of the cerebral hemispheres to affective information.

2. If the perception of facial identity and facial expressions are related processes then they should be associated with similar patterns of laterality. There should be a positive relationship between emotional expression perception and facial identity perception in terms of left and right hemispheric functioning.

3. If the perception of facial expressions and the production of facial affect are related mechanisms then they should show similar laterality patterns. There should be a positive relationship between the perception and production of facial displays of affect in terms of hemispheric functioning.

The following sections will provide a brief review of hemispheric specialization in general followed by more specific reviews of the literature dealing with the lateralization of facial perception and affect perception and expression. Finally, based on the information from these reviews and the considerations raised here concerning the relationship between the face and affect, more specific hypotheses will be presented.

Hemispheric Specialization

Studies of hemispheric asymmetry have demonstrated that the left and right cerebral hemispheres are functionally specialized for different perceptual-cognitive and affective processes (see review volumes by: Harnad, 1977; Kinsbourne, 1979; Mountcastle, 1962). Investigations with normal subjects and with neurologically-impaired patients, including those with various kinds of neuropathology and those with section of the cerebral commissures (split-brain patients), have established that the left hemisphere subserves speech/language, motor and sequential cognitive functions while the right hemisphere predominates in mediating non-verbal, visuospatial, and particular affective behaviors.

As Gur & Gur (1977) point out, the dichotomy between the hemispheres has been alternately referred to as: verbal - non-verbal, analytic - synthetic, propositional - apropositional, logical - intuitive and serial - parallel. Whereas some distinctions have stressed material specific differences such as verbal - non-verbal, more recent characterizations have emphasized hemispheric differences in terms of modes of information processing (i.e. analytic-synthetic; sequential-parallel). These types of

characterizations suggest that the main difference between the cognitive functions of the two hemispheres has to do with the way in which information is processed and not in the type of information being processed (see Moscovitch, 1979; Bradshaw & Nettleson, 1981). For example, in a study with split-brain patients, Levy (Levy, Trevarthan & Sperry, 1972) found that both the isolated left and the isolated right hemispheres were capable of recognizing faces. However, the way in which the task was accomplished differed according to the hemisphere in operation.

Generally, left hemispheric functioning has been more extensively investigated than right cerebral specialization, particularly with respect to the cognitive consequences of unilateral neuropathology (Luria, 1980). Historically, lateralization of function was first realized in terms of left hemispheric specialization for speech and language, with the classic findings of Broca and Wernicke in the later 19th century. Because of its role in functions (speech/language) which are so intimately and conspicuously involved in cognition, and because the effects of right cerebral pathology were less obvious, the left came to be thought of as dominant and the right subservient for all cognitive functions.

However, observations of disturbances in cognition following right pathology have accrued (DeRenzi, 1979; Milner, 1968; Weinstein, 1979) and the unique cognitive functioning of the right hemisphere has been studied in patients with section of the cerebral commissures (Bogen, 1969). Consequently, it is now well established that the left hemisphere is dominant for particular cognitive functions while the right hemisphere is dominant for others. In terms of higher cognitive functions, lesions of the left hemisphere typically result in aphasia, apraxia, or specific agnosias while compromise to the right hemisphere is usually associated with neglect, disorders of spatial orientation, visuoconstructive difficulties and affective disturbances (Goodglass & Kaplan, 1979; Luria, 1980). Concordant findings are obtained from examinations of split-brain patients; the right hemisphere is superior for visuospatial tasks, visuoconstructive tasks and the manipulation of part-whole relationships while the left hemisphere is clearly dominant for language functions (for review see Nebes, 1974).

Information about the differential functioning of the cerebral hemispheres has been obtained from normal samples as well as from brain-damaged groups. The results obtained

using dichotic, tachistoscopic, and dihaptic techniques with normals have yielded findings generally concordant with the description of hemispheric differences that has resulted from the study of neurologically-impaired samples (Moscovitch, 1979; Springer, 1977). To illustrate the underlying rationale of this research, dichotic and tachistoscopic methodology will be briefly described.

In dichotic listening studies, different auditory stimuli are presented simultaneously to both ears. Typically, the input to one ear is better perceived than the other. However, whether a left or right ear advantage is obtained will depend upon the stimuli used. Linguistic stimuli are generally associated with a right ear advantage while emotional, musical and environmental stimuli are associated with a left ear advantage. Since Kimura's early work (1961; 1967), the ear advantage has been related to and thought to reflect the specialized processing capabilities of the contralateral hemisphere. Although auditory fibers project both ipsilaterally and contralaterally, the contralateral pathways are considered dominant and have been shown to inhibit ipsilateral transmission from the opposite ear. Therefore stimuli presented to the right ear are transmitted more strongly to the left hemisphere (LH) and

stimuli presented to the left ear more strongly to right hemisphere (RH). Thus when information provided to one ear is processed more efficiently it is thought to reflect the specialized capacities of the contralateral hemisphere for processing that material or for the type of processing required by the task.

Tachistoscopic presentation of information also has been frequently used to study cerebral asymmetries in normal samples. The rationale of this method derives from the neuroanatomy of the optic pathways. The left hemisphere obtains information from the right visual field (RVF), receiving nasal fibers from the right eye and temporal fibers from the left, while the right hemisphere receives information from the left visual field (LVF) receiving nasal fibers from the left eye and temporal fibers from the right eye. Within this framework, briefly lateralized presentation of visual stimuli when the eyes are fixated at midline insures primary transmission of correlated neural information to the contralateral hemisphere. Again, this method has generally supported the linguistic - non-verbal dichotomy although non-verbal asymmetries have been less reliably obtained (White, 1969).

However, the above discussion should not imply that

specialization is an "all-or-none" or immutable phenomenon. Rather, it is now well known that the right hemisphere does have receptive language competence (Zaidel, 1976; 1977), that the left hemisphere does have visuooperceptual abilities (Levy, et al., 1972), and that even types of processing may not be exclusive to a single hemisphere (Moscovitch, 1979). In both the clinical and the experimental literature, evidence of specialization is most often reflected by relative performance differences. In addition, it has been demonstrated that direction and degree of asymmetry may vary according to age (Witelson, 1977), sex (McGlone & Kertesz, 1973), handedness (McKeever & VanDeventer, 1977) and parametric properties of tasks (Berlin, 1977).

Finally, despite the enormous amount of laterality research that has accumulated over the last two decades, questions remain. For example, researchers continue to explore the nature of individual differences in relation to cerebral organization, the development of lateralization of functions, variations of cerebral specialization in atypical populations (i.e. dyslexic, schizophrenic), and more fundamentally to speculate on just what it is that is lateralized (Goldberg & Costa, 1981).

As noted earlier, the current study has been designed to

more fully explore cerebral asymmetries associated with:
(a) the recognition of faces, (b) the recognition of facial
emotional expressions, and (c) the production of emotional
facial expressions (Zeidler & Rosen, Note 1). In the
following sections the hemispheric specialization literature
pertaining to these processes will be reviewed.

Facial Recognition: Clinical Evidence

Studies With Patients With Unilateral Neuropathology

Initial interest in the process of facial recognition stemmed from clinical observations of neurologically-impaired patients who could not recognize familiar people on the basis of a facial percept while recognition of the same individual through some other means, such as tone of voice, was preserved. This condition, called facial agnosia or prosopagnosia, is relatively rare and consequently difficult to study. In an attempt to learn more about prosopagnosia and working under the hypothesis that the condition could be reflected by a less severe form, researchers developed experimental tasks of facial recognition in which the stimuli were faces unfamiliar to the subject. Typically these tasks involve presentation of a target face that must be identified from a larger display containing the target and distractor faces. As it turned out, the bulk of the evidence, from clinical observation and from experimental investigation, revealed that the assumption that the recognition of familiar and unfamiliar faces were aspects of the same mechanism was erroneous in that these defects could exist independent of one another. For example, subjects might be unimpaired on tests of facial

recognition but exhibit prosopagnosia (Benton, 1980). As noted by Benton, the condition of impaired ability to recognize unfamiliar faces has become of interest in its own right. It is this ability that is of primary concern to this thesis. The review to follow will be primarily concerned with the process of facial recognition of unfamiliar faces and not with prosopagnosia.

DeRenzi & Spinnler (1966) compared the performance of groups of left hemisphere damaged (LBD), right hemisphere damaged (RBD) and neurologically normal control patients on an experimental facial recognition task. The task consisted of a four item test in which a photograph of a previously unfamiliar face was exposed and immediately upon removal had to be identified from a multiple-choice display. Impaired performance was determined by using a cut-off score which was defined as that score below which no control scored. There was a significantly greater number of subjects with impaired scores in the RBD group than in the LBD group. Moreover, among the RBD group, subjects with hemianopsia performed more poorly than those without suggesting that a posterior lesion was particularly important in the occurrence of the deficit. The presence or absence of hemianopsia was unrelated to performance in the LBD group.

Warrington & James (1967) confirmed the finding of an association between right hemisphere pathology and impaired facial recognition. In this study a procedure similar to that used by DeRenzi & Spinnler (1967) was employed in that a single face was exposed and upon removal had to be identified in a multiple choice display. A comparison of the mean error rates of the LBD and RBD groups indicated that the RBD patients scored significantly more poorly than the LBD group. Unlike DeRenzi & Spinnler, these researchers did not find an association between visual field defects and impaired performance. However, in Warrington & James' study several subjects had only quadrant defects while in the DeRenzi & Spinnler's study all patients had a hemianopsia. Therefore, the groups were not comparable in terms of underlying neurological involvement.

Benton & Van Allen (1968) also compared performance of groups of neurologically-impaired and control patients on tasks of facial recognition. This study differed from the two discussed above in that a matching rather than an immediate memory test was used to assess the patients facial recognition abilities. That is, subjects were required to identify a target face from a multiple-choice display with the target in view. A comparison of the mean error rates

indicated that the RBD group scored significantly more poorly than the LBD group. These researchers also analyzed the data by calculating the frequency of patients in each group showing impaired performance. Impaired performance was defined by a cut-off score above which 97% of the control subjects scored. The findings indicated that 68% of the RBD group scored below the cut-off while only 13% of the LBD group scored below the cut-off. Therefore not only was the mean error rate of the RBD patients greater but a greater proportion of patients with right pathology exhibited grossly impaired performance. Finally, the relationship of impaired performance to the presence or absence of visual field defect was also studied. There was no relationship between defective performance and field defect in either of the neurologically-impaired groups.

A more recent investigation using Benton & Van Allen's facial recognition matching test produced somewhat different findings (Hamsher, Levin, & Benton, 1979). Although a high proportion of patients with right hemisphere disease exhibited impaired performance, there was also a high proportion of LBD patients who showed impaired performance. Among patients with right sided pathology, there was a significantly greater proportion of defective performance in

patients with posterior lesions than in those with anterior lesions. Among those with right posterior lesions, there was a greater frequency of defective performance among patients with visual field defect than those without but the difference did not reach statistical significance. Among patients with left hemisphere pathology, there was a high frequency of defective performance among patients with language deficits regardless of the anterior or posterior location of the lesion. Thus, in the LBD group, all patients with posterior or anterior lesions but without comprehension deficits performed within the normal range. In the LBD group with posterior lesions and comprehension deficits, there was approximately the same frequency of impaired performance among those with and without visual field defect. In the left posterior group without comprehension deficits, those with and without visual field defects scored within normal limits.

In summary, this review of the literature suggests that there is an association between right hemisphere pathology and impaired facial recognition abilities. Earlier studies suggested that the occurrence of the defect was substantially less frequent among patients with left hemisphere pathology. However, a relatively recent

investigation suggests that the occurrence of the deficit is relatively high among patients with left hemisphere damage and comprehension deficits. Benton (1980) has suggested that the contrasting results may relate to the earlier investigations not including this particular subgroup of LBD patients. While this may be the case as these studies (DeRenzi & Spinnler, 1966; Warrington & James, 1967) did in fact exclude some aphasic patients, the findings of this association needs to be replicated.

Studies With Patients With Section Of The Corpus Colossum

Levy and her colleagues (Levy, Trevarthen & Sperry, 1972) have studied facial recognition skills in split-brain patients. The subjects in this study were four individuals who had undergone surgery to disconnect the cerebral hemispheres as a treatment for intractable epilepsy. The surgery involved section of the entire corpus colossum and the anterior commissure. Three patients showed abnormal EEG activity in the left hemisphere. In one the locus of the seizure activity is not clearly specified, although it was reported that aside from the seizure activity "there were no distinct...signs of brain damage to either hemisphere" (p. 62). In contrast, of the three with abnormal EEG activity in the left hemisphere, one had evidence of additional RH

involvement prior to surgery and one showed evidence of RH involvement post-surgically.

In order to study facial recognition skills, patients were presented with chimeric stimuli. A chimeric facial stimulus consists of half-faces of two different people connected at midline to form what appears to be a single face. For example, the left side of one person's face would be connected to the right side of another person's face. These chimeric facial stimuli were presented briefly at midline so that the half-face of one individual appeared in one visual field and the half-face of the other individual appeared in the other visual field. The rationale for this procedure is based on previous work with split-brain patients which demonstrated that when presented with stimuli that extend across the midline, these patients will say that they see the entire stimulus even though each hemisphere is exposed to only half the stimulus. In other words, the patient will have the illusion of having seen a complete stimulus even though each hemisphere is presented only with the stimulus from the contralateral visual field. The result of presenting chimeric faces then would be that the two cerebral hemisphere would be receiving different input and each hemisphere by completion should perceive a

different whole stimulus.

Subjects were required to perform two tasks with these stimuli. For one task the patients were presented with a multiple-choice display containing the two whole faces from which the chimeric stimulus was formed and asked to point to the face they had seen. In the other condition subjects were asked to name the face they had seen based on previously learned face-name associations for each whole face.

When subjects were asked to point to the face that they had seen, there were significantly more responses to the stimulus exposed to the LVF or disconnected right hemisphere than to the RVF or disconnected left hemisphere. In the naming condition, subjects more often named the face appearing in the RVF than the LVF. However, the difference between hemispheres was much less pronounced in the naming condition than in the pointing condition. In addition, qualitative observation of the patient's behavior suggested that the left hemisphere found this to be a difficult task and often described distinctive features of the face rather than naming it as a whole. Further testing, in order to more fully examine the functioning of the left hemisphere in facial recognition, was carried out. In this supplementary

testing whole faces were presented in the LVF and subjects were required to then point to the target on a multiple-choice display. Although no data is presented, the researchers indicate that the performance mediated by the left hemisphere "was markedly inferior to that mediated by the right hemisphere in the preceding sessions" (p.67).

These findings, particularly the qualitative observations of the way patients performed the task, suggested a right hemispheric predominance for facial perception related to different modes of information processing in the isolated left and right hemispheres. The left hemisphere appeared to be more analytical in its perceptual abilities and so needed to rely on distinctive features for recognition. In contrast, right hemispheric perceptual skills seemed to be more immediate and gestalt-like and more efficient in direct apprehension of the visual facial configuration.

Facial Recognition: Experimental Evidence In Normals

The experimental evidence derived from studies of normal samples has been typically interpreted as supporting the notion of a right hemispheric superiority in facial recognition. Closer examination of the literature however, reveals that differential patterns of asymmetry are found depending upon the task requirements and procedural manipulations.

Earlier studies tended to find a left visual field-right hemispheric (LVF-RH) superiority for reaction time (RT) and accuracy. In the earliest demonstration of lateral asymmetry for faces, Rizzolatti et al.(1971) found an LVF-RH advantage in manual reaction time when subjects were asked to discriminate previously learned target from non-target faces viewed monocularly. Faces were presented in the left and right visual fields and subjects were asked to respond manually when either of two target faces was presented and not to respond when the two non-target faces appeared. Reaction time for target faces appearing in the LVF was speedier than reaction time for targets in the RVF.

Using a slightly different procedure, Geffen et al. (1971) also found an LVF-RH advantage for facial discrimination. In the Geffen study, subjects were required

to make same/different discriminations between successively presented central and lateralized faces separated by 1040 msec.

Hilliard (1973), using accuracy and not reaction time as the dependent measure, also found an LVF advantage for facial discrimination. Again, subjects were required to make a same/different discrimination between successively presented central and lateral faces which were separated by 500 msec or 10 sec.

Ellis & Shephard (1973) replicated Hilliard's results finding an LVF-RH advantage for discriminating very briefly lateralized and central faces with a 3 sec delay between the comparison stimuli.

Notwithstanding the consistency of these early studies for finding an LVF-RH superiority for facial recognition, more recent investigations have found that the direction of the field advantage may vary as a function of certain procedural manipulations and task parameters. Relative right visual field-left hemispheric (RVF-LH) superiority has been reported in several instances and no difference in reaction time of the LVF and RVF has also occurred.

Umilta, et al. (1979) reported an RVF-LH advantage for familiar faces and an LVF-RH for unfamiliar faces using a

procedure similar to Rizzolatti (1971) in which two target faces had to be discriminated from non-target faces. The familiar face condition differed from the non-familiar face condition in that subjects were required to become familiar with all the faces prior to the experimental task. Subjects were required to recognize these faces among a larger display which also contained non-test facial stimuli prior to the experimental task. In the unfamiliar condition subjects were not exposed to the faces prior to the experimental session.

Galper & Costa (1979) found that asymmetries varied according to encoding strategies by which faces were initially learned and which presumably encouraged different kinds of processing strategies. In this experiment, subjects learned faces according to two strategies. In the "social" condition the target faces (which had to be discriminated from other non-target faces) were presented with a description that mentioned personality traits (e.g. This woman is loyal and generous. Her favorite color is yellow.). In the "physical" condition the description mentioned physical characteristics (e.g. This woman has short hair and a round face.). The results indicated that the hemispheric advantage varied as a function of the

encoding strategy but not consistently. That is, some subjects showed an LVF-RH advantage with the physical strategy and a simultaneous RVF-LH advantage with the social strategy while other subjects showed the reverse pattern.

Patterson & Bradshaw (1975) reported an RVF-LH advantage for discriminating face-like geometric designs in conditions which involved the detection of a single feature difference.

Studies have also found equally speedy performance associated with LVF and RVF presentations on facial discrimination tasks. For example, Moscovitch (1976) found that when the delay interval between the target and test face was less than 100 msec there was no visual field effect (Moscovitch, 1979). In discussing these results Moscovitch has suggested that hemispheric asymmetries will not emerge when the task requires only 'precategorical' processing. Thus, when faces are presented simultaneously or when the interval between the comparison faces is very brief (less than 100 msec) and the discrimination can be made on the basis of a visual trace rather than by reference to an abstract code held in memory, equal performance of the right and left hemispheres would be predicted. However, when the task requires higher level processing, such as would be necessary using a delay interval long enough so that

reference to an abstract representation (and not a visual trace) is required, the specialized capacities of the hemispheres will emerge.

Based on an extensive review of the literature and her own research, Sergent (Sergent & Bindra, 1981; Sergent, 1982) noted that studies reporting an RVF-LH advantage and those reporting an LVF-RH advantage were characterized by opposing procedural conditions. Studies finding an LVF-RH advantage used brief exposure durations, longer delay intervals between comparison stimuli and highly discriminable physiognomies. In contrast, studies finding a left hemispheric advantage used longer exposure durations, shorter interstimulus intervals or some other factor such as familiarity which allowed for a clearer stimulus representation. According to Sergent's hypothesis hemispheric asymmetries emerge as a function of complex interactions among these procedural conditions and task requirements. She suggests that the left hemisphere may prove to be superior when the procedural conditions are such that a clear stimulus representation is available and/or the task demands are such that the unique processing capabilities of the left hemisphere are required. In contrast, the right hemisphere advantage may obtain when

the procedural conditions are such that holistic processing is encouraged as when operations need to be performed on relatively degraded stimulus material.

In addition to the aforementioned procedural characteristics, the emotional salience of the face appears to affect hemispheric asymmetries. All things being equal (exposure duration, delay interval, stimulus discriminability), emotion has been shown to augment the LVF-RH effect. In the first demonstration of this, Suberi & McKeever (1979) measured manual reaction time to previously learned target faces which had to be discriminated from non-target faces. That is, subjects learned two faces and had to respond only when these faces appeared. Subjects who memorized non-emotional faces (faces displaying a neutral expression) showed an LVF-RH advantage but those who memorized emotional faces (faces displaying sad, angry or happy expressions) showed a significantly greater LVF-RH advantage.

A follow-up study was conducted in order to further explore the effect of emotional processing on the emergence of hemispheric asymmetries (McKeever & Dixon, 1981). In the follow-up study only the faces displaying neutral expressions were used as stimuli. Visual field asymmetries

varied as a function of the perceived emotionality of the faces. Subjects were required to rate the 'emotionality' of the faces on a seven point scale ranging from emotional to non-emotional. Subjects who rated the stimuli as emotional showed more pronounced LVF-RH asymmetries than subjects who rated the faces as non-emotional, suggesting that emotional processing played a role in the LVF-RH effect.

Consistent with these results, Ley & Bryden (1980) found an LVF-RH advantage for accurately discriminating (same/different) central and lateralized faces of five male cartoon-like physiognomies ranging in affect from very positive to very negative. In addition to a main effect for visual field, a significant visual field by type of emotion interaction was obtained. The interaction indicated that the LVF-RH superiority was most pronounced for the extremely negative expressions, and also significant for the others (extremely positive, positive and neutral) with the exception of mildly negative for which there was a nonsignificant RVF-LH advantage.

In sum, the experimental evidence suggests the following:

1. Although patterns of hemispheric asymmetry in facial recognition may vary, certain conditions are more

often associated with an LVF-RH or an RVF-LH advantage. The RH advantage is related to shorter exposure durations and longer delay intervals between the comparison stimuli while the LH advantage is related to longer exposure durations and shorter delay intervals.

2. In addition to procedural manipulations per se, hemispheric asymmetries may vary according to the nature of the task demands which may influence processing strategies employed.

3. All else being equal, emotion as a variable tends to augment the LVF-RH advantage. That is, even when the task is to recognize a particular face and not the expression displayed on the face, the LVF-RH effect is augmented when faces display emotional expressions or are perceived as being relatively more emotionally-toned.

Lateralization Of Affect: Clinical Evidence

While clinical investigations have focused mainly on the cognitive effects of neuropathology, there is a growing body of literature focusing on the affective consequences of unilateral pathology. Most studies can be characterized either as: (a) comparing the emotional-behavioral sequelae of unilateral pathology or as (b) comparing the performance of different groups of brain-damaged patients on experimental affective tasks.

Emotional Sequelae Associated With Unilateral Pathology

Although systematic investigations of cerebral asymmetries associated with affect are relatively recent, early clinical observations suggested a difference in the affective states of right and left hemisphere damaged patients. These early descriptions characterized left damaged patients as depressed and prone to catastrophic reactions whereas the mood of right damaged patients was characterized by a seeming indifference to their disability and inappropriate euphoria (Denny-Brown, Meyer & Hornstein, 1952; Goldstein, 1939).

In a systematic investigation of the emotional characteristics of patients suffering from unilateral cerebral pathology associated with vascular, neoplastic or

"other" etiologies, Gainotti (1972) examined 80 right and 80 left hemisphere damaged patients for patterns of emotional behavior exhibited during a standard neuropsychological evaluation. These patients were assessed for three types of emotional reaction: (a) catastrophic reaction (e.g. anxiety, tears, swears, etc.), (b) depressive mood (discouragement, anticipation of incapacity, etc.), and (c) indifference reaction (indifference, jokes, minimization, etc.). The findings indicated that catastrophic reactions were significantly more frequent among left-hemisphere damaged patients while the indifference reaction was significantly more frequent among right-hemisphere damaged patients. The depressive mood reaction was found to be more frequent among left-hemisphere damaged patients although the difference did not reach statistical significance. Gainotti interpreted these findings within the context of a right hemispheric predominance for affective processing. The emotional reaction of LBD patients was thought to be an appropriate reaction to their cognitive deficits, while the reaction of the RBD patients was thought to reflect a primary disturbance in the regulation of affect which resulted in aberrant emotional responsivity. However, the findings reported by Gainotti have also been interpreted as

reflecting differential involvement of the cerebral hemispheres in affect per se. According to this interpretation, the mood of the left-hemisphere damaged patients is not secondary to their cognitive deficits but is the result of a primary disturbance in left hemispheric mediation of affect.

In order to more fully investigate the hypothesis that the hemispheres may differentially participate in mediating positive and negative affect, Sackeim and his colleagues (Sackeim, Weiman, Gur, Greenburg, Hungerbuhler, & Geschwind, 1982) conducted a series of retrospective studies of patients with uncontrollable laughing and crying due to irritative lesion, destructive lesions or associated with hemispherectomy. According to these findings, uncontrollable laughing (or euphoric mood) was associated with irritative left lesions, destructive right hemisphere lesions and with right hemispherectomy. Given this, it was concluded that the left hemisphere is involved in mediating positive affective states. Negative affect states were associated with destructive left lesions. There was not enough data to consider irritative and hemispherectomy cases associated with pathological laughing. These findings are interpreted as indicating that the hemispheres

differentially participate in subserving positive and negative affect. While these findings are intriguing (and are in agreement with observations of emotional reaction following barbituration of the hemispheres), there are difficulties with drawing firm conclusions from retrospective accounts and in generalizing from these kinds of circumscribed emotional reactions to the control of affect in general.

In summary, observations of the emotional reactions of patients with unilateral dysfunction have suggested that affective states may vary according to the lateralization of the pathology. However, this has been interpreted as either reflecting a right hemispheric predominance in the regulation of affect in general or alternately as reflecting differential contributions to affect.

Performance Of Neurologically Impaired Patients On Experimental Affective Tasks

Investigations using this methodology have emerged only within the last decade. In a relatively early study, Heilman, Scholes, & Watson (1975) compared the performance of groups of left and right damaged patients on a task requiring the comprehension of emotional intonation for sentences in which the semantic content was affectively

neutral but the tone of voice in which the sentences were read was varied to include four different affective tones (happy, sad, angry or indifferent). Subjects were asked to demonstrate an understanding of emotional intonation by both pointing to a line drawing of a facial expression that corresponded to the emotional intonation of the sentence and by saying the name of the emotion. Subjects demonstrated an understanding of the content by pointing to a pictorial representation of the semantic content (e.g. a picture of "The man is showing the boy the dog food"). The results indicated that the RBD group was impaired relative to the LBD group in the comprehension of emotional intonation while both groups could correctly identify the semantic content of all the sentences. In a later follow-up study, it was reported that RBD patients were relatively impaired in the discrimination (same/different) of emotional intonation and in the expression of emotional intonation (Tucker, Watson, & Heilman, 1979). It is not clear from the presentation of results if there was a correlation in performance on the receptive and expressive tasks.

Cicone, Wapner & Gardner (1980) compared the performance of right and left brain damaged patients on a variety of tasks including: (a) matching facial identity,

(b) matching emotional facial expressions, (c) matching drawings on the basis of the emotional tone depicted, and (d) matching emotional situations from phrasal descriptions (rather than drawings). For the facial identity task, subjects were presented with a target face along with four test faces and required to identify the target in the four choice display. In the emotional expression task, subjects were presented with a target face displaying an emotional expression and were required to find another face showing the same expression but displayed by another individual. In the drawing task, subjects were shown drawings that depicted different affective situations (e.g. a picture of a man sinking in quicksand to depict fear). The task again involved matching and required the subject to match a target drawing with a drawing of a different situation that depicted the same emotion. For example, if the target were the picture of a man sinking in quicksand to depict fear, the correct response might be a picture of a man held at gunpoint which also depicts fear. The stimuli for the last task were phrasal descriptions rather than pictures and again the subject was asked to match the phrases that would be associated with the same affect. For example, in this condition the phrase "a man being held at gunpoint" might

have to be matched with the phrase "a man sinking in quicksand" because both connote fear. The results indicated that the RBD group was impaired relative to the LBD group on all but the last task for which the left hemisphere group were relatively impaired but not significantly so. The relative impairment of the LBD group on the last task was interpreted as secondary to linguistic disturbance rather than as a primary emotional processing deficit. Furthermore, because of the well known right hemispheric involvement in facial recognition and because the performance of the RBD group was in fact more impaired than the LBD group (whose performance was perfect) on the facial identity task, analyses were performed in order to examine the relationship between performance on facial recognition and facial expression recognition. Correlational analyses on the two types of face tasks across all patients in the RBD group revealed a low correlation between performance on the two tasks. Therefore, it was concluded that impaired performance on the emotional expression task could not be attributed to impaired facial recognition. The authors interpret the totality of the findings (that the RBD group were impaired relative to the LBD group on most tasks and the dissociation between facial identity and facial

expression recognition) as indicating that RBD patients are relatively impaired in emotional processing in general.

The difficulty with this interpretation is that there are no other measures of the cognitive functioning of these groups of patients. It is not clear for example, the degree to which the LBD patients were indeed linguistically impaired or if the RBD patients were perceptually impaired for non-emotional pictorial stimuli. In fact, there are empirical studies which have addressed issues related to the difficulties raised here and have generated findings which are not concordant with those of Cicone et al. (1980).

First, the conclusion that impaired facial affect recognition can not be attributed to a more general impairment in facial recognition has been questioned (DeKofsky, et al., 1980). The results of DeKofsky's study suggested that impaired performance on tests of affect sensitivity using facial and pictorial stimuli was related to impaired facial recognition. Evidence for this derived from finding that the difference between the LBD and RBD groups on emotional facial and pictorial tasks disappeared when facial recognition scores were used as a covariate. However, when the results were examined on an individual basis the relationship between performance on facial

recognition and recognition of emotional facial expression or pictures depicting emotional situations became less clear. Three subjects did relatively poorly and three relatively well on both the face recognition and facial affect tasks. However, for three patients the tasks were not related. Therefore, for at least three patients there was a dissociation between facial recognition and facial affect discrimination. Consequently, the relationship between impaired performance on facial identity recognition and facial affect recognition is still unclear. Similarly, the extent to which a more pervasive visuo-spatial disturbance might account for the RBD group's difficulty on tests of emotional processing employing pictorial stimuli also remains uncertain.

Second, the conclusion that left hemisphere damaged patients are impaired for affective processing only secondary to a linguistic disturbance has been questioned. Kolb & Taylor (1981) found that patients with excision of the left temporal, frontal or parietal areas were relatively impaired for processing affect linguistically, even though they were not dysphasic. These subjects were presented with sentences describing an event which connoted a particular emotion and were required to name the appropriate emotion.

In sum, experimental investigations with unilaterally brain damaged patients suggest that the right hemisphere may be crucial for emotional expression and perception. However, there are several difficulties with the literature. First, interpretation of the evidence is problematic because of difficulties separating emotional from other cognitive (e.g. visuo-spatial or linguistic processing) deficits. Further unresolved issues concern the nature of left hemispheric contributions to affect and the nature of the relationship between facial identity recognition and the recognition of affective facial expressions.

Lateralization Of Affect: Experimental Evidence With Normals

As with the clinical literature, the bulk of research in the field of hemispheric specialization has concerned cognitive processes. However, there is a growing body of literature investigating hemispheric asymmetries associated with affective processes. This section will consider some of the research in this area. Specifically, in this section auditory studies and visual studies which have not employed facial stimuli per se will be reviewed.

Within the auditory modality several studies have demonstrated a slight but significant left ear advantage for the perception of affective information, which presumably reflects relative right hemispheric specialization for affective processing.

Haggard & Parkinson (1971) presented subjects with stimuli to one ear and masking noise to the other. The stimuli were sentences which were read in four different tones of voice (happy, angry, distressed and bored). The results indicated that subjects identified the affective intonation more accurately when stimuli were presented to the left ear than when stimuli were presented to the right ear. Similarly, Carmon & Nachson (1973) found a left ear

advantage for dichotically presented nonverbal emotional sounds (crying shrieking and laughing). Subjects were presented with the sounds and asked to identify them by pointing to a pictorial representation of the appropriate sound. For example, a picture of a person crying was the referent for the crying sound, a picture of a person laughing was the referent for the laughing sound, etc. Interestingly, the left ear effect was most pronounced for "crying" suggesting that, as noted previously, different types of affect may be differentially lateralized.

Safer & Levanthal (1977), using monaural presentation of stimuli, found that subjects who listened with their left ear tended to evaluate passages according to the affective tone by which they were read rather than by the semantic content expressed by the words while subjects listening with the right ear tended to use content cues more often. In this study subjects were presented with passages that consisted of three levels of tone of voice (positive, negative and neutral) crossed with the same three levels of content. When subjects were simply asked to evaluate the passage as positive, negative or neutral, without being instructed whether to use the tone of voice or the content cue, subjects listening with the left ear tended to evaluate

using tone of voice cues while subjects listening with the right ear used the content cues.

In sum, all these studies suggest that the right hemisphere is more sensitive in the perception of affective intonation which is consonant with the notion of a right hemispheric predominance in emotional processing. While one study found that the RH advantage was more pronounced for negative affect, none of these studies reported differential patterns of asymmetry as a function of the positive/negative valence of the emotion. However, most of these studies were not specifically designed to examine differences for emotion-type so that more systematic investigation is required.

Hemispheric differences in emotional perception also have been investigated within the visual modality. In two related studies, Dimond & colleagues (1976; 1977) examined autonomic and cognitive responses to lateralized stimuli projected by means of a specially designed contact lens system. Subjects were required to rate each of three films after viewing according to categories of horrific, unpleasant, humorous and pleasant. All three films were rated as more unpleasant and two of the three as more horrific when initially directed to the right hemisphere.

The autonomic responses differed according to the lateralization of the input in conjunction with the type of stimuli. Heart rate responses were greater with right hemisphere viewing of a surgical operation and left hemisphere viewing of a cartoon. These findings are consistent with the view that the hemispheres may participate differentially in affect. The right hemisphere seemed to be associated with negative emotional experience and the left with positive experience.

In summary, the empirical evidence favors the notion of a right hemispheric predominance in the perception of affect. On the other hand, more direct examination of emotional experience suggests that the left and right hemispheres may contribute differentially to emotional responsivity such that the right hemisphere predominates in the mediation of negative affect and the left hemisphere in mediating positive affect. It may be that the contrasting results reflect differential lateralization of different affective mechanisms (i.e. responsivity versus perception of affective information). However, the empirical studies have not systematically investigated the issue of differential patterns of lateralization so that more information is needed before this hypothesis can be

accepted.

The evidence reviewed thus far suggests that right hemispheric mechanisms are predominant in facial perception and in the perception of affective information but that variations may occur according to the task demands and affective valence in question. Given these findings it is reasonable to expect that there may be a relatively stronger involvement of the right hemisphere in the perception and production of facial displays of affect but that this pattern might vary according to the specific task demands or the type of affective stimuli used. In the following sections the evidence related to hemispheric mediation of facial affect will be reviewed.

Perception Of Facial Affect: Experimental Evidence In Normal
Subjects

In the previous section it was suggested that the right hemisphere played a special role in affect, and particularly affect perception. This was based on studies with neurologically-impaired and normal samples for auditory and visual information. In normals the literature pertaining to tachistoscopic studies of facial affect perception has not yet been addressed. This section will focus on the lateralization of the perception of facial displays of affect. Specifically, the following issues will be addressed: (a) Do intensity judgements of emotional facial expressions differ as a function of the hemisphere to which they are initially transmitted? and (b) Are emotional facial expressions discriminated and/or identified more accurately and/or quickly as a function of visual field? This second issue differs from the tasks described earlier in the facial recognition section in that the task is to discriminate the particular expression displayed on the face whereas in facial recognition the task is to recognize the particular face.

Intensity Judgements

Related to Dimond & Farrington's findings that the

affective evaluation (e.g. how unpleasant, how humorous, etc.) of films varied according to the hemisphere to which they are initially transmitted, hemispheric differences in the evaluation of the intensity of emotional facial expressions might also be expected. Although ratings of emotional intensity have been found to vary according to the lateralization of the stimuli, the results are inconclusive.

In the first demonstration of lateral asymmetry associated with intensity judgements, Campbell (1978) found that chimeric photographs (half smile, half non-smile), presented briefly at midline, were perceived as happier when the half-smile appeared in the LVF than when it appeared in the RVF suggesting heightened RH sensitivity to affective information. Heller & Levy (1981) replicated the finding using the same paradigm. Seemingly discrepant results were recently reported by Natale, Gur & Gur (Exp. III, 1983). In this experiment subjects were asked to identify the positive/negative valence of laterally presented chimeric (half happy/half sad) faces. The results indicated that faces presented in the RVF received more positive judgements than faces in the LVF, suggesting what these researchers refer to as a positive bias for the left hemisphere.

Using a variety of facial expressions Hirschman & Safer (1982) found no lateral differences in intensity ratings. Davidson (Note 2) has also reported finding no lateral differences when subjects were asked to rate the intensity of happy and sad expressions. However, differences were obtained when subjects were asked to rate their own subjective response to the expressions. In the later case, the findings revealed reversed patterns of asymmetry for happy and sad responses with elevated ratings favoring the RVF-LH and LVF-RH respectively.

Discriminating Facial Expression

A second approach to the study of lateral asymmetries associated with the perception of emotional facial expressions has been to ask subjects to discriminate pairs of expressions. In the Ley & Bryden (1980) experiment described earlier in the facial recognition section, subjects were required to discriminate the emotional expression displayed on the face as well as the facial identity of the five physiognomies that ranged in expression from very positive to very negative. Thus, for each pair of physiognomies presented, subjects had to say whether the face was the same regardless of the expression and whether the expression was the same regardless of the facial

identity. In expression discrimination, as in facial identity discrimination, a main effect for visual field indicated faster processing in the LVF. For both tasks an emotion by visual field interaction was obtained. However, the pattern of the interaction was not exactly the same in the two tasks. As noted, in the facial identity task there was an LVF-RH advantage when faces displayed extremely positive, extremely negative, mildly positive and neutral expressions while there was a nonsignificant RVF advantage for faces displaying mildly negative expressions. In the expression task there was a significant LVF effect for the extreme emotional expressions but nonsignificant effects for the mild and neutral expressions. Furthermore, analyses of covariance indicated that the LVF-RH advantage for facial identity did not obtain when emotion was used as a covariate, but the LVF-RH effect for emotion discrimination was unaltered when identity was used as a covariate. These findings suggest that the LVF effect for recognizing facial identity may be in part due to the LVF effect for emotional expression recognition and that the right hemispheric predominance for facial recognition may be related to its emotional processing capabilities.

The findings of Strauss & Moscovitch (1981) were

consistent with those of Ley & Bryden (1980) in suggesting that affect and identity discrimination are more efficiently mediated by the right hemisphere, and that although related, the two tasks do not involve identical processing mechanisms. In the Strauss & Moscovitch experiment, separate groups of subjects were required to discriminate emotional expression or facial identity for pairs of faces unilaterally and simultaneously presented. Although "same" judgements resulted in a LVF-RH superiority for both expression and facial identity discrimination, RT differences for the tasks were also found. Overall latencies in identity perception were faster than in emotion perception, "different" judgements were handled faster than exact matches in facial perception but not in expression perception and males responded faster than females in facial identity but not in emotion perception.

Also using a same/different discrimination paradigm for successively presented pictures, Safer (1984) examined the effects of two encoding strategies on hemispheric asymmetries. Subjects were instructed to match central and lateral faces on the basis of a verbal label or a feeling generated by the expressions. The findings indicated an overall LVF advantage in accuracy and no main effect for

instructions. Despite the absence of a field by instruction interaction which would have suggested differential patterns of asymmetry as a function of instruction, a substantial number (18 out of 31) of subjects did in fact show contrasting asymmetries.

Using a procedure in which neutral and emotional faces were bilaterally presented, subjects discriminated sad (from neutral) expressions more quickly in the LVF and happy more quickly in the RVF (Reuter-Lorenz & Davidson, 1981; Reuter-Lorenz, Givis & Moscovitz, 1983). These findings are not consistent with the results discussed above in which a LVF-RH advantage was obtained for discriminating both positive and negative affective expressions (Ley & Bryden, 1981; Strauss & Moscovitch 1981). The studies however, are not directly comparable as Reuter-Lorenz used different procedures than the others. Reuter-Lorenz used bilateral presentations, relatively long exposure durations and did not require a same/different discrimination but the detection of the side showing the face displaying an affective expression. In contrast, the other experiments did require same/different discriminations and used shorter exposure durations. These factors may influence the emergence of hemispheric asymmetries although additional

research is necessary to specify the nature of these affects.

Identification of emotional expressions has also been studied by: (a) asking subjects to respond manually if the expression matched the verbal label presented by the examiner (Pizzamiglio, Zoccolotti, Mammucar, Cesaroni, 1983) and (b) by asking subjects to verbally identify lateralized expressions (Hirschman & Safer, 1982). The later found no lateral effects for accuracy of naming. Pizzamiglio et al. (1983) found that asymmetries in RT varied as a function of cognitive style and type of emotion. Cognitive style was defined by performance on the Rod and Frame Test and the Embedded Figure Test. Field independent subjects showed a LVF advantage for fear and disgust, an RVF advantage for anger and no asymmetry for happy and sad expressions. Field dependent subjects did not show any significant differences although an insignificant LVF superiority was exhibited for four of the six expressions.

The findings on the perception of facial expression can be summarized as follows:

1. The bulk of studies examining lateral differences associated with the discrimination of emotional expression have found a relative LVF-RH superiority.

2. Differential participation of the hemispheres for the discrimination of positive and negative affect has been found only when bilateral presentations were used and the task involved the detection of the affective stimulus rather than a same/different discrimination per se.

3. The findings with regard to intensity judgements have been inconclusive. Although initial studies suggested that chimeric faces were perceived as 'happier' when the half-smile appeared in the LVF, more recent studies using laterally presented photographs suggest an RVF-LH positive bias. Methodological differences in exposure duration and mode of presentation (central versus lateral) may have contributed to these differences. Further research is needed to explore these discrepancies.

Finally, the exact nature of the relationship between facial expression and facial identity perception has not been determined but the two types of discriminations appear to be dissociable. As suggested in the previous section, there is evidence suggesting that, even though these tasks may not involve exactly the same cognitive mechanisms, the right hemispheric advantage for processing facial identity is related to the face as an emotionally salient stimulus.

Production Of Emotional Facial Expression: Experimental Evidence In Normal Subjects

Investigations have only recently focused on lateral asymmetries associated with the production of emotional facial expressions. In general, studies have tried to determine whether the left or right side of the face is more emotionally expressive. Because innervation from cortex to the facial nerve is predominantly contralateral, at least for the lower face (Carpenter, 1978), side of face asymmetries are taken as a reflection of hemispheric asymmetry for emotion expression.

The earliest demonstrations of such asymmetries were reported by Sackeim & Gur (1978) and Campbell (1978). The former used the Ekman photographic series of seven different emotional expressions (sadness, happiness, anger, disgust, fear, surprise and neutral) which have been shown to be reliably identified cross-culturally (Ekman, 1973). Although most of the expressions were elicited by requesting particular facial movements from trained posers, happy expressions were mainly spontaneous. Right-sided and left-sided composite photographs were created by cutting normal and mirror-reversed prints down the midline and joining like-sided halves. These composite photographs were

shown to groups of subjects who rated the intensity of the emotional expressions on a 1 to 7 Likert-type scale. The results indicated that left-composites, presumably reflecting the influence of contralateral right hemispheric mechanisms, were rated as portraying expressions more intensely. Although a significant interaction between type of emotion and side was not obtained, posthoc comparisons revealed statistically significant differences for a subset of the negative emotional expressions (anger and disgust). Happy was the only expression for which there was a statistically nonsignificant trend in the opposite direction.

Campbell's results were concordant in that expressions represented by left-composites were perceived as more intense than those represented by right-composites. However, unlike Sackeim & Gur, Campbell also found the left-sided effect for a "smile" (happy) expression. It is noteworthy that Campbell employed different procedures than Sackeim in that these differences may have affected the results and may in part account for the differences in the findings obtained by the two studies. In Campbell's study subjects were required to select the composite that was most expressive when presented with left and right-sided pairs.

The results in turn were presented in terms of frequency counts of the number of raters selecting right or left-composites as more intense. In the Sackeim study the photographs were presented singly with subjects asked to rate the intensity of each facial expression and the results presented in terms of mean intensity ratings for right and left composites. Second, in the Campbell study posers were untrained and were simply asked to smile or to relax while in the Sackeim study posers were trained in the movement of facial musculature and for the most part were asked to create expressions by being instructed to make particular facial movements.

I conducted a series of studies attempting to replicate these findings. Posers were untrained and asked to pose an expression when presented with an emotion label. Both the forced-choice technique of Campbell and the rating scale procedure of Sackeim resulted in the same outcome: the left side of the face was judged as more expressive for negative expressions and the right more expressive for positive expressions.

In the course of the study, however, it became apparent that differences in the illumination and width of the composites might be confounding the interpretation of the

results. That is, it appeared as though left-composite photographs were consistently darker and thinner than right-composite photographs. If this were the case then it may have been that judgements of intensity were influenced by these characteristics rather than the facial expression per se. Specifically, facial displays of negative affect may have been perceived to be more intense if they are dark and thin as opposed to wide and bright while facial displays of positive affect may appear more intense if they are relatively bright and wide. In order to determine if differences in illumination and width were perceptible characteristics of the stimuli, subjects were asked to sort the photographs into categories representing different degrees of width and illumination. The results indicated that in fact there were systematic differences between left and right-composites as predicted. Left-composites tended to be judged as being thinner and darker than right composites. Consequently, there may have been an influence of these artifactual characteristics such that negative expressions appeared more intense because they were darker and thinner while positive pictures appeared more intense because they were wider and lighter.

It is not clear the degree to which these factors were

influential in other studies. However, our findings suggest that conclusions about underlying hemispheric asymmetries should be offered cautiously as the judgement of emotional intensity might be affected by characteristics of the stimuli which are not poser generated (Zeidler, Brozgold, Rosen & Gerstman, Note 3).

Borod and her colleagues have conducted a series of studies on facial asymmetries (Borod & Caron, 1979; Borod & Koff, Note 4) employing different procedures than the symmetric-composite technique. In the first report in this series of investigations, posers were untrained and expressions were elicited by providing visual cues and verbal descriptions of emotional situations concurrently. Posers were videotaped and expressions were analyzed by three judges who rated the relative emotional intensity of the sides of the face. Over all emotions, a majority of the posers exhibited expressions more intensely on the left side of the face. It may not be obvious but Borod's results are presented in a different way than the results of the studies already discussed. Borod presented her findings in terms of the number of posers showing the left-face effect. The studies described earlier presented results in terms of either the number of judges selecting the left-composite or

of the mean intensity ratings for left and right-composites summed across posers and judges.

Subsequent investigations by Borod and her colleagues showed that: (a) in posers measures of facial asymmetry were not related to handedness or footedness but were related to eyedness, (b) a majority of posers showed the left-face effect for spontaneous as well as posed emotional expressions, (c) there were differences in hemiface width and motility favoring the right and left face respectively which were thought to be concomitant to right hemispheric specialization for emotion, and (d) males expressed emotion more intensely on the left for both positive and negative emotions while females did so only for negative emotions.

Other techniques have also been employed. For example, using a chimeric photograph procedure, Heller & Levy (1981) and Campbell (1978) found that faces were perceived as happier when the smile derived from the left face. Rinn (Note 5) replicated these results having judges rate the extent of spontaneous smiles on the left and right side of the face from videotape, although Ekman (1981), using the FACS scoring technique which is a more objective measure looking at the movement of particular parts of the face, found that spontaneous smiles were more randomly

lateralized.

Some of the differences in the findings obtained by the studies reviewed may be related to the differences in the kinds of expressions studied. Rinn used smiles of individuals who were videotaped during verbal activities in which they were asked to explain the meaning of proverbs and were thus engaged in a highly cognitive activity. In contrast, Ekman used smiles generated spontaneously during the subjects' viewing of a film. Campbell simply asked subjects to smile while Heller & Levy used a combination of posed and genuine (i.e. in response to a joke) smiles. It may be then that asymmetry will vary according to the eliciting circumstances. That is, different situations may be associated with different cognitive-emotional responses which are mediated by different neurological substrates which in turn are reflected by different patterns of hemispheric asymmetry.

In summary, the bulk of the literature suggests that the left side of the face is judged to portray emotion more intensely than the right. This finding presumably reflects the predominance of right hemispheric mechanisms in the production of emotional expression. However, as is evident from this review, the results may vary as a function of the

sex of the poser, the circumstances used to elicit expressions, rating procedure, and type of expression.

Specific Questions And Hypotheses

1. If the right hemisphere plays a special role in the expression of facial affect, then left facial composites should be rated as displaying emotional expressions more intensely than right facial composites. However, if the hemispheres differentially participate in mediating the expression of positive and negative affect, then there should be a reversed pattern of asymmetry for happy and sad expressions. Left-composites should be rated more intensely for sad and right-composites more intensely for happy expressions.

2. If the perception of facial affect and facial identity are preferentially dependent on right hemispheric processing (under certain procedural constraints), then a LVF-RH advantage should obtain in facial affect and facial identity discrimination tasks.

3. If the hemispheres are differentially involved in the perception of positive and negative emotional expression, then a reversed pattern of asymmetry should be obtained in the affect discrimination task. Presumably this

would be reflected by RVF and LVF advantages for happy and sad expressions respectively.

4. If emotional saliency augments the LVF-RH advantage in facial identity and facial affect discrimination tasks, then:

(a) Photographs that elicit higher intensity ratings should elicit a greater LVF-RH advantage. This would be particularly expected for negative expressions and more ambiguous for positive expressions.

(b) Raters who perceive emotional expressions more intensely may also exhibit more asymmetrical processing.

5. If the expression and perception of facial affect are related, then there should be a relationship between direction and degree of asymmetry demonstrated for these tasks such that:

(a) Posers who generate the most asymmetric composites should also evidence the largest perceptual asymmetry. Presumably the modal relationship would be reflected in concordance between left facial composites and the magnitude of the LVF advantage. Nonetheless, it is conceivable that a minority of the posers will generate a more intense

right-composite and it would be interesting if these individual also evidenced a RVF advantage. It is also possible that the relationship will be reflected by a concordance of reversed asymmetry for positive and negative affect.

(b) Posers who generate more intense expressions should demonstrate larger asymmetries in perceptual tasks than those who express less intense expressions, but this relationship again may be dependent upon the type of affect in question.

6. If facial identity and affect discrimination are related then there should be a concordance in the visual field asymmetries demonstrated for these tasks.

Method

Subjects

Two groups of subjects participated. All were right-handed as assessed with the Annett Handedness Questionnaire (Annett, 1972). With the exception of one poser, all familial history of left-handedness was negative. All subjects were paid for their services.

Posers. Thirteen posers were selected from a total of 38 who had participated in three photographic sessions. The final selection of posers was restricted to those individuals who exhibited the most discernable expressions. In addition, in an effort to eliminate gross identifying cues, only clean shaven Caucasians without eye glasses were selected. The final sample consisted of ten females and three males. The majority of posers were graduate and undergraduate students from City College. Three posers did not attend the City College. Of the 13 posers who provided pictures, nine returned to participate in two perceptual tachistoscopic tasks.

Raters. Thirty two subjects (16 male 16 female), all of whom were graduate and undergraduate students of the City College, served as raters. These subjects did not

participate in photographic sessions. Like the nine returning posers they were required to: (a) rate the intensity of a series of photographs of the posers portraying emotional and neutral expressions and (b) participate in two tachistoscopic sessions involving facial identity and emotional expression discrimination.

Stimuli:

Posers were photographed under controlled photographic conditions in which they were sitting full face to camera and the lighting was arranged to assure even illumination of the face. All wore a cap to eliminate asymmetrical hairlines and all pictures were cropped at the neck.

Right and left-sided composite photographs were created by cutting normal and mirror-reversed prints down the midline, joining like-sided halves and rephotographing the composite. Midline was defined as the line extending from the midpoint between the internal canthi and the cleft of the upper lip. For non-composite photographs two normal prints were cut, rejoined and rephotographed.

During the first photographic session posers were asked to exhibit posed emotional expressions by requesting that they "show how their face looks when they feel sad, happy, etc.(Buck, 1975). During the two last photographic

sessions, if expressions were not discernable to the experimenter, the subject was verbally coached to try to be more expressive. The final stimuli were chosen on the basis of the discriminability of the expressions regardless of coaching.

A total of 117 stimuli were created. These consisted of normal, right and left-sided composites of the 13 posers exhibiting a happy, sad and neutral expression. Each photograph (25cm * 33cm) was presented in free view affixed to a white card.

General Procedure

Each of the 41 subjects (32 raters and nine posers) participated in two individual sessions conducted on two consecutive days. One session included an intensity rating task and a facial discrimination tachistoscopic task. One session included the intensity rating task and an affect discrimination tachistoscopic task. Half the subjects performed the intensity rating and the facial discrimination task during the first session. Half the subjects performed the intensity rating and the affective expression discrimination task during the first session. The intensity rating task was performed prior to the tachistoscopic tasks on both days.

Two kinds of asymmetry measures were thus available for the nine returning posers. A measure of expressive was provided by the differential intensity ratings generated by their left and right composite photographs. Measures of perceptual asymmetry were obtained from differential right and left visual field reaction time in the tachistoscopic tasks. Measures of perceptual but not productive asymmetry were available for the raters.

Intensity judgements

Stimuli

The deck of 117 stimuli was arranged in counterbalanced order so that within each block of 39 each poser appeared three times (one of each facial expression and one of each composite).

Procedure

As noted, each subject participated in two individual rating sessions in which they were asked to rate the intensity of the facial expressions. Subjects were instructed that they were going to be shown a series of photographs of positive, negative and neutral facial expressions that may differ in the degree of expressiveness

portrayed. They were directed to rate the intensity of the expressions by using a scale which ranged from +7 to -7, with a zero point in the center for pictures which were neither positive nor negative. Examples of pictures showing positive, negative and neutral expressions were provided. While there was no time limit imposed, most subjects rated a single photograph within ten sec. Half the subjects saw the 117 stimuli in one sequence (1 to 117) and half the subjects saw the stimuli in the reverse stimulus order.

Facial Identity Perception

Stimuli

Five of the 13 posers' faces were selected as stimuli. The selection of the five was based on a piloting procedure in which nineteen raters (none of whom were among the 41 raters and posers) were asked to categorize the non-composite neutral, happy and sad expressions of all 13 posers. The five posers' faces selected for the tachistoscopic task were those which were most accurately categorized.

For the tachistoscopic facial identity task only the neutral expressions of five posers' right left and non

composites were used. Each of the composites was paired once with itself and once (in the center position) with the same composite of another face. This resulted in 30 stimulus pairs consisting of 15 "same" and 15 "different" combinations. Each pair appeared once with the lateralized face in the left and once with it in the right visual field resulting in a total of 60 trials.

These 60 trials were divided into three blocks of 24, 24 and 12 trials each. Within each block of 24, 12 were LVF (left visual field) and 12 RVF (right visual field) presentations. Within each 12, six were "same" and six "different" combinations. Within each six, two were right composites, two left composites and two non-composites.

The photographs of the five posers' faces were constant across all raters. Four of these were also constant across posers. The fifth face was rotated so that each poser saw his own face.

Lateralized faces appeared with the center of the face three degrees to the left or right of fixation. Faces subtended an angle of 1.8 degrees horizontal and 2.4 vertical when viewed tachistoscopically.

Procedure

Faces were presented in pairs of "same" or "different"

as described. Each of the 60 trials consisted of a central face presented for 1500 msec followed by a 400 msec fixation followed by a 100 msec lateralized face. A timer was triggered at stimulus onset and stopped when the subject responded or at three sec. Subjects were required to respond manually, to "same" pairs only by touching a plate, (centered at midline), with their right index finger. Twenty practice trials preceded the experimental trials. For the practice trials, non-test faces were used and feedback was provided.

Equipment

A Gerbrands three-channel tachistoscope (Model T-3B-1) and Gerbrands model 1201 clock/counter was used.

Facial Affect Perception

Stimuli

For the facial affect discrimination task, right-, left- and non-composite neutral, sad and happy expressions of the same five posers' whose faces served as stimuli in the facial identity task were used. Each face was paired once with itself and once with the same composite of the same poser showing a different expression. Thus, each poser was

represented in 18 stimulus pairs as follows: each of the three composites in emotion pairs of happy-happy, sad-sad, neutral-neutral, happy-sad, sad-neutral and neutral-happy. Across the five posers this resulted in 90 stimulus pairs. Each pair was seen once in the LVF and once in the RVF resulting in a total of 180 trials.

The 180 trials were divided into five blocks of 36 trials each. Each block contained 18 "same" and 18 "different" pairs. Within each 18, nine appeared in the LVF and nine in the RVF. Within each nine, three were left, three right and three non-composites. Within each of the composites one of each emotion pair was represented. Posers were randomly assigned to the blocks and the counter-balancing procedures arranged such that any one stimulus configuration (i.e. Happy-happy left composite LVF) was represented by only one poser's face in a single block.

As in the facial identity experimental session, lateralized faces appeared centered three degrees to the left or right of fixation. Faces subtended an angle of 1.8 degrees horizontal and 2.4 degrees vertical.

Procedure

The procedure was identical to that used in facial perception. Thus, faces were presented in pairs of "same"

and "different" as described above. Each trial consisted of a central face presented for 1500 msec. immediately followed by a 400 msec. fixation immediately followed by a lateralized face exposed for 100 msec. Twenty practice trials using non-test faces preceded the experimental trials. Feedback was provided for the practice items.

As in the facial identity recognition task, subjects were required to respond manually to "same" pairs only by using their right index finger to touch a plate centered at midline.

Equipment

The equipment and luminance were the same as that described for the facial recognition task.

RESULTS and DISCUSSION

Intensity Judgements

Results

In order to ascertain whether the photographs were perceived as portraying the affect dimension intended by the poser, the percentage of positive, negative or neutral ratings for each individual stimulus was calculated. Table 1 shows the percentage of positive, negative and neutral ratings generated for each happy, sad, and neutral expression, respectively.

For sad pictures, the percentage of negative ratings ranged from 72 to 100. Out of 13 posers, two generated photographs for which the percentage of negative ratings fell below 90.

The percentages of positive ratings for happy expressions was between 97 and 100. The two posers (Posers 10 & 13) who produced somewhat lower percentages for sad did not generate lower percentages for the positive ratings.

For the neutral expressions it seemed reasonable to examine the percentage of ratings that fell between +1 and -1, the least extreme positive or negative rating. As indicated in Table 1, the range, between 28 and 100 percent,

was wider than for either sad or happy. The majority of the posers however, generated ratings which ranged between 80 and 90 percent.

In order to determine whether the magnitude of the intensity ratings for the neutral expressions differed from happy and sad ratings, Wilcoxon tests comparing neutral with sad and neutral with happy for each poser composite combination were performed. In this analysis, for example, the ratings for Poser 1's left-composite neutral were compared to the ratings for Poser 1's left-composite sad and left-composite happy. The results indicated that the magnitude of the neutral ratings differed significantly from happy and sad for each poser composite combination. That is, ratings for neutral expressions were always less extreme than for happy or sad expressions for each individual poser.

These findings suggest that the three different expressions were reliably differentiated by the raters. Posed happy expressions were perceived by raters as portraying positive affect; posed sad expressions were perceived by raters as portraying negative affect and posed neutral expressions were perceived as portraying only moderately negative or positive affect.

Ratings for each composite group. Ratings for the composite

types, collapsed over poser, were examined in two ways. For one comparison, the percent of positive, negative and neutral ratings was based on a ratio in which the denominator was the total number of ratings possible (13 composites x 32 raters x 2 rating sessions) and the numerator was the sum of the number of negative or positive or neutral ratings summed over the 13 composites and 2 rating sessions. These values are presented in Table 2. As indicated, for sad expressions 96, 94 and 95 percent of all ratings for left, right and non-composites respectively were negative. For happy, 99 percent of the ratings for each of the composites were positive. For neutral, 80, 84, and 83 percent of the ratings fell between +1 and -1 for left, right and non-composites respectively.

The second comparison examined the proportion of ratings for which all of a particular composite type were rated negatively or positively or neutrally. A rater is only figured into the numera or if his/her ratings for all 13 instances of the composite type were negative, positive or neutral (see Table 3). Left-composite sad photographs generated more consistent (all 13 composites) negative ratings than right-composite sad photographs ($p < .01$, test for correlated proportions). For happy left and right

composites the difference did not differ significantly. For neutral expressions, right composite photographs generated more consistent neutral ratings than left composites ($p < .01$, test for correlated proportions). This last finding suggests that left composite neutral expressions were more often associated with higher intensity ratings than the right composite photographs.

Nonparametric Tests

These analyses are similar to those reported by many researchers and are based on frequency counts (Campbell, 1978; Heller & Levy, 1981; Rinn, 1982; Zeidler, Brozgold, Rosen & Gerstman, 1982). For these analyses the occurrence of a difference in magnitude of intensity for left and right composites was determined while the magnitude of the difference was disregarded. 'Left-choices' were then defined as those instances for which the intensity rating of the left composite was greater than the right composite and 'right-choices' as instances for which the intensity of the right composite was greater. Since each of the 32 raters generated two sets of ratings the total number of cases is equal to 64.

Two types of frequency analyses were then conducted: For one analysis the number of cases associated with

left-choices and right-choices summed across all posers was calculated. This was done in the following way. For each case the number of left and right-choices out of the 13 posers was determined. Then the number of cases associated with a greater frequency of left-choices and the number of cases associated with a greater frequency of right-choices were tabulated. For the second analysis the number of cases associated with left-and right-choices elicited by each poser.

Sad

As shown in Table 7, 35 cases were associated with a left-choices, while only 20 were associated with a greater frequency of right-choices. The number of cases associated with left-choices is significantly greater than would be expected given the null hypothesis ($p < .05$, binomial test).

On an individual poser basis, the number of posers associated with a greater frequency of cases choosing the left composite (8) was not significantly different than the number of posers (5) for whom there was a greater frequency of right-choice cases.(see Table 8)

Happy

Approximately half the cases had a greater frequency of left-choices and about half had a greater frequency of

right-choices as shown in Table 7.

The number of posers who elicited a greater proportion of left-choice cases (7) was not significantly different from the number (6) who elicited a greater proportion of right-choice cases. (See Table 8)

Neutral

The number of cases associated with more frequent left-choices differed significantly from what would have been expected given the null hypothesis ($p < .05$, binomial test). As shown in Table 7, left-choices were more frequent than right-choices for 34 cases while the converse was true for only 18 cases.

The number of posers (8) eliciting a greater proportion of cases choosing the left composite was not significantly different than the number of posers (5) for whom there was a greater proportion of cases choosing the right composite as more intense (See Table 8).

Parametric Tests

Initially, ANOVAs were performed using the full set of variables. These variables included the following within subject factors: rating session (2), emotion (3), composite (3) and poser (13) and the following between-subject factors: stimulus order (2) and sex (2). The first set of results found significant higher order interactions (e.g. rating session by stimulus order by poser by composite by emotion) which were difficult to interpret. Because of this, ANOVAs were then performed for each poser separately and for each emotion separately. From these analyses it was found that EMOTION as a factor and POSER as a factor accounted for large portions of the variance. For example, when ANOVAs were performed for each poser separately, the emotion factor accounted for from between 71 to 85 percent of the total variance. When ANOVAs were performed for the three emotions separately, the poser factor accounted for 13 percent of the variance in the HAPPY analysis, 37 percent of the variance in the SAD analysis and 18 percent of the variance in the NEUTRAL analysis. Figure 1 illustrates the variation among the three emotions and the 13 posers by presenting the mean intensity ratings for each poser within an emotion category.

Because these factors were accounting for large portions of the variation, and because difficult to interpret higher-order interactions were still being obtained, ANOVAs were conducted for each poser emotion combination separately. Tables four through six present the results of the analyses for each poser within an emotion category. Each ANOVA used Sex (male raters and female raters) and Sequence (the 117 stimuli were presented from 1 to 117 in the "frontwards" group and from 117 to 1 in the "backwards" group) as between-subject factors and Rating Session (first rating and second rating) and Composite (left, right and non -composite) as within-subject factors.

Sad

MAIN EFFECTS

Sex:

Posers 4 & 9. Female raters generated significantly more intense ratings than male raters for these posers' photographs. As is shown in Figure 2, the pattern of females generating more intense ratings is evident for 10 of the 13 posers eventhough it reached significance in only these two cases.

Rating Session:

Posers 4,6 & 9. Overall intensity ratings were more

intense for the first rating session than for the second rating session for these three posers. As displayed in Figure 3, this pattern was evident in 12 of the 13 posers although it reached significance only in three cases.

Sequence:

Posers 2 & 8. For these posers there were significant differences between ratings as a function of the sequence in which the stimuli were viewed. For both, ratings were more intense when the stimuli were viewed in the "backwards" direction. As shown in Figure 4, there was a more random pattern to the sequence effect than there was for the rating session or sex effects. Approximately half the posers were associated with more intense ratings when viewed by the "front" group and half with more intense ratings when viewed by the "back" group.

Composite:

Posers 1,6,9 & 10. Intensity ratings were more intense for left than right-composites for these posers.

Posers 2,7,&8. The opposite pattern was evident for these posers so that right-composites were rated more intensely than left-composites.

Poser 4. For this poser the significant main effect for composite was related to the difference between the left

and non-composite.

Of the six posers for whom the difference between left and right was not significant, five generated more intense left-composites and one a more intense right-composite. In sum, as shown in Figure 5, four posers generated more intense right-composites and nine posers generated more intense left-composites when posing a sad expression. According to the binomial test this difference in frequencies is not significant.

INTERACTION EFFECTS

Sex By Rating Session

Poser 4. Although both males and females generated more intense ratings during the first rating session, the difference was significant only for females (Newman-Keuls $p < .05$). This interaction is illustrated in Figure 6.

Poser 10. Also shown in Figure 6 is that males and females exhibited a reversed pattern of ratings as a function of rating session for this poser. Female ratings were more negative on the first as compared to the second rating while male ratings were more negative on the second rating.

Sequence By Rating Session:

Poser 5. As shown in Figure 7, ratings for the first and second rating session were not consistent for the two stimulus order groups. For one group (stimulus order=front) higher ratings were obtained during the second session, while for the other stimulus order group ratings were higher on the first session. The interaction also indicates differences between sequence groups within rating sessions. During the first rating session the 'back' group generated more intense ratings than the 'front' group, while for the second rating session the 'front' group generated more intense ratings (Newman-Keuls $p < .05$).

Sex By Composite:

Poser 6. Within composite comparisons indicate that the difference between the left and right-composite was significant for females but not for males (Newman-Keuls $p < .05$). Within sex comparisons indicate that females rated the left-composite stimulus more intensely than males (Newman-Keuls $p < .05$). This interaction is depicted in Figure 8.

Sequence By Composite: (see Figure 9)

Poser 6. The difference between left and right-composites was significant for the "back" group but not the "front" group. The interaction also indicates that

the difference between sequence groups was significant for the non-composite stimulus but not the right or left stimulus. The non-composite was rated more intensely when viewed in the "backwards" stimulus order as compared to the "frontwards" stimulus order (Newman-Keuls $p < .05$).

Poser 12. In contrast, for Poser 12 the difference between right and left-composites was significant for the "front" group. Within composite comparisons indicate that the ratings for the "front" and "back" group for the right-composite stimulus differed such that the "back" group generated a more intense rating (Newman-Keuls $p < .05$).

Poser 9. Ratings for the left and right-composite differed for the "back" group but not the "front" group. The difference between the two sequence groups was significant for the right-composite stimulus but not the left or non-composite stimuli (Newman-Keuls $p < .05$).

Poser 3. There was a significant difference between ratings of the left and right-composite for the "back" group but not the "front" group. The difference between sequence groups was not significant for any of the three composites (Newman-Keuls $p < .05$).

Rating Session By Composite

Poser 7. The difference between left and

right-composite ratings was more pronounced on the first as compared to the second rating session as illustrated in Figure 10 (Newman-Keuls $p < .05$).

Sex By Sequence By Composite:

Poser 9. This interaction is shown in Figure 11. The difference between right and left-composites was significant for the female "back" group only. It was not significant for the female "front" group nor for either of the two male sequence groups. The difference for ratings between female "front" and "back" groups was significant for the non-composite. This difference was not significant for males (Newman-Keuls $p < .05$).

HAPPY

MAIN EFFECTS:

No significant main effects were obtained for the sex or sequence factors. It is of interest to note however that females generated more intense ratings than males for all posers even though the differences were not significant. Again, the pattern for the sequence factor was more random. (See Figures 12-13.)

Rating Session:

Posers 1,2,4,8,11,12 & 13. A main effect for rating

session was obtained for these seven posers. As shown in Figure 14, for all posers there was a decrement in the ratings from the first to the second session.

Composite:

Posers 4,7,12 &13. Left composites were perceived as portraying more intense expressions than right-composites.

Poser 2. The right-composite was perceived as expressing a more intense positive expression than the left-composite.

While the left/right differences did not reach a reliable level of significance for the remainder of the posers, left-composites were more intense for three posers and right-composites more intense for five posers. As shown in Figure 15, in total, seven posers generated a more intense left-composite and six posers a more intense right-composite. The difference in frequencies is clearly not significant.

INTERACTION EFFECTS

Sequence By Rating Session:

Poser 2. There was a decrement in the first to the second ratings for both sequence groups as shown in Figure 16. However, the difference was significant only for the "backwards" group. The interaction also reveals that the

"front" group generated more intense ratings than the "back" during the second session but the ratings between groups did not differ for the first session (Newman-Keuls $p < .05$).

Sequence By Composite (See Figure 18):

Posers 2 & 7. The difference between left and right-composite ratings was significant for the "backwards" group only. In addition, the difference between sequence groups was not significant for any of the three stimuli (Newman-Keuls $p < .05$).

Posers 11 & 12. The difference between left and right-composite ratings was significant for the "front" group only. In addition, within composite comparisons indicate that the ratings between the two stimulus groups differed for the right-composite but not for the left or non-composite (Newman-Keuls $p < .05$).

Poser 13. The rating for the non-composite was significantly greater than the left or right for the "front" group only. Within stimuli comparisons indicate that the differences between the "front" and "back" groups were significant for the left and right-composites but not for the non-composite (Newman-Keuls $p < .05$).

Rating Session By Composite:

Poser 13. The difference between left and

right-composites was significant for the first but not the second rating. The difference between the first and second rating sessions was significant for the non-composite but not for the right or left-composites (Newman-Keuls $p < .05$). See Figure 17.

Sequence By Sex By Rating Session By Composite (See Figure 19):

Poser 3. No meaningful patterns were revealed by analysis of this interaction.

Poser 12. For the male "back" group the difference between ratings of the first and second session differed significantly for the left-composite but not for the right or non-composite. This was not the case for the male "front" group nor for either of the female groups (Newman-Keuls $p < .05$).

NEUTRAL

MAIN EFFECTS

There were no significant effects for the rating session or sequence factors. However, the patterns of ratings as a function of rating session and stimulus order for each poser are presented in Figures 20 and 21 so that comparisons with the patterns obtained with sad and happy

ratings are possible.

Sex:

In contrast to the pattern obtained for happy and sad, for the majority of posers male ratings were more intense than female ratings as shown in Figure 22. However, the difference reached a reliable level of significance only for Poser 7.

Composite:

Posers 7, 10 & 12. Left-composites were perceived as portraying more intense expressions than right-composites.

Poser 1, 2, 3 & 5. Right-composites were perceived as portraying more intense expressions than left-composites.

Of the six remaining posers for whom the difference between the left and right-composite did not reach a reliable level of significance, five were associated with more intense left-composites.

In total, as shown in Figure 23, eight posers were perceived as portraying more intense left-composite expressions and five with more intense right-composites. This difference is not significant.

INTERACTION EFFECTS

Sex By Rating Session:

Poser 12. For males, ratings for the first and second

session did not differ significantly but for females the ratings were significantly more intense on the second rating. The interaction also indicates that male and female ratings did not differ during the first session but females generated more intense ratings than males on the second session (Newman-Keuls $p < .05$). See Figure 24.

Sequence By Rating Session:

Poser 5. The "backwards" group generated more negative ratings on the first session. For the front group, the difference between first and second ratings was smaller and more negative than on the second rating (Newman-Keuls $p < .05$). See Figure 25.

Sex By Composite:

Poser 6. Within sex comparisons indicate that the difference between left and right-composite ratings was significant for males but not for females. Within composite comparisons indicate that males and females differed in their ratings of right-composite but not of left or non-composites (Newman-Keuls $p < .05$). See Figure 27.

Sequence By Composite (See Figure 26):

Poser 10. Within composite comparisons indicate that the two sequence groups generated significantly different ratings for non-composites but not for left or

right-composites. Within group comparisons indicate that left-composite ratings were significantly more intense than right-composite ratings for the "front" but not for the "back" group (Newman-Keuls $p < .05$).

Poser 7. For the "front" group, ratings for left and right-composites were significantly different while for the "back" group the difference was not significant. Within composite comparisons indicate that the difference for the two groups was significant for the right-composite but not for the left or non-composite (Newman-Keuls $p < .05$).

Rating Session By Composite:

Poser 13. The difference between left and right-composite ratings was significant for the first but not the second rating session. Within composite comparisons indicate that for the left and non-composite there was no difference between the first and second rating session. However, for the non-composite there was a significant difference between the first and second ratings (Newman-Keuls $p < .05$).

Poser 3. The difference between left and right-composite ratings was significant for the second but not the first rating session. The difference between right and non-composites was significant for the second but not

the first rating session. Within composite comparisons indicate that the difference between the first and second sessions was not significant for any of the composites (Newman-Keuls $p < .05$) See Figure 28.

Sequence By Time By Composite:

Sex By Sequence By Time By Composite:

No meaningful patterns were revealed through an analysis of these higher-order interactions which are displayed in Figures 29 and 30.

Discussion

The results of the analyses with the intensity data can be summarized as follows:

1. The three expressions were reliably perceived as portraying the different affect dimensions intended by the posers. This was reflected by finding that the great majority of the ratings for 'sad' expressions were negative while 'happy' expressions were positive and 'neutral' expressions were only minimally positive or negative.

2. For each poser composite combination neutral ratings differed significantly from sad or happy ratings.

3. In keeping with the findings that happy expressions were associated with positive ratings, sad expressions with negative ratings and neutral expressions with neutral ratings, the emotion factor accounted for a large portion of the variance in the ratings.

4. A large proportion of the variation in the data set was also attributable to the Poser factor. The greatest amount of Poser variation occurred for the sad expressions and the least for happy.

5. The results of the ANOVAs indicated that there was substantial variability in the data set. Depending upon the poser and emotion, ratings could vary as a function of sex

of rater, stimulus order, rating session, and complex interactions among these. While these findings are of interest they are peripheral to the experimental hypotheses under examination.

6. For sad expressions, left-composites were associated with more consistent negative ratings than right-composites. In addition, in a comparison of the intensity of left and right-composites, higher intensity ratings occurred more frequently for left-composites. Nevertheless, there was no difference between the overall mean intensity ratings for left and right-composites.

7. For happy, there was no difference in the frequency of cases more often choosing left or right-composites as more intense. In addition, no difference was found in a comparison of the overall mean intensity ratings for left and right-composites.

8. For neutral, there was a significantly greater proportion of cases for which left-choices were more frequent than right-choices. Nevertheless, the overall mean intensity ratings for left and right-composites did not differ significantly.

9. For each of the three expressions, there was no significant difference in the number of posers for whom the

left was judged to be more intense than the right-composite. This was the case whether the comparisons were based on the magnitude of the intensity ratings or on the number of cases more often rating the right or left as more intense.

These findings can be interpreted as supporting the notion of a right-hemispheric predominance in the production of negative expression. However, although the data can be interpreted in this way, the findings from this experiment, as well as those reported elsewhere, are somewhat complex and need to be examined within the context of certain methodological and theoretical constraints.

The first consideration has to do with what measurement is used to determine differences in perceived intensity of left and right-composites. Essentially two types of measurements have been used. One type involves a forced-choice technique in which a left or right choice is made and the number of associated responses are calculated. The second technique compares the magnitude of the intensity ratings given to left and right-composites.

While differences between left and right-composites have been found using both techniques, the bulk of the literature has used some variant of the forced-choice method. For example, the findings reported by Ekman (1981),

Rinn (1982), Campbell (1978) and Heller & Levy (1981) and Borod (1980; 1983) have all depended upon making a left or right choice. Sackeim & Gur (1978) and Zeidler, Brozgold, Rosen & Gerstman (1982) reported differences using the intensity rating technique.

In the current study both measurements were used leading to somewhat discrepant results for the sad and neutral expressions. Whereas there was a greater frequency of left-more-intense than right-more-intense choices, the mean intensity values for the composites did not differ. The implication is that the forced-choice frequency method may be more sensitive to differences than a mean comparison method. It is of interest to note that a similar pattern of results were obtained in earlier studies (Zeidler, Brozgold, Rosen & Gerstman 1982), although a between subject comparison and not a within subject comparison was made. That is, the mean rating technique was used with one sample and the forced-choice technique with another sample. In these experiments it was found that whereas the mean intensity rating for left and right-composites did not differ (for particular emotions), the number of subjects making right and left choices (for those same emotions) did differ significantly.

In conclusion, it is important to note that different patterns of results may be obtained using different measurement techniques. Subsequent research should be sensitive to these issues when drawing conclusions as different ways of handling data may lead to different data-based inferences.

The second issue to consider has to do with examining the results as reflected by the number of posers that show the left-face effect. In the current study, the number of posers showing the left-face effect was not significant for any of the expressions, even when a left-preference among subjects was obtained over all posers. This finding is not atypical though it perhaps has not received enough attention. For example, the Campbell (1978) and Heller & Levy (1981) studies are often cited as supporting the notion of a RH predominance in facial expression. In both these studies the number of posers showing the left-face effect was not significant. On the other hand, a majority of posers showing the effect has been reported by several studies (Borod & colleagues, 1981,1983; Rinn, 192; Sackheim & Gur, 1978).

Since a substantial proportion of subjects do not show the effect, individual differences may be an important

issue for subsequent research. Most studies to date have controlled broad subject variables such as sex and handedness finding individual variation even within these groups. Another factor that might contribute to the occurrence of individual variation has to do with strategies that posers adopt in order to generate expressions. For example, although in this study we examined only 'posed' expressions, posers may have differed in the strategies they used to produce the posed expressions. Some posers may have tried to deliberately move facial muscles based on a visual image of the expression while others may have attempted to recreate the feeling correlated with the expression.

The experimental literature does not speak to the issue of strategy per se. However, differences in asymmetry associated with posed and spontaneous or voluntary and involuntary expressions have been considered.

The findings from behavioral neurology suggest that there is a dissociation between the neural pathways mediating voluntary and involuntary expression (Carpenter 1978; see review by Rinn, 1984). It has been observed that voluntary expressions of emotions may be disrupted while involuntary expressions are preserved.

The experimental literature with normal subjects is problematic. First, some studies have not clearly

differentiated the kinds of expressions being considered. For example, in Borod's study (1980) posers were presented with emotion-inducing contexts as well as visual cues and Levy & Heller (1981) used both posed and spontaneous smiles. Second, those studies that have explicitly controlled eliciting circumstance have generated inconsistent findings. For example, Borod (1983) found that both spontaneous and posed expressions were left-lateralized while Ekman (1980) suggested that spontaneous expressions were randomly lateralized.

The issue here is that what the literature has shown about spontaneous and posed or voluntary and involuntary expressions might speak to the possibility of differences related to the adoption of different kinds of posing strategies which in turn may lead to individual variation in samples. If patterns of asymmetry differ according to how an emotion is generated and if posers may adopt different strategies when posing then some of the individual variation reported in samples may be related to these strategies.

The issue of valence also deserves further consideration. The importance of valence as a variable was initially discovered when Sackeim reported that only certain negative expressions were associated with more intense mean ratings for left-composites. However, subsequently it was

pointed out that the difference was not only one of valence but one of eliciting condition. The happy expressions were spontaneous while the negative expressions were deliberate movements of facial muscle. Subsequent research has been inconclusive. Borod found that positively toned expressions were less lateralized than negative expressions in a study that did not clearly control the posing conditions. Many other studies (some using spontaneous some posed and some mixed posing circumstances) found that positive expressions were left-sided (Campbell 1978; Heller, & Levy, 1981; Rinn, 1982).

In summary, the findings reported in the current study may be interpreted as supporting the notion of a RH predominance for negative affective expression. However, since the number of posers showing the left-face effect was not significant for any of the expressions the more crucial implication seems to be that posers may adopt different posing strategies that may in turn effect lateral asymmetries. Since this issue has been barely touched upon in the literature, future research might do well to consider this variable. At present, although the bulk of the research suggests a left-face effect the issues of valence and eliciting condition have not been well enough controlled to support broad-based claims.

REACTION TIME EXPERIMENTS

The following analyses are based on the reaction time data for the facial identity (or person identity) discrimination and facial expression discrimination experiments. The analyses are applicable to only 'same' trials since RT values were not recorded for 'different' trials. For both sets of data, individual mean RT values were substituted for missing values. Missing values (or errors) were trials for which the subject had not responded by the arbitrary cut-off of three sec. Two comparable sets of analyses were performed. One was conducted using the raw values and one on a data set composed of log (base 10) transformed values in order to correct for positively skewed distributions.

Person Identity Discrimination

Results

Error Analysis

A 2 (sex) x 2 (order of RT task) x 5 (posers' faces) x 3 (composite) x 2 (visual field) with repeated measures on the last three factors was conducted on the error data. There were no significant main effects. However, the

difference in the error rates in the LVF (7%) and RVF (11%) was marginally significantly ($df=1,28$; $f=3.74$; $p=.06$). Of the interaction effects, only the Poser by Sex interaction was significant ($df=4,112$; $f=2.59$; $p<.05$) indicating that the error rates for the five faces varied according to sex as shown in Table 9. As is evident, the error rates for males and females were relatively equivalent for faces 5 and 3. For face 1, females generated more errors than males whereas for faces 2 and 4, males generated more errors than females.

Reaction Time

A repeated measures ANOVA using SEX (2) and ORDER of RT task (2) as between-subject factors and POSER (5), COMPOSITE (3), and FIELD (2) as within-subject factors was conducted. Since the between-subject factors sex and order did not produce any significant main or interaction effects, these variables were collapsed in a subsequent analysis. A summary of the ANOVA results is presented in Table 10.

A significant main effect for FIELD ($df=1,31$; $f=4.96$; $p=.034$) indicates that the mean overall response time for the LVF (696 msec) was significantly shorter than the mean response latency for the RVF (737 msec). A significant main

effect for POSER ($df=4,124$; $f=11.61$; $p<.001$) indicates that the mean response times for the five different faces varied from that yielding the shortest to the longest RT as follows: face 5, 3, 4, 2 and 1. Mean response times for the five faces and significant differences among them are presented in Table 11.

A significant POSER BY FIELD effect ($df=4,124$; $f=3.134$; $p=.018$) indicates that the LVF advantage did not obtain for each of the five faces. As is shown in Figure 32, two faces were associated with a significant left field advantage (faces 2 and 4), one with a nonsignificant left field advantage (face 1), and two with a nonsignificant right field advantage (faces 3 and 5).

It is also of interest to analyze this interaction by examining the within-field differences between faces that generated the significant LVF asymmetry and those that did not. In order to do this, Faces 2 and 4 which elicited the strongest LVF advantage were compared to Faces 3 and 5 which elicited nonsignificant right field advantages. As shown in Figure 32, the faces differed more strikingly in terms of RVF reaction time than LVF reaction time. That is, in a comparison of Face 2 with Faces 3 and 5, it was found that the LVF differed for Face 5 only but the RVF differed for

both Faces 5 and 3. Similarly, in the comparison of Face 4 with Faces 3 and 5 there were no differences among the LVF RTs though the RVF RTs were significantly different (Newman-Keuls $p=.05$). This finding suggests that left hemispheric processing is a crucial factor involved in differentiating faces that are associated with different patterns of asymmetry. That is, in comparing faces that are associated with different patterns of asymmetry, those faces showing a LVF advantage differed from those which did not show a LVF advantage by virtue of right field processing time and not left field processing time.

Discussion

The major finding from the person recognition experiment is that the LVF-RH was associated with a faster response latency than the RVF-LH but that this pattern is not consistent across stimulus faces.

The finding that the LVF-RH is associated with more efficient processing of faces is generally consistent with the bulk of the experimental literature using normal subjects (Rizzolati, 1971; Hilliard, 1973;). However, as indicated earlier, more recent research has suggested that patterns of laterality may vary according to task requirements, procedural manipulations and stimulus

characteristics. The task requirements and procedural manipulations used in this experiment, namely: (a) RT values based on same responses only, (b) a delay interval exceeding 100 msec between target and stimulus, and (c) a relatively short exposure duration, have been consistently associated with a LVF-RH effect (Sergent, 1983). It appears however, that even within these procedural and task requirements, different stimuli may generate different patterns of laterality. It is of interest then to explore the relationship between the stimulus characteristics and the pattern of laterality obtained.

Emotional saliency has been identified as one aspect of the stimuli that might influence patterns of asymmetry. It has been suggested that the LVF-RH advantage in facial processing is related to the emotional processing capabilities of the RH and to the face as an emotionally salient stimulus. For example, Suberi & McKeever (1979) found that the LVF advantage in a facial recognition task was more pronounced for faces that displayed affective as compared to neutral expressions. McKeever & Dixon (1983) subsequently found that only faces idiosyncratically perceived as emotional generated a LVF advantage. More specifically, subjects who perceived faces as emotional

showed a more pronounced LVF advantage than subjects who perceived faces as non-emotional. If emotional saliency is related to an LVF advantage, then it may be that the stimuli in this experiment which most strongly elicited a LVF effect were more emotionally salient stimuli. Since the subjects had rated the intensity of the expressions this hypothesis could be examined.

In one analysis overall mean intensity ratings for the five stimulus faces were correlated with the overall field asymmetry scores associated with those faces. When the faces were ranked from the most negatively-toned to the most positively-toned there was little relationship between intensity and field asymmetry (Spearman $r=.500$, $p=.196$). In Figure 33 it can be seen that the two most negatively-toned faces actually elicited nonsignificant RVF advantages, whereas the two faces associated with the greatest LVF advantage were only intermediate in negatively-toned intensity. In another analysis, the relationship between intensity and field asymmetry was examined across subjects and not according to faces. It was hypothesized that those subjects perceiving the stimuli as more intense would yield greater asymmetry scores. For each subject an intensity score was calculated which represented the sum of all the

ratings across the three composites and five posers' faces. These intensity scores were then correlated with the overall asymmetry scores (RVF-LVF). If intensity (regardless of positive or negative valence) is related to the magnitude of the LVF advantage (and if intensity is represented as most negative to most positive while RT is represented as increasing difference scores), then a U-shaped function would be expected. However, it is also possible that the relationship might be such that the more negative the intensity the greater the RVF-LVF difference score. In that case a negatively-sloped function would be expected (if RT was expressed as moving from negative to positive from the origin and intensity was expressed as moving from negative to positive). The actual function, shown in Figure 34, resembled neither of these hypothetical functions. A Spearman rank-order correlation generated a very low and nonsignificant correlation (Spearman $r=.055$ $p=.331$) between the intensity and field asymmetry scores. The analysis was also performed using only those subjects with negative intensity scores and the correlation was again very low and not statistically significant.

Both sets of analyses then suggest that emotional saliency was not related to field asymmetry. Moreover, the

pattern reflected in the visual field by face interaction found in the ANOVA also suggested that emotional processing was not the crucial factor differentiating faces associated with different patterns of asymmetry. If the hypothesized effect of emotion is to enhance right field processing time then it would have been expected that the more emotional faces would have yielded faster right field times than the other faces. However, as shown in the interaction it was the left field times that differed and not the right field times. That is, whereas the stimulus faces that elicited the right field advantage could be differentiated from the other faces by virtue of processing time in the right field, the left field processing times were not significantly different. It could be argued then that some faces show a relative RVF-LH advantage or disadvantage. Given the finding that faces did not differ with respect to right hemispheric processing time, the argument that emotion augments the right hemisphere advantage would be irrelevant. In sum, both the pattern of the interaction and the results obtained with the correlations suggested that emotion was not a significant factor in affecting patterns of asymmetry.

The process of facial discrimination may involve any number of cues that do not necessarily include the emotional

saliency of the expression. While this set of photographs were cropped at the neck and posers wore caps to eliminate peripheral cues to recognition, the faces did vary according to facial characteristics such as eyebrow, mouth, general contour, coloring, etc. Consequently, based on these characteristics, the faces may have differed in their levels of discriminability and the strategies used for recognition may have also varied across stimulus faces. Moreover, it may be that these structural components, by influencing the strategies used for discrimination, outweighed any influence of emotion.

The two stimulus faces that were most aberrant in terms of a LVF advantage were associated with the lowest mean response times and the lowest error rates suggesting that they were the most easily recognizable. Visual inspection of these faces indicated that they were most different from the others in terms of general facial contour, skin color and other prominent features such as eyebrows. It may be then that, related to these characteristics, the cognitive processes involved in matching these faces were qualitatively different than those involved with the other faces. We can speculate on two possibilities.

The first possibility involves specifying differences

in hemispheric processing of visual-spatial material according to interactions among task parameters such as stimulus characteristics, delay interval, and exposure duration. It may be, as Sergent (1983) has suggested, that the relative efficiency of RH and LH processing depends upon complex interactions among these variables. Specifically, it might be that differential RH/LH efficiency is less pronounced for discriminations where, holding exposure duration and delay interval constant, less information is needed for the match. If those faces associated with lower RT and errors did require less information, then according to this hypothesis, it would be expected that the RH superiority would be less pronounced. Moreover, it might also be expected that this pattern would be related to an improvement in LH more than RH efficiency.

Alternately, it may be that certain faces are more readily processed using a verbal mediation or analytic feature detection strategy. Patterson & Bradshaw (1975) for example showed that schematic faces differing according to one stimulus feature were associated with an LH advantage while faces that varied according to several features were associated with an RH advantage. In a series of studies Proudfoot has shown that visual field asymmetries may vary

according to different encoding strategies which presumably influence processing strategies employed by subjects (Galper & Costa, 1980; Proudfoot, 1982).

In sum the major finding of this study, that the LVF-RH is associated with generally more efficient facial processing, was expected and is consonant with the bulk of the literature. However, the results also suggest that patterns of asymmetry vary according to complex interactions among task requirements, procedures and stimulus characteristics. Emotional saliency may be only one aspect of those characteristics and did not influence the pattern of laterality obtained.

Expression DiscriminationResultsError Analysis

A 2 (sex) x 2 (order of RT task) x 2 (field) x 3 (composite) x 5 (poser) x 3 (emotion) ANOVA with repeated measures on the last four factors was conducted on the 'same' errors.

A significant main effect for FIELD ($df=1,28$; $f=5.1$; $p=.03$) indicates that there were fewer errors in the LVF (10.5%) than the RVF (14%). A significant main effect for POSER ($df=4,112$; $f=5.85$; $p<.01$) indicates that that error rates across the five stimulus faces varied. Post hoc analyses (Newman-Keuls $P=.05$) showed that this effect was entirely due to the difference in error rates of Face 5 from Face 1,4, and 3. The error rate for face 5 was significantly less than these faces. There were no other significant differences among the error rates for the faces. A significant main effect for EMOTION ($df=2,56$; $f=1.5$; $p<.01$) indicates that the error rates for the three expressions differed as follows: sad = 8%, happy = 10% and neutral = 18%. Each is significantly different from the other (Newman-Keuls $p=.05$).

There were also several significant interaction

effects. The EMOTION by POSER ($df=8,224$; $f=5.85$; $p<.01$) and EMOTION by POSER by COMPOSITE ($df=16,448$; $f=2.02$; $p=.01$) interactions indicates that errors for emotion varied according to the poser and composite viewed. For example, for left-composites displaying a sad expression the order of the faces from the most to the least errors was as follows: face 4,1, 5, 2 and 3, whereas for right-composites displaying a sad expression the order was: face 1,5, 2,3 and 4 and for non-composites displaying a sad expression the order was face 4, 5, 1, 3 and 2. The SEX by EMOTION by FIELD interaction was also significant. Posthoc analysis revealed that females generated more errors than males in the RVF for neutral but not for happy nor sad. Nor were there sex differences in emotion in the LVF. Within sex comparisons indicated that males generated significantly more errors for neutral than happy in the LVF. For females, neutral errors were significantly greater than both happy and sad in the LVF. For both sexes there were no differences among the three emotions in the RVF.

Reaction Time Analyses

An ANOVA on the reaction time data using sex (2) and order of RT task (2) as between-subject factors and emotion (3), poser (5), composite (3) and field (2) as

within-subject factors was conducted. Because sex and order did not generate any significant main or interaction effects the ANOVA was repeated collapsing across these variables. A summary of the ANOVA results using raw data and log transformed values is presented in Table 12. The findings reported below are based on the results obtained with the log transformed values.

A significant main effect for FIELD ($df=1,31$; $f=6.03$; $p=.02$) indicates that the mean overall response time for the LVF (699 msec) was shorter than the mean overall response time for the RVF (719 msec).

A significant POSER effect ($df=4,124$; $f=8.309$; $p<.001$) indicates that response times for the five faces varied from the face eliciting the fastest to the slowest RT as follows: face 1, 5, 4, 2 and 3. The response times and significant differences are shown in Table 13.

A significant EMOTION ($df=2,62$; $f=54.77$; $p<.001$) effect indicates that the three different expressions were associated with different response times. The mean response time for 'happy' was shortest (656 msec) followed by sad (716 msec) and neutral (754). Each time is significantly different from the others (Newman-Keuls $p=.05$).

The significant POSER BY EMOTION ($df=8,248$; $f=7.805$;

$p < .001$) interaction suggests that the pattern of RT differences among posers was not consistent across the three expressions. RT differences among posers were more frequent for the sad expression and less frequent for the happy and neutral expression. For example, whereas RT for Poser 1's sad expression was significantly faster from Posers' 2 and 3 sad expressions there was no difference among these faces when neutral expressions were displayed.

The interaction also indicates that RT differences among expressions were not consistent across posers, even though the pattern was similar. For all posers' faces, happy expressions were responded to most quickly followed by sad and neutral. However, for Posers 1 and 4, RT for the sad expression was significantly different from RT for the neutral expression, whereas for Posers 2, 3 and 5, sad and neutral did not differ significantly. The interaction is displayed in Table 14.

A significant EMOTION BY COMPOSITE ($df=4,124$; $f=2.750$; $p < .001$) interaction indicates that the pattern of RTs for the composites was not consistent across expressions. For both sad and neutral expressions, there were no significant differences among the composites. For happy, left-composites were responded to more quickly than right or

non-composites. There was no difference between RT for right and non-composites.

Within each type of composite the pattern of RTs for the expressions was similar. Thus, for left, right, and non-composites, happy expressions generated the shortest latencies followed by sad and neutral. However, the difference in RT for sad and neutral was not significant for non-composites as it was for left and right-composites. The interaction is displayed in Table 15.

The significant POSER BY COMPOSITE ($df=8,248$; $f=2.934$; $p=.001$) interaction indicates that the pattern of RT differences among posers was not consistent across composite types. For right and non-composites there were no differences in RT among the posers. However, there were some RT differences among posers for left-composites as shown in Table 16.

It is of note that for each of the five posers there was no differences in RT among the three composite types.

The EMOTION BY POSER BY COMPOSITE interaction ($df=16,496$; $f=2.155$; $p=.006$) indicates that the pattern of rank ordering of composites by posers was not consistent across emotion types.

Laterality Differences For Different Expressions

The presence of a significant field effect indicated that the discrimination of facial expression was achieved more quickly in the LVF than the RVF. The absence of a field by emotion interaction ($df=2,62$; $f=.605$; $p>.50$) further suggested that the pattern of laterality did not vary as a function of the positive/negative valence of the expression. However, even though this interaction failed to reach significance, an examination of the mean asymmetry for the different expressions suggested differences in the magnitude of the LVF advantage. For example, there was a two msec advantage for sad expressions, a 16 msec advantage for happy expressions and a 42 msec advantage for neutral. In order to further investigate these differences separate ANOVAs were performed for each emotion. A summary of the ANOVA results is summarized in Table 17.

The results indicated that the field effect reached a reliable level of significance for the neutral expression ($df= 1,31$; $f=5.149$; $p=.031$) but not for the happy ($df=1,31$; $f=3..521$; $p=.071$) or sad ($df=1,31$; $f=1.077$; $p=.308$) expressions. For the happy expressions there was a significant field by composite interaction ($df=2,62$; $f=3.567$; $p=.034$). Analysis of this finding indicated that

right-composites elicited a significant LVF advantage but left and non-composites did not. Right-composites generated a 49 msec left visual field advantage, left-composites generated a four msec right field advantage and non-composites a four msec left field advantage.

Intensity Ratings And Reaction Time Data

Several analyses were performed in order to investigate the relationship between visual field asymmetry associated with the perception of facial expression and emotional intensity. Specifically, these analyses were conducted in order to determine: (a) if subjects who perceived stimuli as more emotional in free-view showed a greater LVF advantage in the tachistoscopic perception task, and (b) if field asymmetries elicited by stimuli were sensitive to the emotional saliency of those stimuli.

Two related analyses were performed in order to investigate whether subjects who perceived stimuli as more intense showed more asymmetrical processing. Both of those depended upon the creation of an intensity-sum score which was derived from the intensity ratings.

For each subject an intensity score was calculated which represented the sum of that subject's intensity ratings across all 15 tachistoscopic stimuli (five posers x three

composites). Each subject, therefore, had an intensity-sum score for happy, sad and neutral. These intensity-sum scores were used as the basis for creating a between-subject factor.

Subjects were divided into two groups: (a) HIGH raters, and (b) LOW raters. Subjects whose intensity sum score was above the median score for the group were classified as HIGH raters, while those with intensity scores below were classified as LOW raters.

Using this new intensity score as a between-subject factor, ANOVAs were conducted as before. Thus, two 2 (intensity sum) x 5 (poser) x 3 (composite) x 2 (visual field) ANOVAs were conducted; one for happy RT and one for sad RT. An ANOVA for neutral was not conducted because the intensity sum scores included both negative and positive values. Therefore, dividing the group at the median would not have produced two subgroups of HIGH and LOW raters.

It was expected that there would be a significant interaction between intensity rating group and visual field such that HIGH raters would show a more pronounced LVF advantage. For both the happy and sad analyses, there was no main effect for this factor (sad : $df=1,30$; $f=.049$; $p>.50$; Happy: $df=1,30$; $f=.003$; $p>.50$). For the sad analysis

the interaction of this factor with visual field clearly failed to reach significance ($df=1,30$; $f=.032$; $p>.50$). In view of the results to be reported below however, it is important to note that this interaction was marginally significant for the HAPPY analysis ($df=1,30$; $f=3.495$; $p=.07$). Examination of the nature of the relationship showed that the HIGH group actually showed a less pronounced LVF advantage than the LOW group.

In the second analysis, the intensity-sum scores were correlated with the field difference scores (RVF-LVF) in order to see if the intensity sum score could predict the degree of asymmetry. The correlations for the SAD and NEUTRAL analyses were very low and nonsignificant (Spearman $r=.14$, $p=.224$ sad; Spearman $r=-.215$, $p=.119$ neutral). These are illustrated in Figures 35 and 36. For happy however, there was a slight but significant correlation (Spearman $r=-.34$, $p<.03$). The negative relationship suggested that the higher the intensity sum score the less pronounced the LVF advantage. Figure 37 illustrates this negatively-sloped relationship and presents the corresponding Pearson correlation values which are just short of significance.

The second analysis was conducted in order to determine whether there was a relationship between the emotional

saliency of the stimuli and the magnitude of the field asymmetry elicited by that stimulus. In order to do this the overall mean intensity rating for the five stimulus faces were correlated with the mean field asymmetry score elicited by the faces. The correlations presented in Table 18 were low and not significant suggesting that emotional saliency was not a good predictor of visual field asymmetry.

Discussion

The results of the expression discrimination experiment can be summarized as follows:

1. There was an overall LVF advantage in discriminating facial expressions, suggesting an RH superiority for the perception of facial affect.
2. Visual field asymmetries did not vary as a function of the positive/negative valence of the expression.
3. A more pronounced LVF-RH advantage was obtained for the discrimination of neutral as compared to happy and sad expressions.
4. The emotional salience of the stimuli did not affect the magnitude of the visual field difference.
5. For happy expressions there was marginal relationship between subjects' ratings of emotional intensity in free-view and the magnitude of the field

advantage in the expression discrimination. Subjects who gave relatively higher intensity ratings showed a less pronounced LVF advantage.

The findings of an overall LVF advantage and no variation of visual field asymmetry as a function of emotional valence is consistent with previous research which used a similar paradigm (Ley & Bryden, 1981; Strauss & Moscovitz, 1981; Safer, 1983). The mechanisms involved in this effect are not clear, although two hypotheses can be explored.

One hypothesis is that the RH superiority in the perception of expression is related to the emotional processing capabilities of the right hemisphere. This conclusion derives from: (a) Ley & Bryden's findings that field asymmetries for matching neutral expressions were less pronounced than field asymmetries for extreme emotional expressions, (b) inferentially based on the RH involvement in emotion as ascertained from other lines of research, and (c) from facial perception studies showing that the RH advantage in facial identity perception could be augmented if the stimuli were emotional expressions or perceived as emotional.

The results obtained here, while supporting the notion

of an RH predominance in the perception of facial expression, are not entirely consistent with the emotional processing hypothesis. First, neutral expressions and not emotional expressions generated more pronounced visual field asymmetry. Second, the emotional saliency of the stimuli (particularly happy and sad stimuli) was not related to the visual field asymmetry. Third, the perception of emotional intensity did not affect field asymmetry. That is, subjects who perceived stimuli as more intense in free view did not show enhanced RVF advantages.

An alternate, though not necessarily mutually exclusive hypothesis, is that visual field asymmetries may be related to characteristics of the stimuli that are not associated with emotionality per se. Pizzamiglio et al.(1983) have tried to account for laterality patterns by examining the complexity of the facial expression. These researchers found that subjects, classified as having a field independent cognitive style on the basis of performance on the Rod and Frame and Embedded Figures tests, showed different patterns of laterality depending upon the type of expression. A LVF advantage was obtained for disgust and fear, an RVF advantage for anger, and no difference for happiness and sadness. Clearly the different patterns could

not be accounted for by the positive/negative valence of the expression.

They hypothesized that 'expression complexity' might be related to asymmetry patterns such that more complex expressions would yield an LVF advantage whereas less complex expressions would be discriminated equally well. In order to examine this hypothesis a correlation between facial complexity and visual asymmetry was conducted. Facial complexity was defined as the number of facial units involved in the expression (according to Ekman's FACS scoring procedure). The results indicated that there was in fact a very low and nonsignificant correlation between the two measures.

Although this idea is an interesting one, interpretation of these findings is problematic. The difficulty is that there was no independent corroboration that the number of facial units was an adequate measure of expression complexity. There may not be a linear relationship between the number of units and the complexity of the expression. For example, a particular combination of units may result in a more complex expression than some other combination which uses the same number of units. Further analysis along these lines may uncover a relationship that was masked in this

analysis.

In a similar vein, Reuter-Lorenz et al.(1983) have suggested that opposing patterns of laterality obtained for the discrimination of happy and sad might be related to differential involvement of the hemispheres in analyzing stimulus features and not to emotional processing per se. These researchers suggested that happy discriminations might involve an analysis of the lower half of the face whereas sad discriminations may involve an analysis of the entire face. Further investigation will be necessary in order to answer these questions.

At this point it is possible only to speculate about the stimulus differences involved in the discrimination of happy, sad and neutral expressions. For sad the discrimination may involve primarily the analysis of the top (furrowed eyebrows) or bottom (corners of the mouth) portions of the face and not the entire face as suggested by Reuter-Lorenz (1983). Happy discriminations may also involve the top and bottom portion of the face but the bottom may be a more salient cue. Neutral discriminations may require an analysis of the entire face. It may be that the LH can be efficient when limited stimulus cues are required to make the discrimination. While this explanation

would to some extent explain the pattern of results obtained in this experiment it does not readily account for the findings obtained elsewhere.

In conclusion, the findings reported here are consistent with previous research investigations suggesting a right hemispheric superiority for facial expression perception. However, the underlying mechanisms remain unclear. These findings do not strongly support an emotional processing explanation. Additional research is needed to explore the relationship between stimulus characteristics and the emergence of hemispheric asymmetries.

The Relationship Between Person Identity Discrimination And
Expression Discrimination

Results And Discussion

These analyses were conducted in order to investigate the relationship between laterality patterns and general differences in processing time for the two perceptual tasks. The data for these analyses consisted of four RT scores (log values) for each of the 32 subjects: mean LVF for Person discrimination, mean RVF for Person discrimination, mean LVF for Expression discrimination, mean RVF for Expression discrimination.

A 2 (task) x 2 (field) repeated measures ANOVA was performed in order to investigate whether the tasks could be differentiated in terms of overall processing time or in patterns of asymmetry. A significant FIELD effect ($df=1,31$; $f=8.373$; $p=.007$) indicates that, across both tasks, response time in the LVF was faster than in the RVF. The task effect ($df=1,31$; $f=.028$; $p<.50$) was not significant suggesting that the tasks could not be differentiated in terms of overall processing time. The task by visual field interaction ($df=1,31$; $f=.294$; $p>.05$) was not significant either indicating that the tasks could not be differentiated in terms of the magnitude of the left visual field effect.

In order to investigate individual patterns of asymmetry demonstrated for the two tasks, the direction of the field advantage was determined for each subject. The superior field was defined as that field with the faster RT regardless of the magnitude of the difference. The results revealed that 17 subjects showed consistencies in the direction of asymmetry. Twelve showed a superior LVF for both tasks and five a superior RVF. Fifteen subjects showed contrasting patterns for the two tasks.

Further analyses were conducted in order to examine the relationship between the degree of asymmetry demonstrated for the tasks. Since the variable of interest was degree, only those subjects who showed the same direction were used in the analysis. A Pearson correlation between the difference scores for each task indicated that the degree of asymmetry demonstrated for one task was related to the degree of asymmetry shown for the other ($r=.47$, $p=.03$).

These findings suggest the following:

1. Individuals may show contrasting laterality patterns for emotion and person discrimination suggesting that the mechanisms involved may be dissociable. This finding is consistent with previous research suggesting that the tasks are dissociable (Ley & Bryden, 1981; Pizzamiglio et al.,

1983; Strauss & Moscovitch, 1981).

2. When individuals do show consistent patterns of asymmetry the magnitude of the asymmetry for one task is related to the magnitude of the other. This aspect of the relationship has not been addressed previously. It does suggest that these functions are similarly lateralized for a large subset of subjects.

The Relationship Between Perceptual And Expressive AsymmetryResults And Discussion

There were nine subjects for whom measures of both expressive and perceptual asymmetry were available. Measures of expressive asymmetry were based on the intensity ratings elicited by their right and left-composites. Measures of perceptual asymmetry were based on the RT values these posers exhibited in the emotion-discrimination perceptual task. These analyses were conducted in order to determine whether: (a) there was a concordance in the direction of asymmetry exhibited for perceptual and expressive tasks, (b) the magnitude of asymmetry in one task was related to the magnitude demonstrated for the other task, and (c) whether subjects who generated more intense expressions showed more asymmetrical perceptual processing.

The first analysis was performed in order to examine patterns in the direction of perceptual and expressive asymmetry. Table 19 shows the direction of perceptual and expressive asymmetry for each subject within each emotion category. As is evident from the data, the direction of asymmetry was consistent for six of the nine for sad, five of the nine for happy and three of the nine for neutral. These frequencies are not significant.

The second analysis was performed in order to examine the relationship between the degree of expressive and perceptual asymmetry. For these analyses only subjects who showed consistency in the direction of asymmetry demonstrated for perception and expression were used. Subjects were ranked in terms of the magnitude of asymmetry exhibited for both tasks and rank-order correlations were conducted. For both happy and sad the correlations did not reach a reliable level of significance. (sad: Spearman $r=.60$ $p=.10$; happy: Spearman $r=.10$ $p=.44$). Correlations were not computed for neutral since only three subjects showed consistencies in the direction of lateralization.

In order to investigate whether subjects who generated more intense expressions demonstrated larger asymmetries in perception, rank-order correlations between the mean intensity ratings and the mean difference score (RVF-LVF) for each emotion were conducted. Again, the relationship between the variables was very low and nonsignificant (See Table 20).

In sum, these findings suggest the following:

1. The direction of asymmetry for perception and expression may vary within an individual. The number of subjects showing concordance in the direction of asymmetries

for the two tasks was not significant.

2. When subjects do show consistencies in the direction of lateralization for the two tasks, the magnitude of asymmetry for one is not related to the magnitude exhibited for the other.

3. Subjects who generate more intense emotional expressions do not necessarily show a more pronounced LVF advantage in perception.

TABLE 1

The Percentage of Positive, Negative or Neutral Ratings for Each Poser and Composite Within an Emotion Category

	<u>SAD</u>			<u>NEUTRAL</u>			<u>HAPPY</u>		
	Left Comp	Right Comp	Non Comp	Left Comp	Right Comp	Non Comp	Left Comp	Right Comp	Non Comp
Poser 1	100	95	95	83	78	77	100	100	100
Poser 2	98	100	100	100	80	91	98	100	100
Poser 3	94	97	94	86	83	92	100	100	100
Poser 4	100	100	98	89	91	88	100	100	100
Poser 5	97	95	97	78	72	81	98	100	98
Poser 6	97	94	97	94	94	89	98	100	100
Poser 7	91	98	94	55	73	67	100	100	100
Poser 8	98	98	98	83	89	88	98	97	100
Poser 9	98	97	97	94	98	97	100	98	98
Poser 10	92	72	78	69	88	81	98	100	100
Poser 11	98	98	100	94	97	95	100	100	100
Poser 12	100	91	97	28	59	48	98	100	100
Poser 13	89	83	84	92	91	89	100	100	100

percent negative ratings

percent neutral ratings

percent positive ratings

TABLE 2

The Percentage of Positive, Negative or Neutral Ratings for Each Composite Group Within an Emotion Category

	<u>SAD</u>			<u>HAPPY</u>			<u>NEUTRAL</u>		
	<u>Left Comp</u>	<u>Right Comp</u>	<u>Non Comp</u>	<u>Left Comp</u>	<u>Right Comp</u>	<u>Non Comp</u>	<u>Left Comp</u>	<u>Right Comp.</u>	<u>Non Comp</u>
Poser 1	64	61	61	64	64	64	53	50	4 ^a
Poser 2	63	64	64	63	64	64	64	51	58
Poser 3	60	62	60	64	64	64	55	53	59
Poser 4	64	64	63	64	64	64	57	58	56
Poser 5	62	61	62	63	64	63	50	46	52
Poser 6	62	60	62	63	64	64	60	60	57
Poser 7	58	63	60	64	64	64	35	47	43
Poser 8	63	63	63	63	62	64	53	57	56
Poser 9	63	62	62	64	63	63	60	63	62
Poser 10	59	46	51	63	64	64	44	56	52
Poser 11	63	63	64	64	64	64	60	62	61
Poser 12	64	58	62	63	64	64	18	38	31
Poser 13	<u>57</u>	<u>55</u>	<u>54</u>	<u>64</u>	<u>64</u>	<u>64</u>	<u>59</u>	<u>58</u>	<u>57</u>
Sum	802	780	788	826	829	830	668	699	693
Percent	96	94	95	99	99	99	80	84	83

TABLE 3

The Percentage of Cases Rating All 13
Instances of a Composite Group As
Negative, Positive, or Neutral

		<u>SAD</u>		
		<u>Left</u>	<u>Right</u>	<u>Non</u>
N		43	30	34
%		67	47	53
		<u>HAPPY</u>		
		<u>Left</u>	<u>Right</u>	<u>Non</u>
N		59	61	62
%		92	95	97
		<u>NEUTRAL</u>		
		<u>Left</u>	<u>Right</u>	<u>Non</u>
N		11	16	16
%		25	26	25

TABLE 4

Summary Table of the Results
of the Anovas Conducted on the SAD
Ratings for Each Poser

Source	Poser 1	Poser 2	Poser 3	Poser 4	Poser 5	Poser 6	Poser 7	Poser 8	Poser 9	Poser 10	Poser 11	Poser 12	Poser 13
Sex				047					012				
Stim. Order		03											
Sex by Stim. Order													
Rating Session				006		041			018				
Sex by Rate Session				036						02			
Stim. Ord.by Rate Sess.					008								
Sex by Stim. Ord. by Rate Sess.													
Composite	001	01		013		003	001	001	002	002			
Sex by Comp.						007							
Stim. Ord. by Comp.			014			003			001			004	
Sex by Stim. Ord. by Comp.									045				
Rate Sess. by Comp.							011						
Sex by Rate Sess. by Comp.													
Stim. Ord. by Rate Sess. by Comp.													
Sex by Stim. Ord. by Rate Sess. by Comp.													

The numbers in the Table are the significant p values. Values not appearing are p values $>.05$.

TABLE 5

Summary Table of the Results
of the Ancovas Conducted on the HAPPY
Ratings for Each Poser

SOURCE	Poser 1	Poser 2	Poser 3	Poser 4	Poser 5	Poser 6	Poser 7	Poser 8	Poser 9	Poser 10	Poser 11	Poser 12	Poser 13
Sex													
Stim. Order													
Sex by Stim. Order													
Rating Session	009	003		003				042			008	031	009
Sex by Rate Session													
Stim. Ord. by Rate Sess.		013											
Sex by Stim. Ord. by Rate Sess.													
Composite		043	039	014			017	013		005			023
Sex by Comp.													
Stim. Ord. by Comp.		037					030			026	008	001	
Sex by Stim. Ord. by Comp.													
Rate Sess. by Comp.													033
Sex by Rate Sess. by Comp.													
Stim. Ord. by Rate Sess. by Comp.													
Sex by Stim. Ord. by Rate Sess. by Comp.												029	

The numbers in the Table are the significant p values. Values not appearing are p values $>.05$.

TABLE 6

Summary Table of the Results
of the Anovas Conducted on the NEUTRAL
Ratings for Each Poser

SOURCE	Poser 1	Poser 2	Poser 3	Poser 4	Poser 5	Poser 6	Poser 7	Poser 8	Poser 9	Poser 10	Poser 11	Poser 12	Poser 13
Sex													032
Stim. Order													
Sex by Stim. Order													
Rating Session													
Sex by Rate Session													016
Stim. Ord. by Rate Sess.					006								
Sex by Stim. Ord. by Rate Sess.													
Composite	003	017	047		007		038			001		001	
Sex by Comp.							049						
Stim. Ord. by Comp.							014			001			
Sex by Stim. Ord. by Comp.													
Rate Sess. by Comp.			045										050
Sex by Rate Sess. by Comp.													
Stim. Ord. by Rate Sess. by Comp.				016								026	
Sex by Stim. Ord. by Rate Sess. by Comp.													

137

The numbers in the Table are the significant p values. Values not appearing are p values > .05.

TABLE 7

Number of Cases Showing Left/Right Preferences
Summed Over All Posers

<u>SAD</u>	No. of Cases Choosing Left>Right =	35	
	No. of Cases Choosing right>left =	<u>20</u>	
	Total =	55	p < .05
<u>HAPPY</u>	No. of Cases Choosing left>right =	32	
	No. of Cases Choosing right>left =	<u>27</u>	
	Total =	59	p > .05
<u>NEUTRAL</u>	No. of Cases Choosing Left>Right =	34	
	No. of Cases Choosing Right>Left =	<u>18</u>	
	Total =	52	p < .05

TABLE 8

The Frequency of Cases Showing
Left/Right Preferences Elicited by Each Force

<u>SAD</u>	<u>Left</u>	<u>Right</u>	<u>Total</u>		<u>P</u>
Poser 1	36	11	47	L	.01
Poser 2	16	29	45	R	.05
Poser 3	15	32	48	R	.01
Poser 4	28	15	43	L	<.05
Poser 5	23	15	38	L	.05
Poser 6	27	7	34	L	.01
Poser 7	7	46	53	R	.01
Poser 8	5	41	46	R	.01
Poser 9	30	9	39	L	.01
Poser 10	26	5	31	L	.01
Poser 11	20	11	31	L	.05
Poser 12	24	28	52	R	.05
Poser 13	20	19	39	<u>L</u>	.05
				8L	
				5R	

<u>HAPPY</u>	<u>Left</u>	<u>Right</u>	<u>Total</u>		<u>P</u>
Poser 1	23	16	39	L	.05
Poser 2	10	22	32	R	<.05
Poser 3	18	21	39	R	.05
Poser 4	28	11	39	L	.01
Poser 5	23	17	40	L	.05
Poser 6	23	24	47	R	.05
Poser 7	27	11	38	L	.01
Poser 8	16	26	42	R	.05
Poser 9	10	28	38	R	.01
Poser 10	12	19	31	R	.05
Poser 11	29	13	42	L	<.05
Poser 12	30	17	47	L	.05
Poser 13	30	13	43	<u>L</u>	.01
				<u>7L</u>	
				6R	

TABLE 8 (Cont'd)

<u>NEUTRAL</u>	<u>Left</u>	<u>Right</u>	<u>Total</u>		<u>P</u>
Poser 1	12	25	37	R	.05
Poser 2	5	26	31	R	.01
Poser 3	17	18	35	R	>.05
Poser 4	20	13	33	L	>.05
Poser 5	7	24	31	R	.01
Poser 6	12	6	18	L	>.05
Poser 7	29	15	44	L	.05
Poser 8	13	10	23	L	>.05
Poser 9	9	1	10	L	.05
Poser 10	33	7	40	L	.01
Poser 11	7	5	12	L	>.05
Poser 12	36	7	43	L	.01
Poser 13	10	13	23	R	>.05
				5R	
				8L	

TABLE 9

Errors for Person Discrimination as a
Function of Sex of Subject and Poser (

	Poser 1	Poser 2	Poser 3	Poser 4	Poser 5
MALES	6	16	5	10	5
FEMALES	<u>17</u>	<u>10</u>	<u>6</u>	<u>6</u>	<u>4</u>
Total	23	26	11	16	9

TABLE 10

Summary Table of Anova Results for
Person Discrimination

	<u>Raw Data</u>			<u>Log Transformed Data</u>	
	<u>df</u>	<u>f</u>	<u>p</u>	<u>f</u>	<u>p</u>
Poser	4,124	7.635	<.001	11.607	.001
Composite	2,62	1.399	.255	2.230	.117
Field	1,31	5.193	.030	4.955	.034
Poser x Comp.	8,248	.660	>.500	.614	>.500
Poser x Field	4,124	2.530	.044	3.134	.018
Comp. x Field	2,62	1.601	.210	.801	.454
Poser x Comp. x Field	8,248	1.262	.265	1.229	.283

TABLE 11

Mean RT for Each of the Five
Stimulus Faces in Person Discrimination

	<u>Raw Values</u> (MSEC)	<u>Log Transformed</u> Values
Poser 1	771	2.860
Poser 2	761	2.859
Poser 3	680	2.809
Poser 4	733	2.837
Poser 5	636	2.783

Significant Differences:

	1	2	3	4	5		1	2	3	4	5
1		NS	*	NS	*	1		NS	*	NS	*
2			*	NS	*	2			*	NS	*
3				NS	NS	3				*	NS
4					*	4					*

*p < .05 (Newman-Keuls)

TABLE 12

Summary Table for Repeated Measure Anova
Results for Emotion Discrimination

	<u>Raw Data</u>			<u>Log Transformed Data</u>	
	<u>df</u>	<u>f</u>	<u>p</u>	<u>f</u>	<u>p</u>
Emotion	2,62	32.337	.001	54.766	<.001
Poser	4,124	5.632	.001	8.309	<.001
Composite	2,62	1.832	.169	2.930	.061
Field	1,31	3.444	.074	6.031	.020
Emotion by Poser	8,248	5.338	.001	7.805	<.001
Emotion by Composite	4,124	1.729	.148	2.750	.032
Poser by Composite	8,248	2.934	.004	4.357	.001
Emotion by Field	2,62	1.677	.196	.605	>.500
Poser by Field	4,124	1.246	.296	1.815	.131
Composite by Field	2,62	1.370	.262	2.362	.103
Emotion by Poser by Comp.	16,496	1.699	.044	2.155	.006
Emotion by Poser by Field	8,248	.644	.500	.694	>.500
Emotion by Comp. by Field	4,124	.601	.500	1.205	.313
Poser by Comp. by Field	8,248	1.239	.277	1.708	.097
Emotion by Poser by Comp. by Field	16,496	1.605	.064	2.578	.071

TABLE 13

Overall Mean Response Time for the Five Stimulus
Faces in Emotion Discrimination

	<u>Raw Values</u> (MSEC)					<u>Log Transformed</u> Value					
Poser 1	687					2.815					
Poser 2	726					2.838					
Poser 3	739					2.846					
Poser 4	699					2.822					
Poser 5	694					2.818					
Significant Differences											
	1	2	3	4	5	1	2	3	4	5	
1		*	*	NS	NS	1		*	*	NS	NS
2			NS	*	*	2			NS	*	*
3				*	*	3				*	*
4					NS	4					NS

*p .05 (Newman-Keuls)

TABLE 14Poser by Emotion Interaction
For Expression Discrimination

<u>SAD</u>					<u>Poser 1</u>		
(2.803)	(2.862)	(2.867)	(2.817)	(2.816)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	*	*			SAD	*	NS
2			*	*	NEUT.		*
3			*	*			
4							
<u>NEUTRAL</u>					<u>Poser 2</u>		
(2.862)	(2.870)	(2.848)	(2.862)	(2.830)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	NS	NS	NS	*	SAD	NS	*
2		NS	NS	*	NEUT.	*	*
3			NS	NS			
4				*			
<u>HAPPY</u>					<u>Poser 3</u>		
(2.779)	(2.782)	(2.821)	(2.788)	(2.807)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	NS	*	NS	NS			
2		*	NS	NS	SAD	NS	NS
3			*	NS	NEUT.		NS
4				NS			
<u>SAD</u>					<u>Poser 4</u>		
(2.803)	(2.862)	(2.867)	(2.817)	(2.816)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	*	*			SAD	*	NS
2			*	*	NEUT.		*
3			*	*			
4							
<u>NEUTRAL</u>					<u>Poser 5</u>		
(2.862)	(2.870)	(2.848)	(2.862)	(2.830)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	NS	NS	NS	*	SAD	NS	NS
2		NS	NS	*	NEUT.	*	*
3			NS	NS			
4				*			
<u>HAPPY</u>					<u>Poser 6</u>		
(2.779)	(2.782)	(2.821)	(2.788)	(2.807)	<u>SAD</u>	<u>NEUT.</u>	<u>HAPPY</u>
<u>P1</u>	<u>P2</u>	<u>P3</u>	<u>P4</u>	<u>P5</u>			
1	NS	*	NS	NS			
2		*	NS	NS	SAD	NS	NS
3			*	NS	NEUT.		NS
4				NS			

* p .05 ≤ (Newman-Keuls)

TABLE 15

Emotion by Composite Interaction
For Emotion Discrimination

		<u>SAD</u>			<u>Left Comp.</u>		
	(2.829) <u>Left</u> <u>Comp.</u>	(2.832) <u>Right</u> <u>Comp.</u>	(2.839) <u>Non</u> <u>Comp.</u>		<u>HAPPY</u>	<u>SAD</u>	<u>NEUTRAL</u>
Left		NS	NS	HAPPY		*	*
Right			NS	SAD			*
		<u>HAPPY</u>			<u>Right Comp.</u>		
	(2.778) <u>Left</u> <u>Comp.</u>	(2.806) <u>Right</u> <u>Comp.</u>	(2.803) <u>Non</u> <u>Comp.</u>		<u>HAPPY</u>	<u>SAD</u>	<u>NEUTRAL</u>
Left		*	*	HAPPY		*	*
Right			NS	SAD			*
		<u>NEUTRAL</u>			<u>Non Comp.</u>		
	(2.855) <u>Left</u> <u>Comp.</u>	(2.857) <u>Right</u> <u>Comp.</u>	(2.851) <u>Non</u> <u>Comp.</u>		<u>HAPPY</u>	<u>SAD</u>	<u>NEUTRAL</u>
Left		NS	NS			*	*
Right			NS			NS	NS

*p ≤ .05 (Newman-Keuls)

TABLE 16

Poser by Composite Interaction
For Expression Discrimination

<u>Left Comp.</u>					<u>Poser 1</u>			
	(2.821) <u>P1</u>	(2.847) <u>P2</u>	(2.844) <u>P3</u>	(2.796) <u>P4</u>	(2.794) <u>P5</u>	<u>Left</u>	<u>Right</u>	<u>Non</u>
1		NS	NS	NS	NS	Left	NS	NS
2			NS	*	*	Right		NS
3				*	*			
4					NS			
<u>Right Comp.</u>					<u>Poser 2</u>			
	(2.814) <u>P1</u>	(2.823) <u>P2</u>	(2.849) <u>P3</u>	(2.838) <u>P4</u>	(2.834) <u>P5</u>	<u>Left</u>	<u>Right</u>	<u>Non</u>
1		NS	*	NS	NS	Left	NS	NS
2			NS	NS	NS	Right		NS
3				NS	NS			
4					NS	Left	NS	NS
						Right		NS
<u>Non Comp.</u>					<u>Poser 3</u>			
	(2.809) <u>P1</u>	(2.845) <u>P2</u>	(2.843) <u>P3</u>	(2.832) <u>P4</u>	(2.825) <u>P5</u>	<u>Left</u>	<u>Right</u>	<u>Non</u>
1		*	*	NS	NS	Left	*	*
2			NS	NS	NS	Right		NS
3				NS	NS			
4					NS			
					<u>Poser 4</u>			
						<u>Left</u>	<u>Right</u>	<u>Non</u>
						Left		
						Right	*	*
								NS
					<u>Poser 5</u>			
						<u>Left</u>	<u>Right</u>	<u>Non</u>
						Left		
						Right	*	NS
								NS

* $p \leq .05$ (Newman-Keuls)

TABLE 17

Summary Tables of Anova Results
For Each Expression Separately

NEUTRAL

<u>Source</u>	<u>Raw Scores</u>			<u>Log Transformed Scores</u>	
	<u>df</u>	<u>f</u>	<u>p</u>	<u>f</u>	<u>p</u>
Poser	4,124	2.152	.079	3.839	.006
Composite	2,62	.091	.500	.292	.500
Field	1,31	5.572	.025	5.149	.031
Poser by Comp.	8,248	1.835	.072	2.569	.011
Poser by Field	4,124	.467	.500	1.045	.387
Comp. by Field	2,62	.314	.500	.738	.483
Poser by Comp. by Field	8,248	.867	.500	1.425	.187

HAPPY

Poser	4,124	4.620	.002	5.501	.001
Composite	2,62	6.227	.004	7.537	.002
Field	1,31	.975	.332	3.521	.071
Poser by Comp.	8,248	2.215	.027	2.328	.020
Poser by Field	4,124	1.614	.175	1.450	.222
Comp. by Field	2,62	1.742	.184	3.576	.034
Poser by Comp. by Field	8,248	2.241	.026	1.850	.069

SAD

Poser	4,124	10.636	.001	15.678	.001
Composite	2,62	.551	.500	1.025	.365
Field	1,31	.014	.500	1.077	.308
Poser by Comp.	8,248	2.450	.015	3.921	.001
Poser by Field	4,124	.773	.500	.807	.500
Comp. by Field	2,62	.360	.500	.124	.500
Poser by Comp. by Field	8,248	1.719	.095	1.653	.111

TABLE 18

The Relationship Between Emotional Saliency
and Visual-Field Asymmetry for the
Five Stimulus Faces in Emotion Discrimination

	<u>Spearman r</u>	<u>p</u>
HAPPY	-.31	.31
SAD	.0	.50
NEUTRAL	.70	.94

TABLE 19

The Direction and Degree of Asymmetry
 Demonstrated for Perceptual
 and Expressive Tasks

<u>HAPPY</u>	Direction of Expressive Asymmetry (the more intense composite)	Direction of Perceptual Asymmetry (the faster visual field)	<u>Concordance</u>
P1	L	L	*
P2	R	L	
P3	L	L	*
P4	L	R	
P5	R	R	*
P7	L	L	*
P10	R	L	
P12	L	L	*
P13	L	R	

Spearman $r = .10$
 $p = .44$
 $n = 5$

P1	L	R	
P2	R	R	*
P3	R	L	
P4	L	L	*
P5	L	L	*
P7	R	L	
P10	L	L	*
P12	L	L	*
P13	L	L	*

Spearman $r = .60$
 $p = .10$
 $n = 6$

Table 19 (cont'd)

<u>NEUTRAL</u>	<u>Direction of Expressive Asymmetry (the more intense composite)</u>	<u>Direction of Perceptual Asymmetry (the faster visual field)</u>	<u>Concordance</u>
P1	R	L	
P2	R	R	*
P3	R	L	
P4	L	R	
P5	R	R	*
P7	L	R	
P10	L	R	
P12	L	L	*
P13	L	R	

TABLE 20

The Relationship Between the Magnitude of
Expressed Emotion and Visual Field Asymmetry
Demonstrated for Perceptual Discrimination

	<u>Spearman r</u>	<u>p</u>
HAPPY	-.05	.45
NEUTRAL	-.22	.29
SAD	.03	.47

FIGURE 1
Mean Intensity Rating For Each Poser

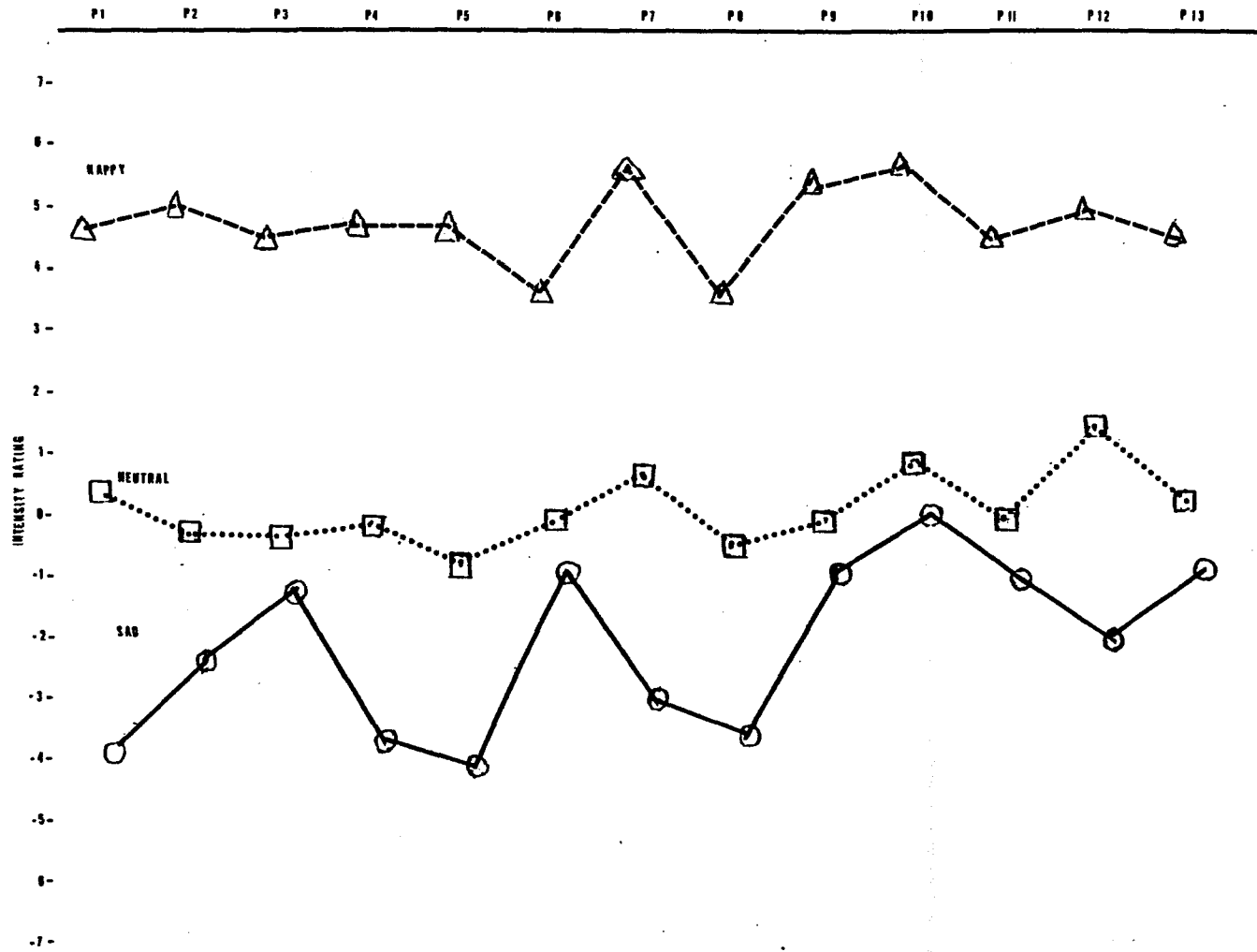


FIGURE 2
Sad Ratings For Each Poser As A Function Of Sex Of Rater

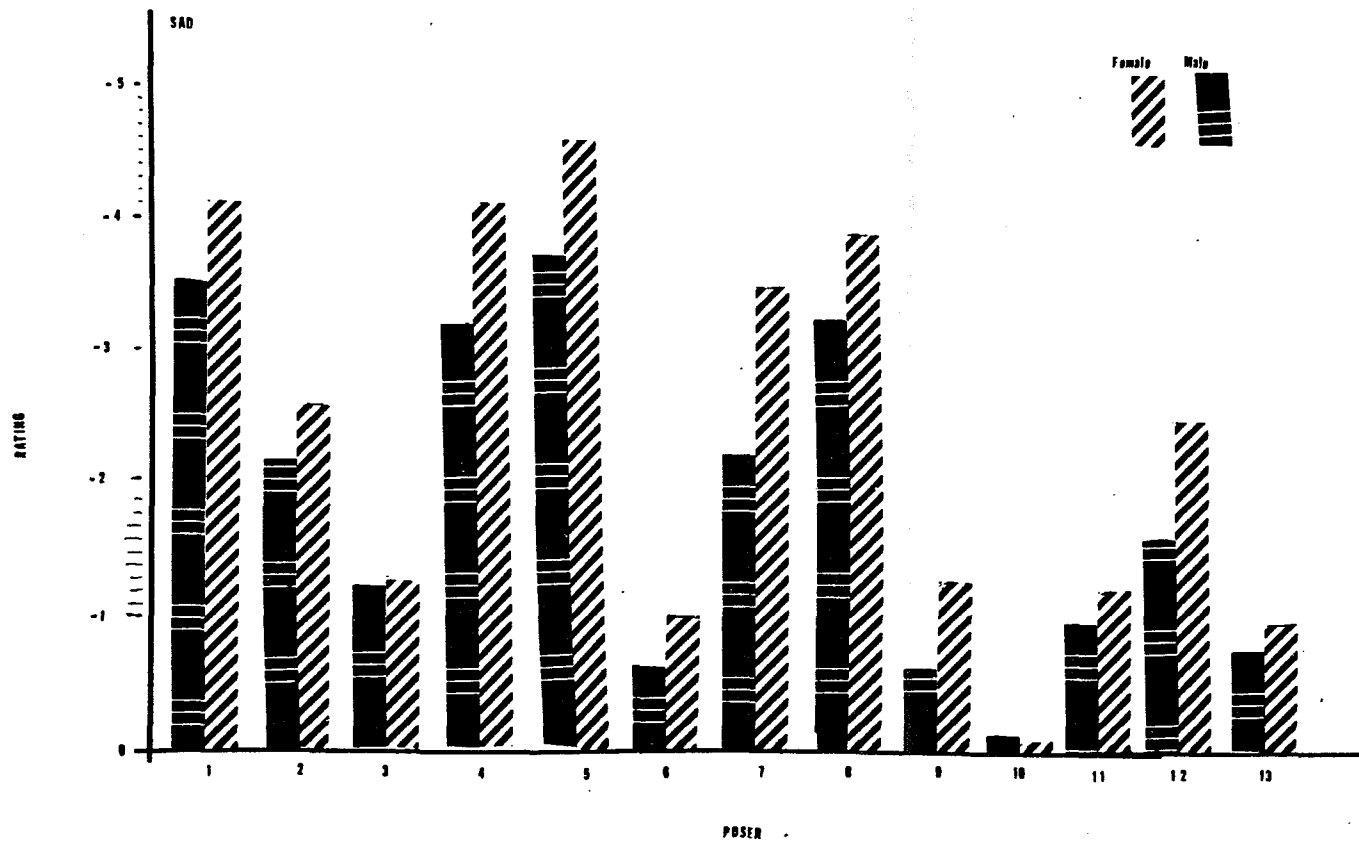


FIGURE 3
 Mean Intensity Rating For Each Poser As A Function Of Rating Session

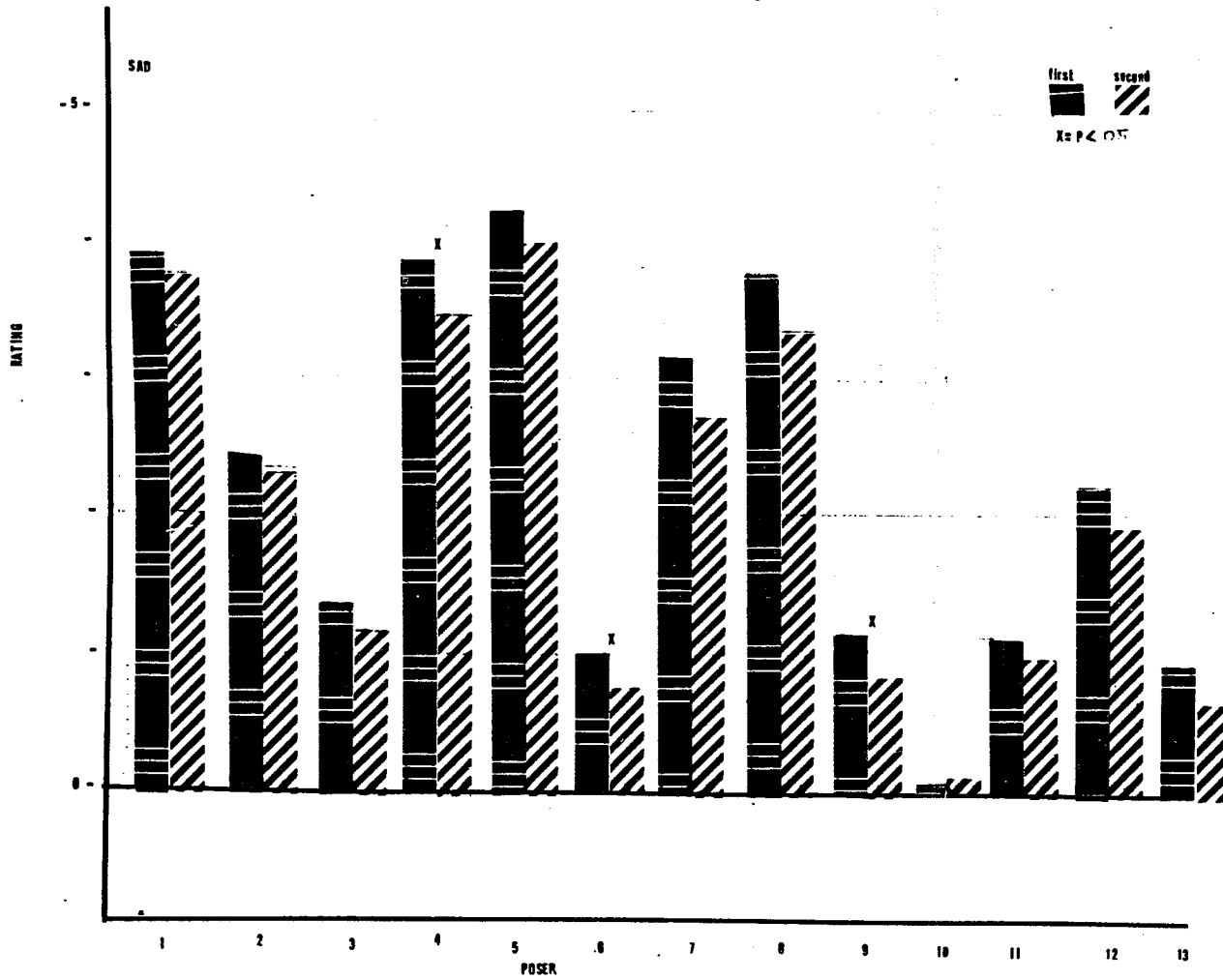


FIGURE 4
Mean Ratings For Each Poser As A Function Of Sequence

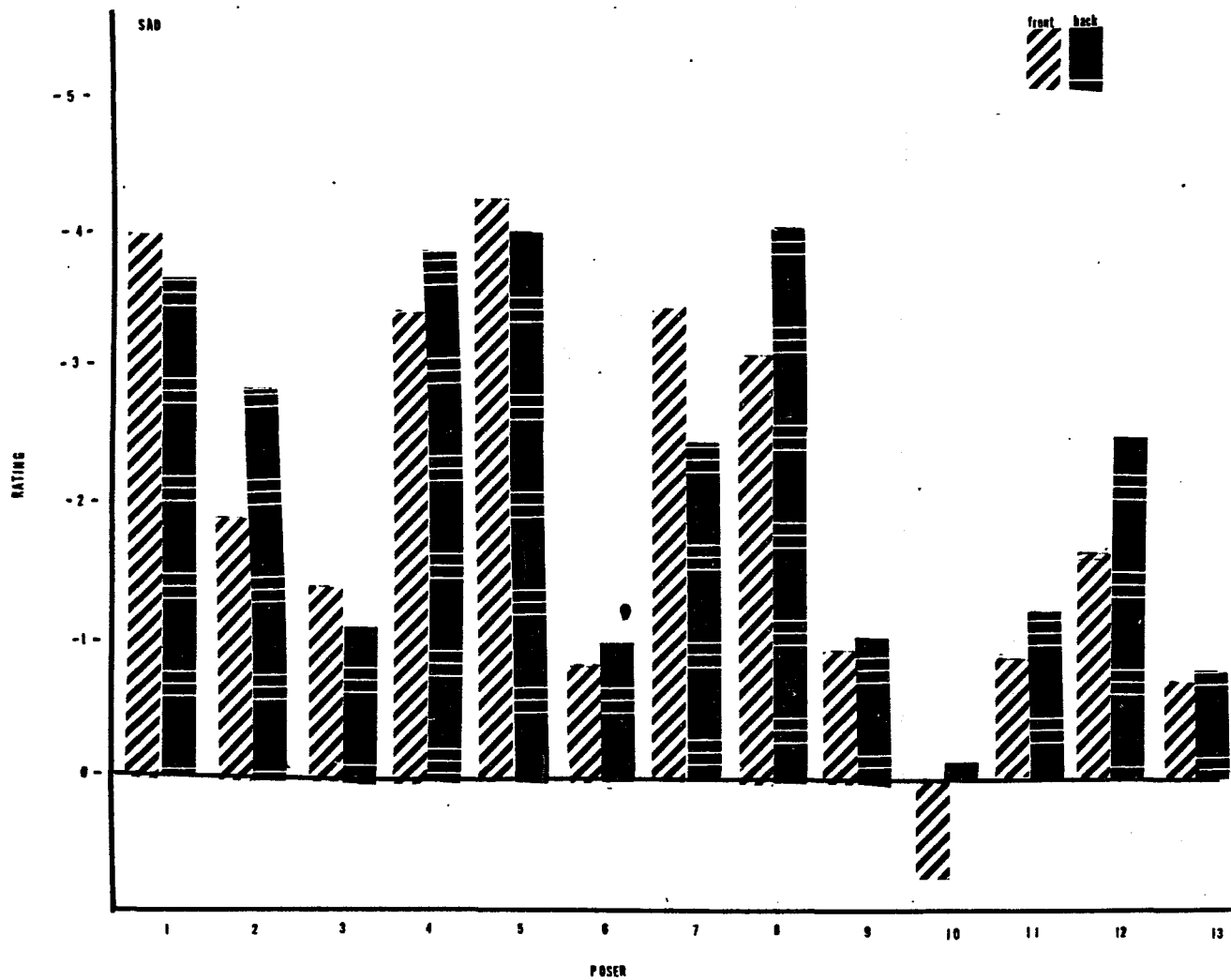


FIGURE 5
Mean Intensity Rating For Left And Right Composites For Each Poser

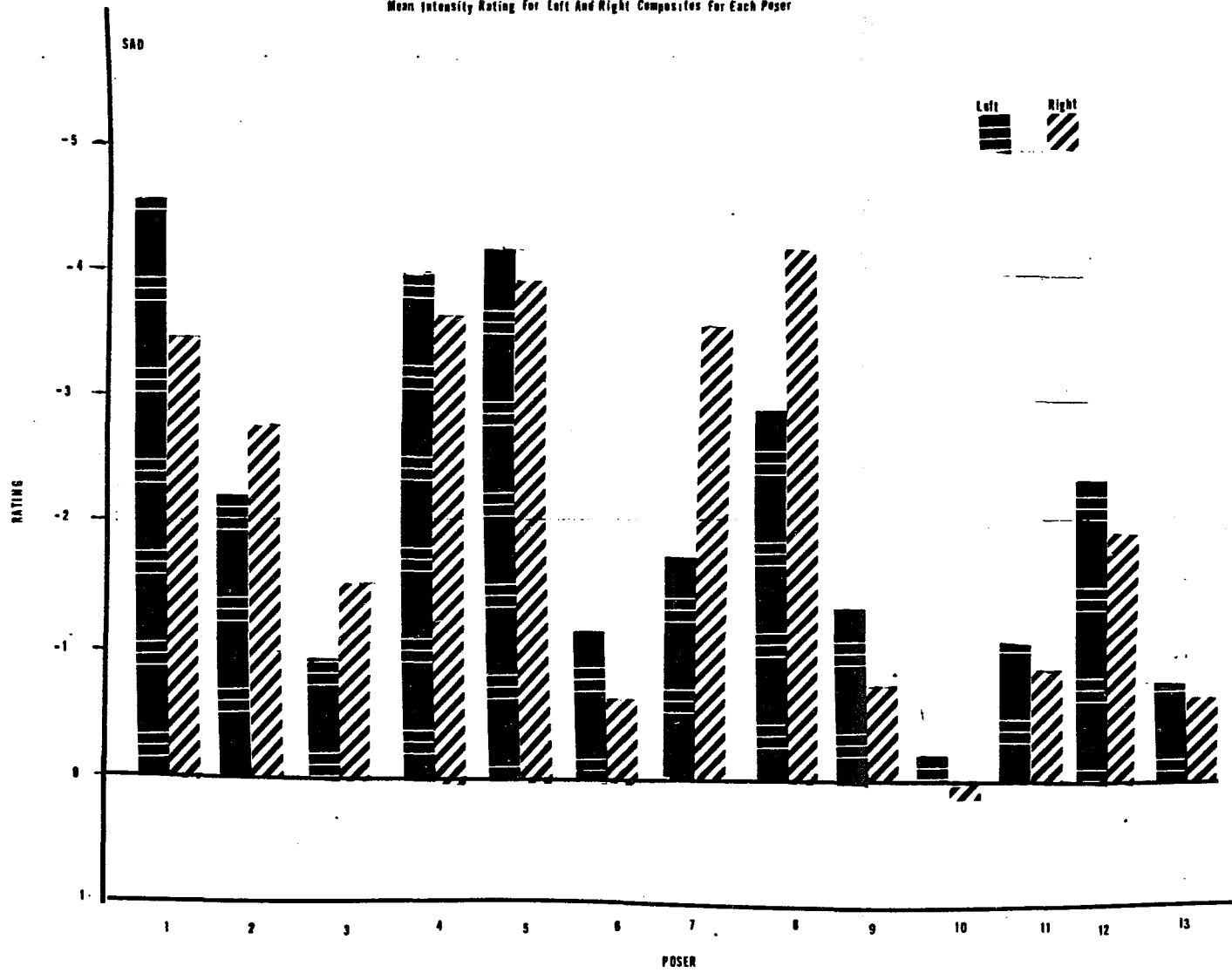


FIGURE 8
Sad Ratings As A Function Of Sex And Session

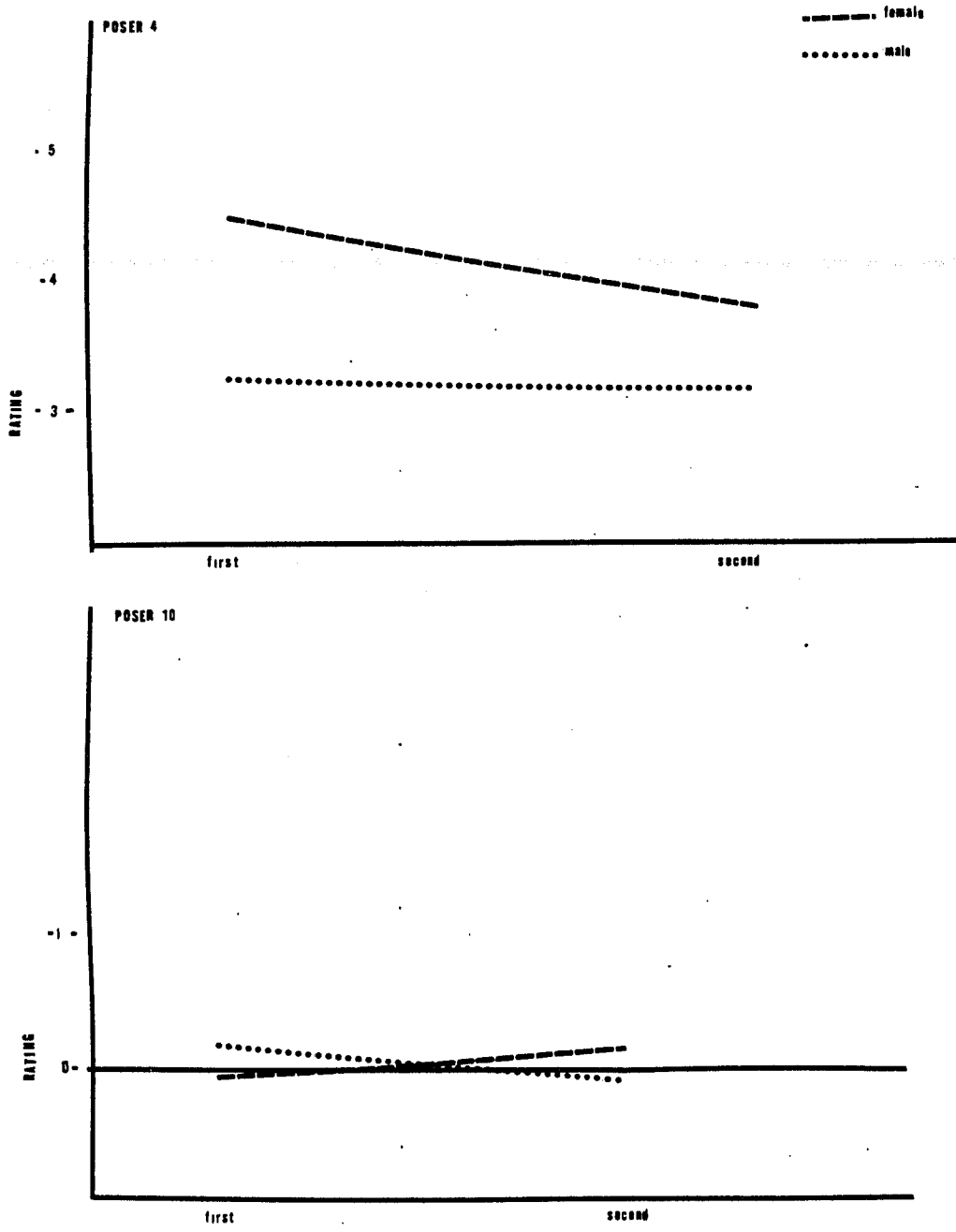


FIGURE 7
Sad Ratings As A Function Of Stimulus Order And Rating Session

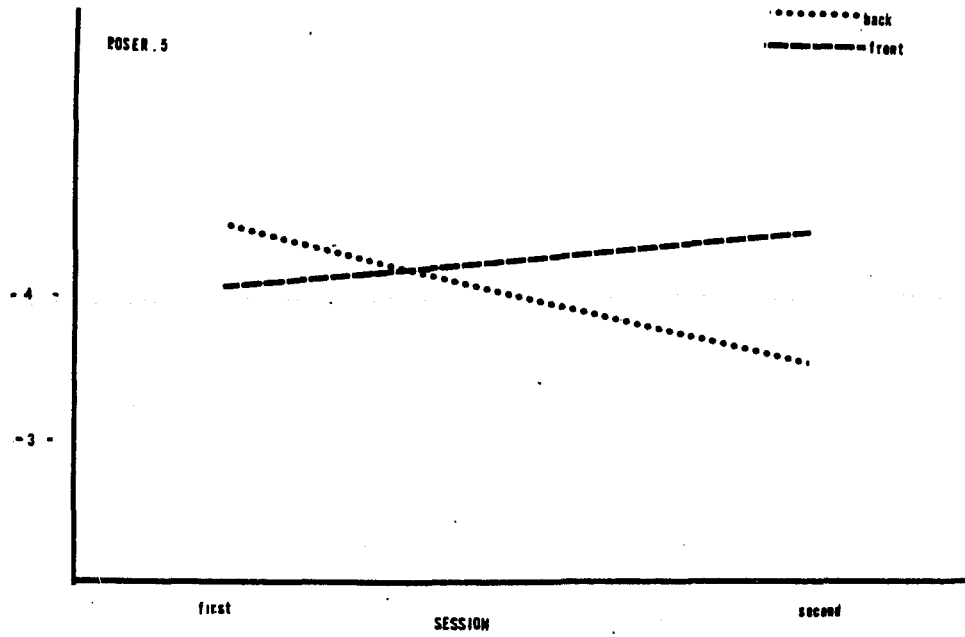


FIGURE 8
Sad Ratings As A Function Of Sex And Composite

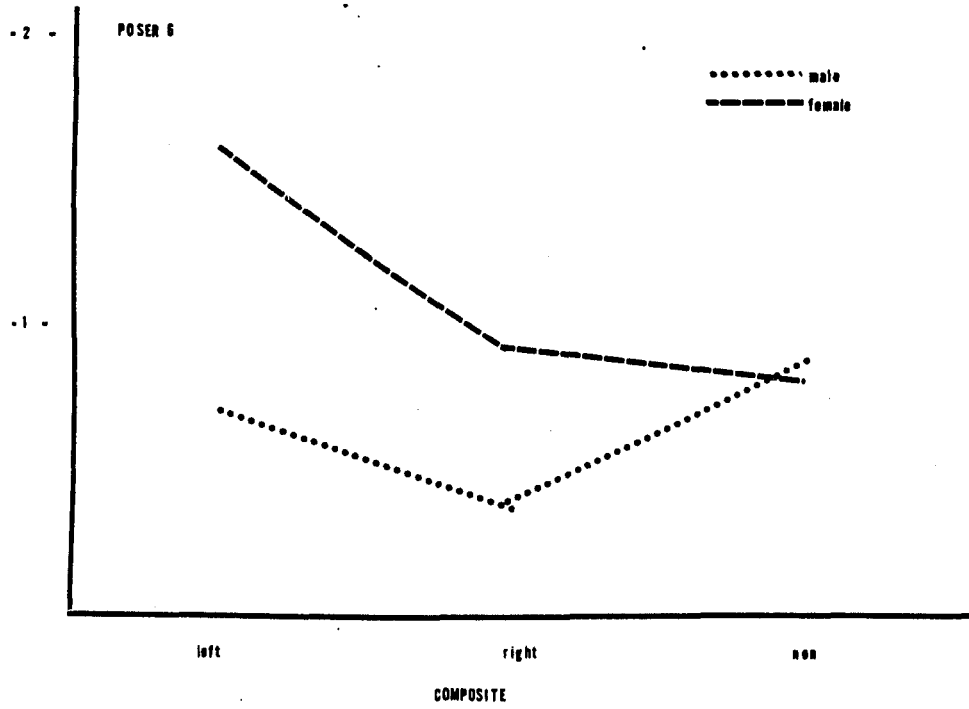


FIGURE 9
Sad Ratings As A Function Of Composite And Stimulus Order

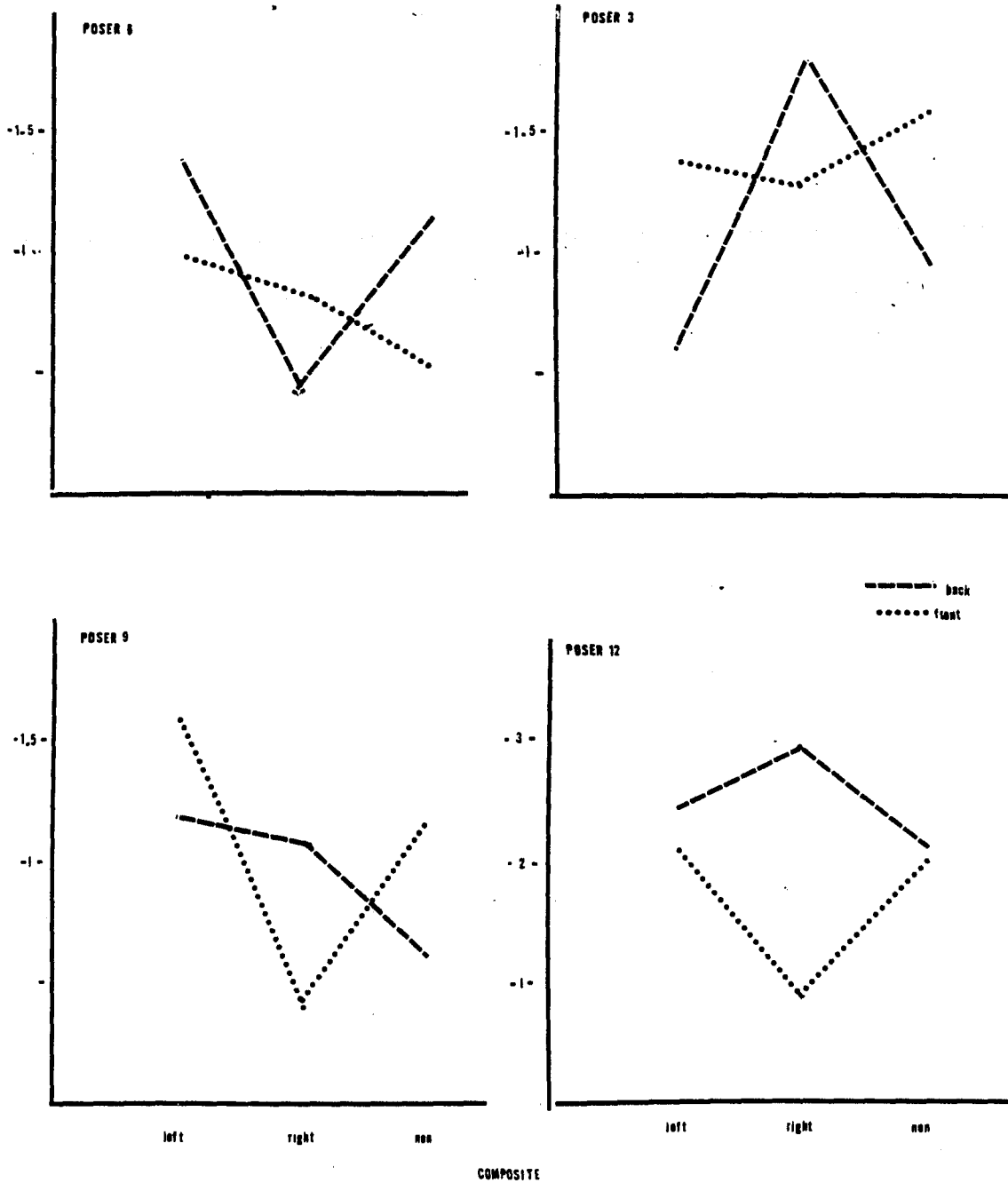


FIGURE 10
Sad Ratings As A Function Of Composite And Rating Session

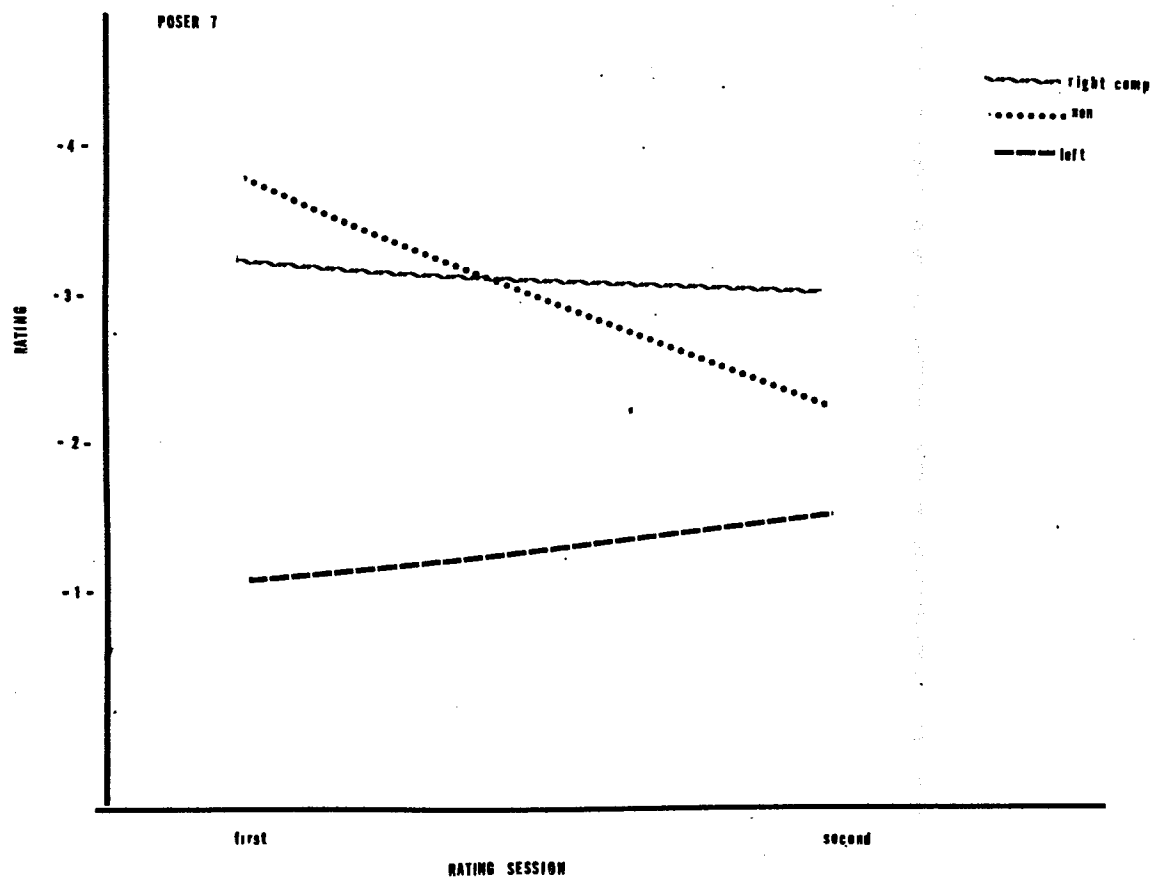


FIGURE 11
 Sad Ratings As A Function Of Sequence Sex And Composite

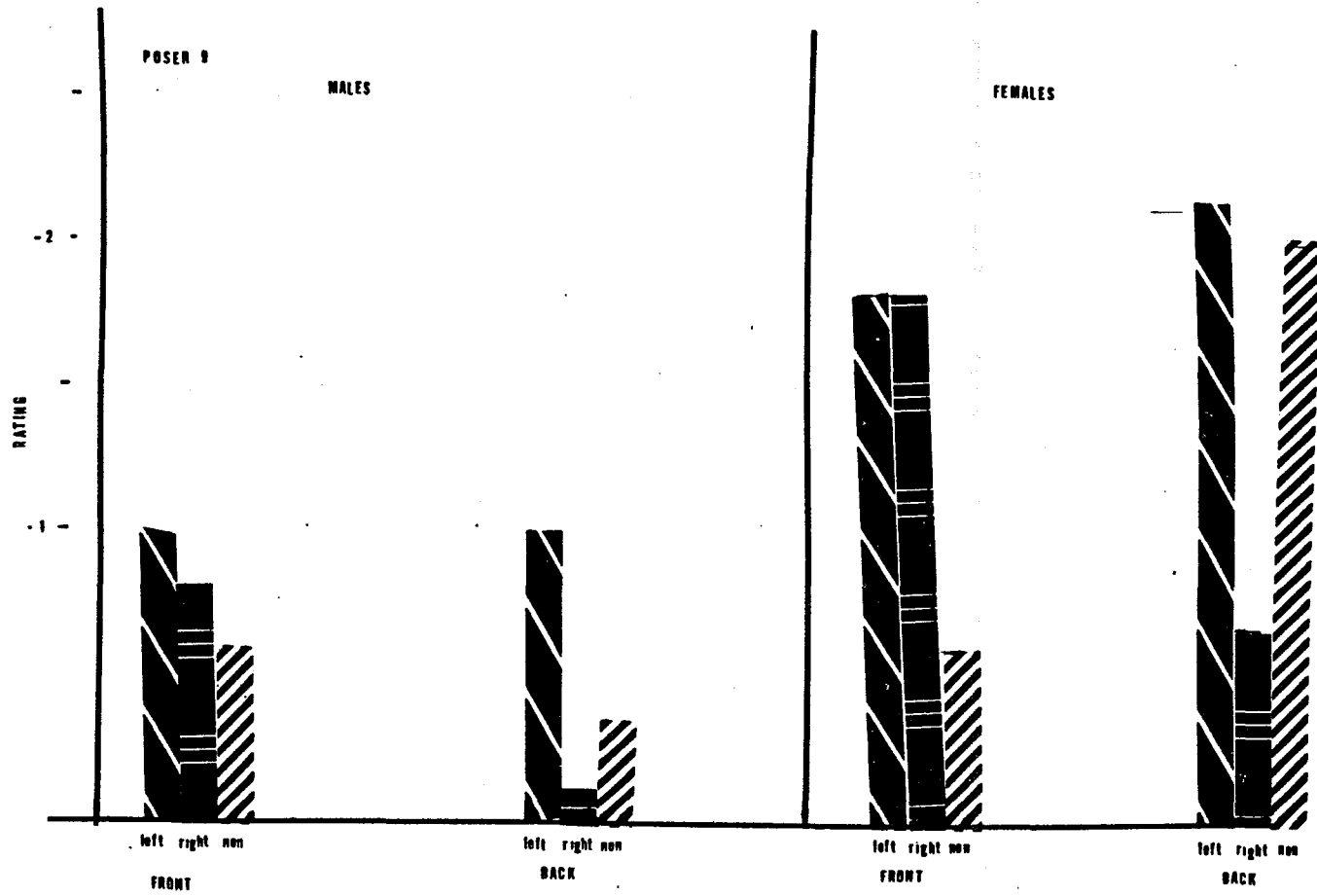


FIGURE 12
Mean Intensity Rating For Each Poser As A Function Of Sex

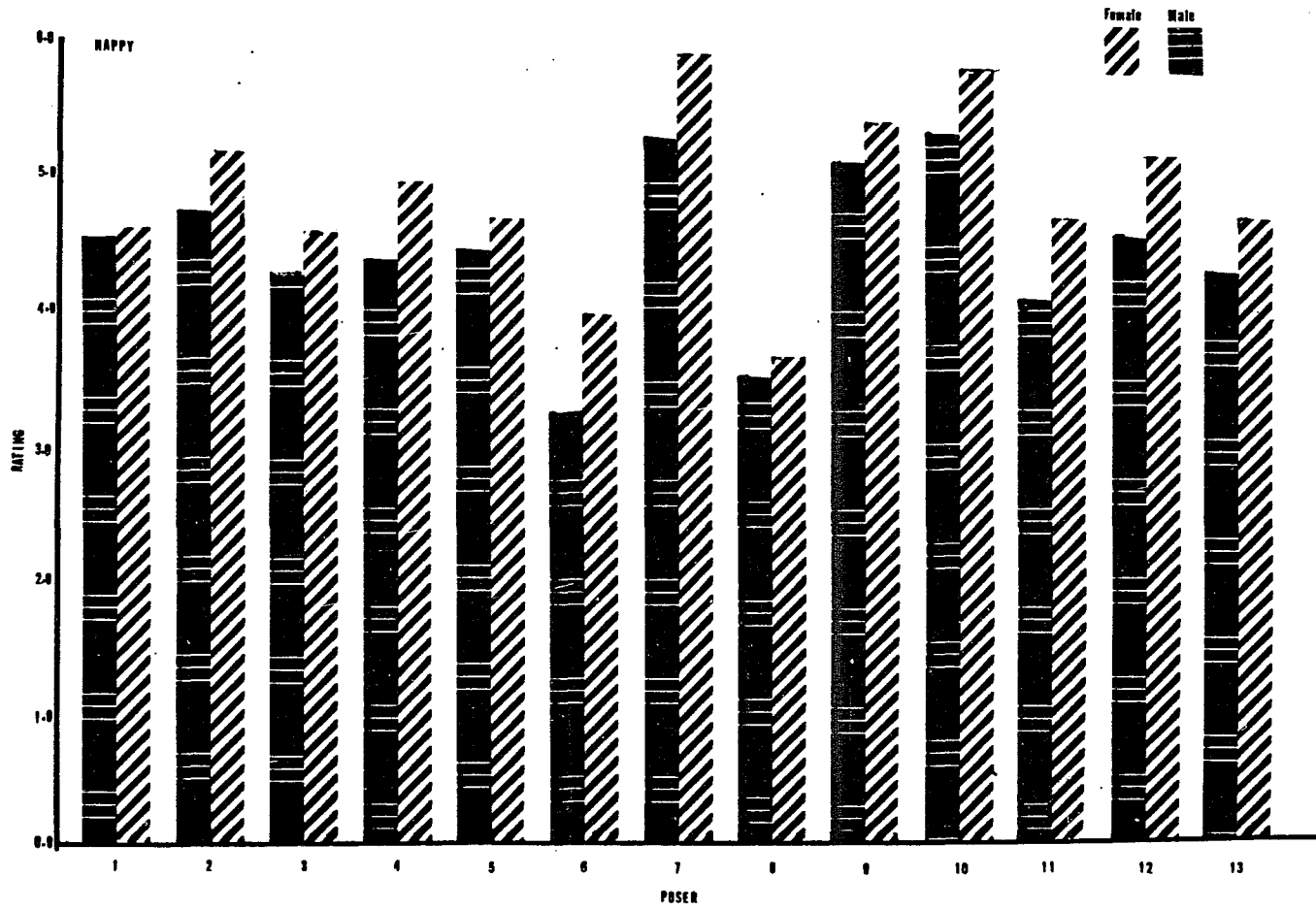


FIGURE 13
Mean Intensity Rating For Each Poser As A Function Of Stimulus Order

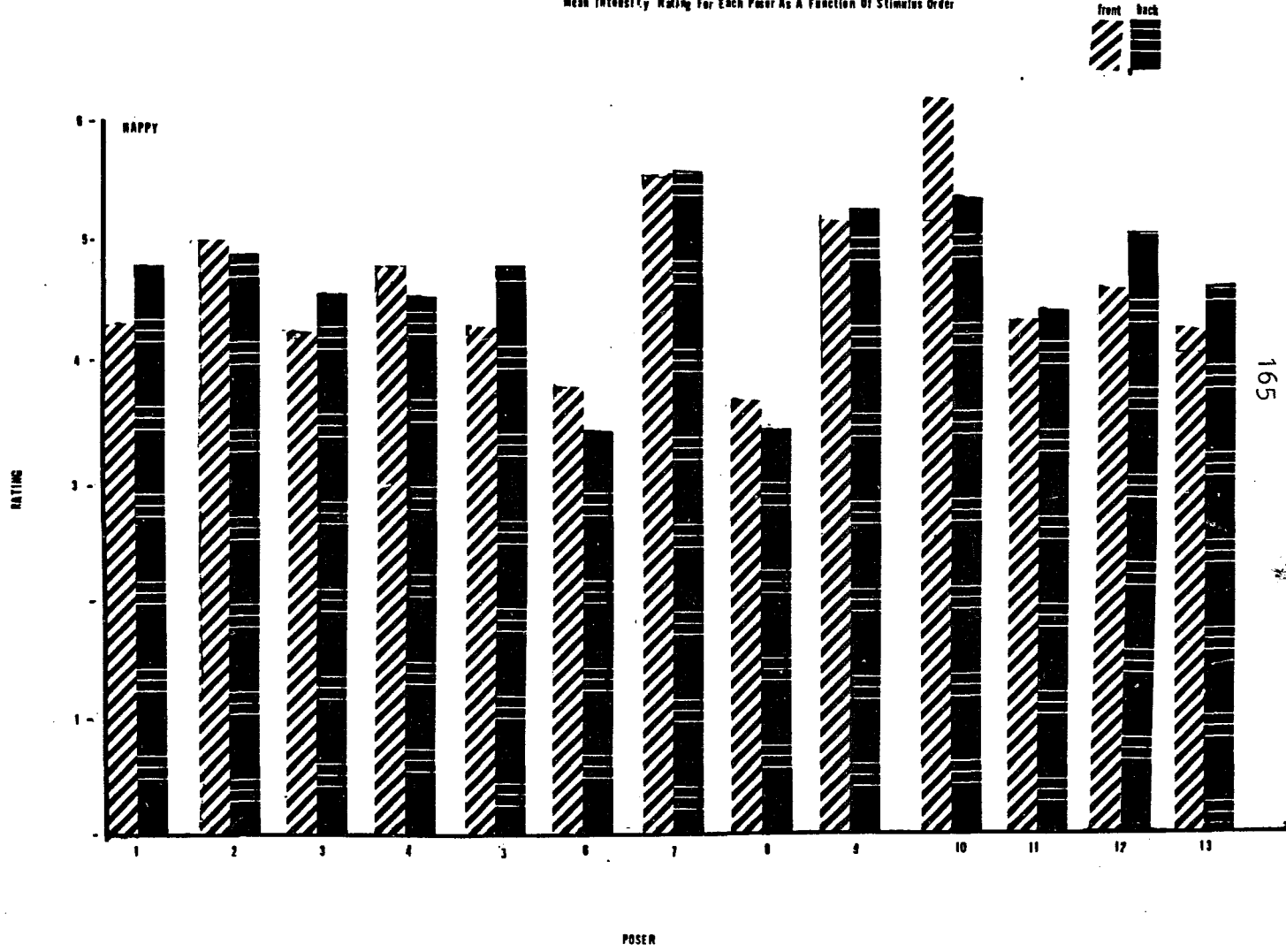


FIGURE 14
 Mean Intensity Rating For Each Poser As A Function Of Rating Session

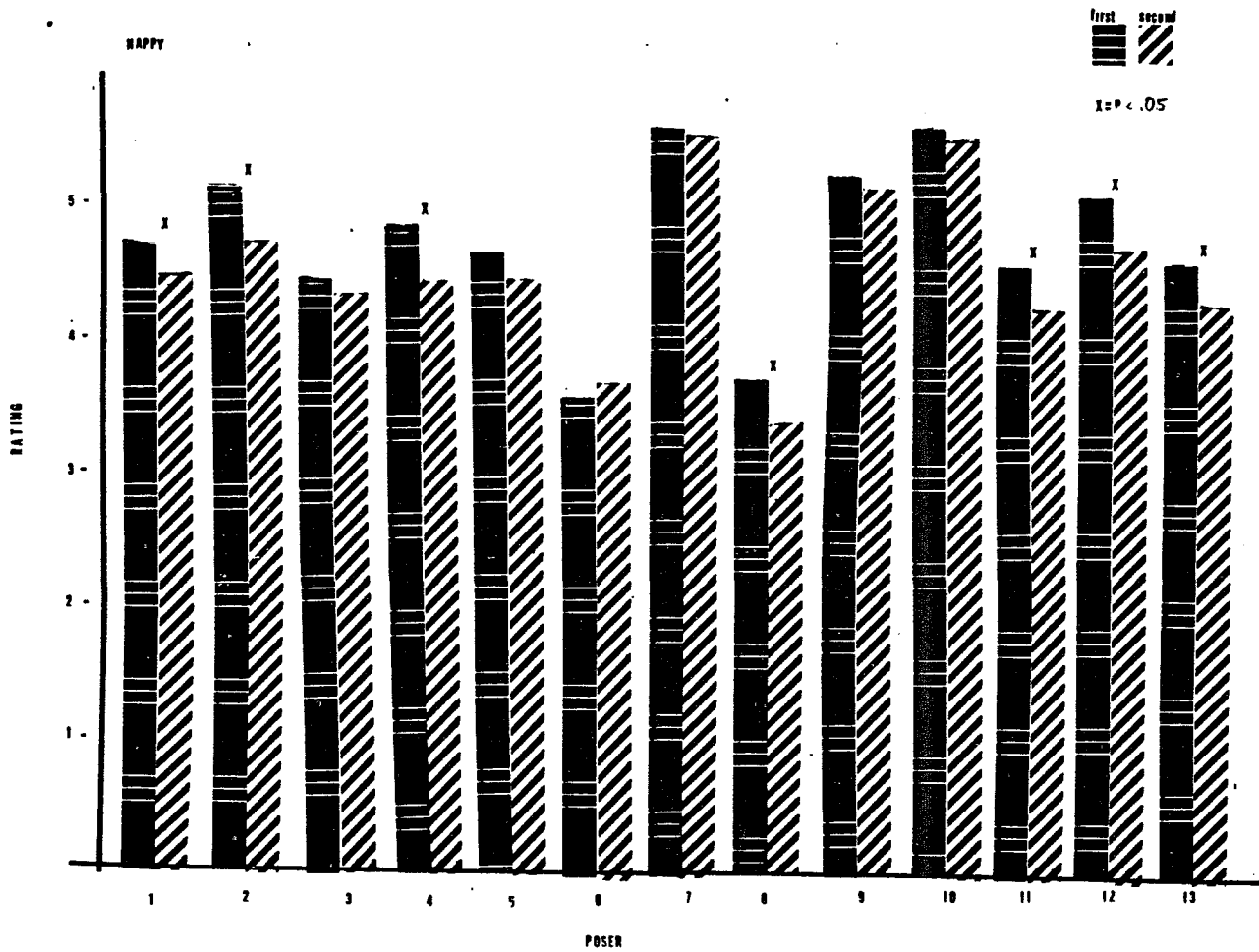


FIGURE 15
Mean Intensity Rating Of Right And Left Composites For Each Poser

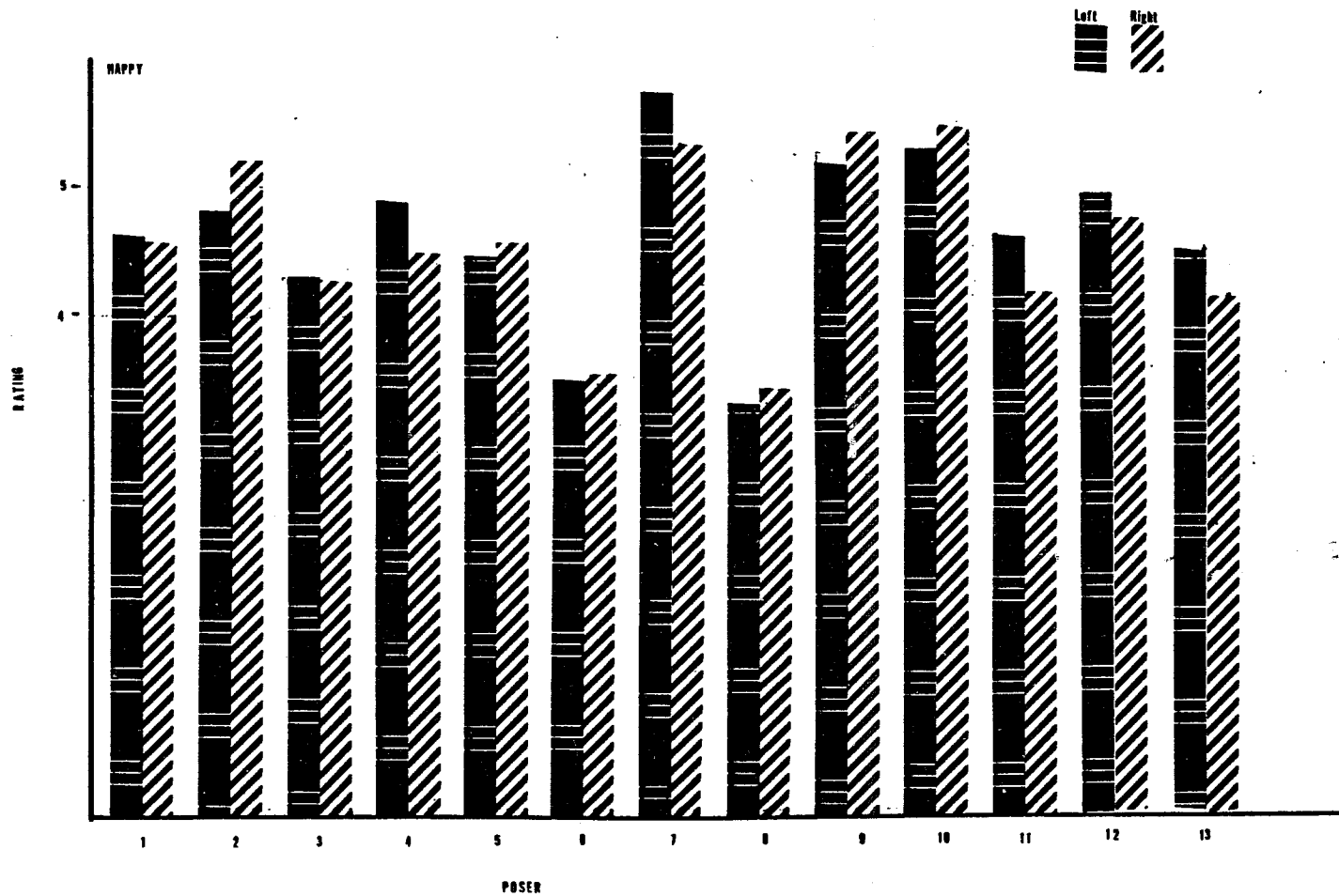


FIGURE 16
Stimulus Order By Rating Session

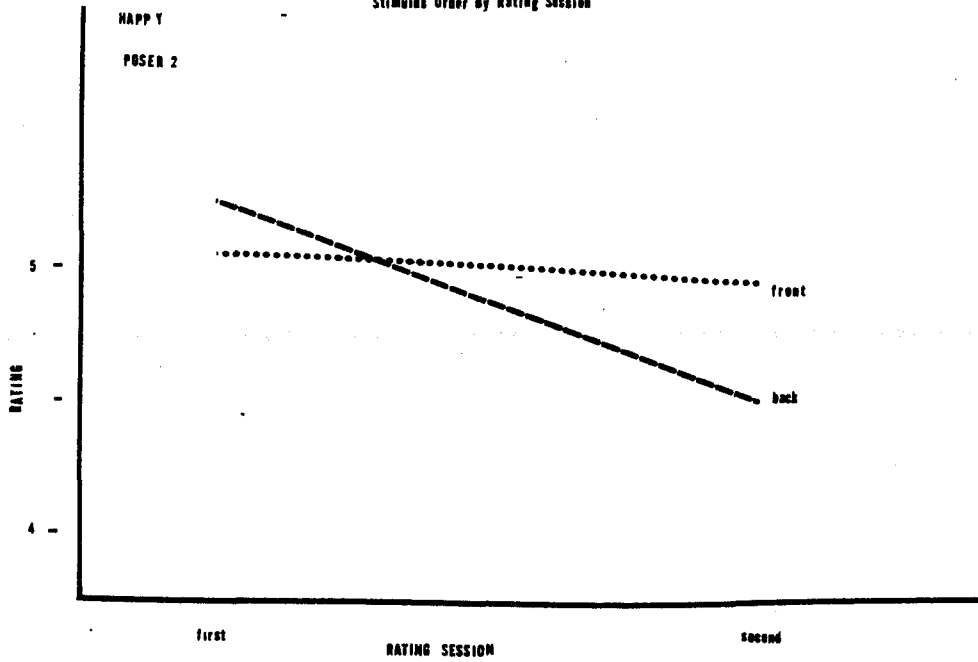


FIGURE 17
Composite By Rating Session

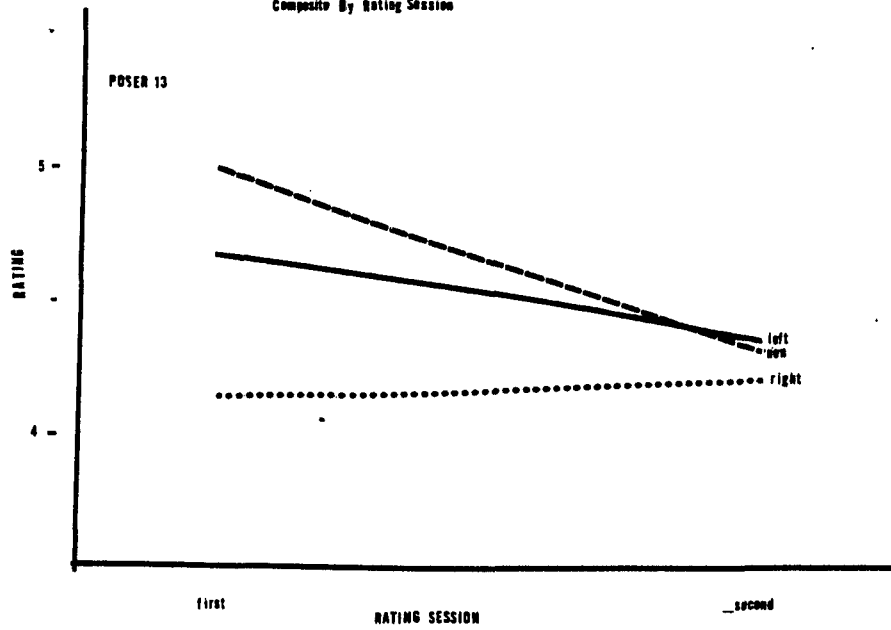


FIGURE 10
Stimulus Order by Composite

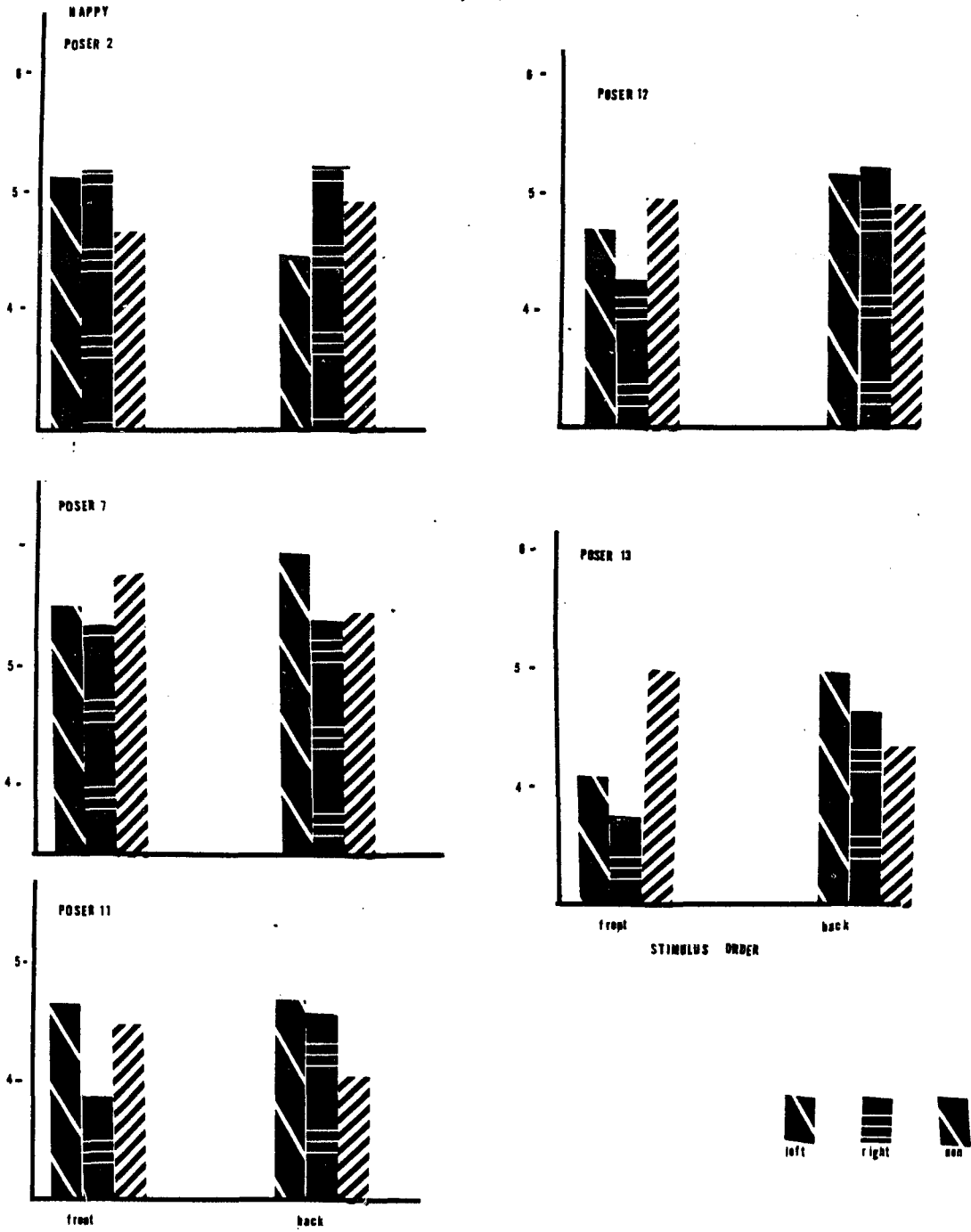


FIGURE 10
Stimulus Order By Sex By Session By Composite

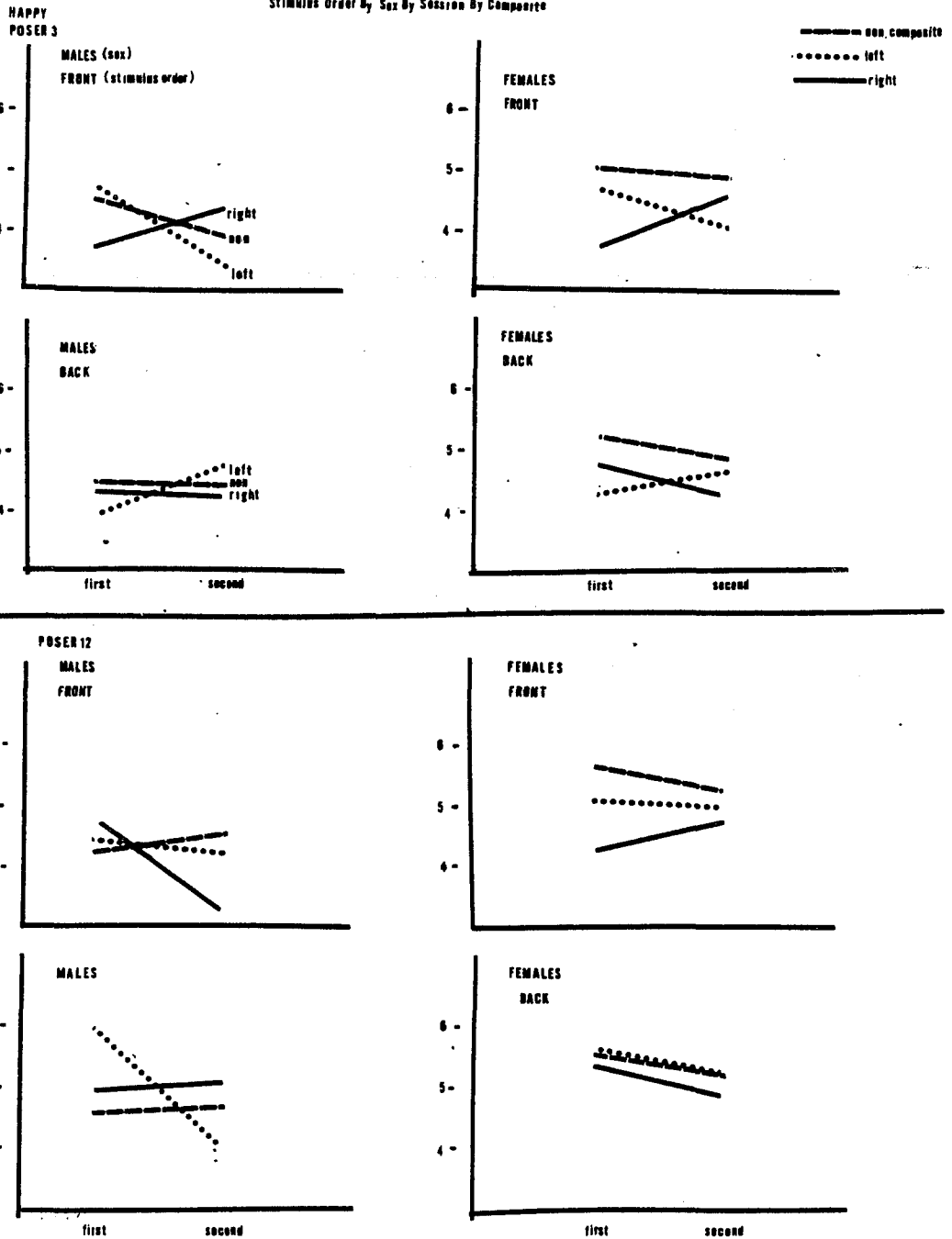


FIGURE 20
Mean Intensity Rating For Each Poser As A Function Of Rating Session

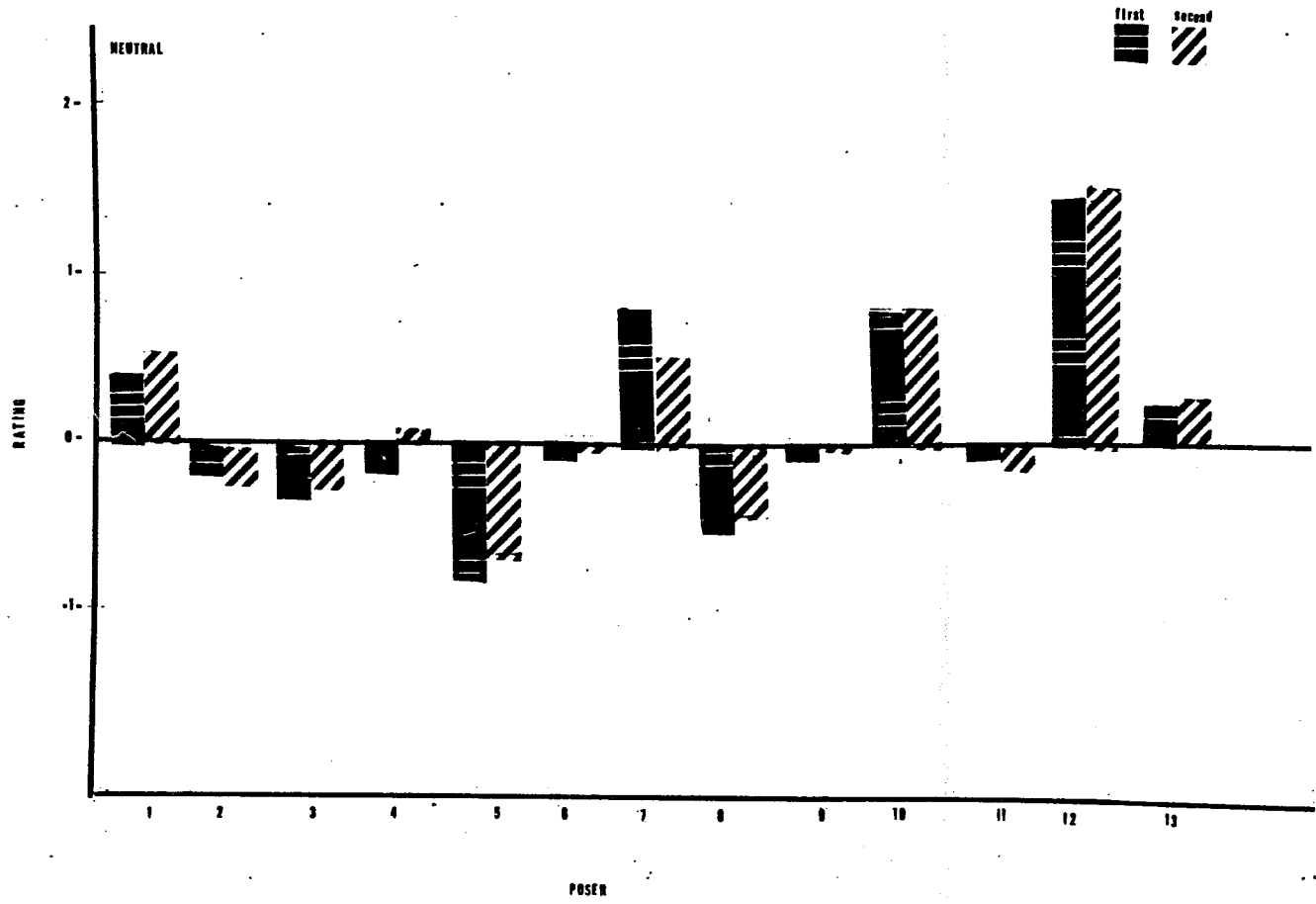


FIGURE 21

Mean Intensity Rating For Each Poser As A Function Of Stimulus Order

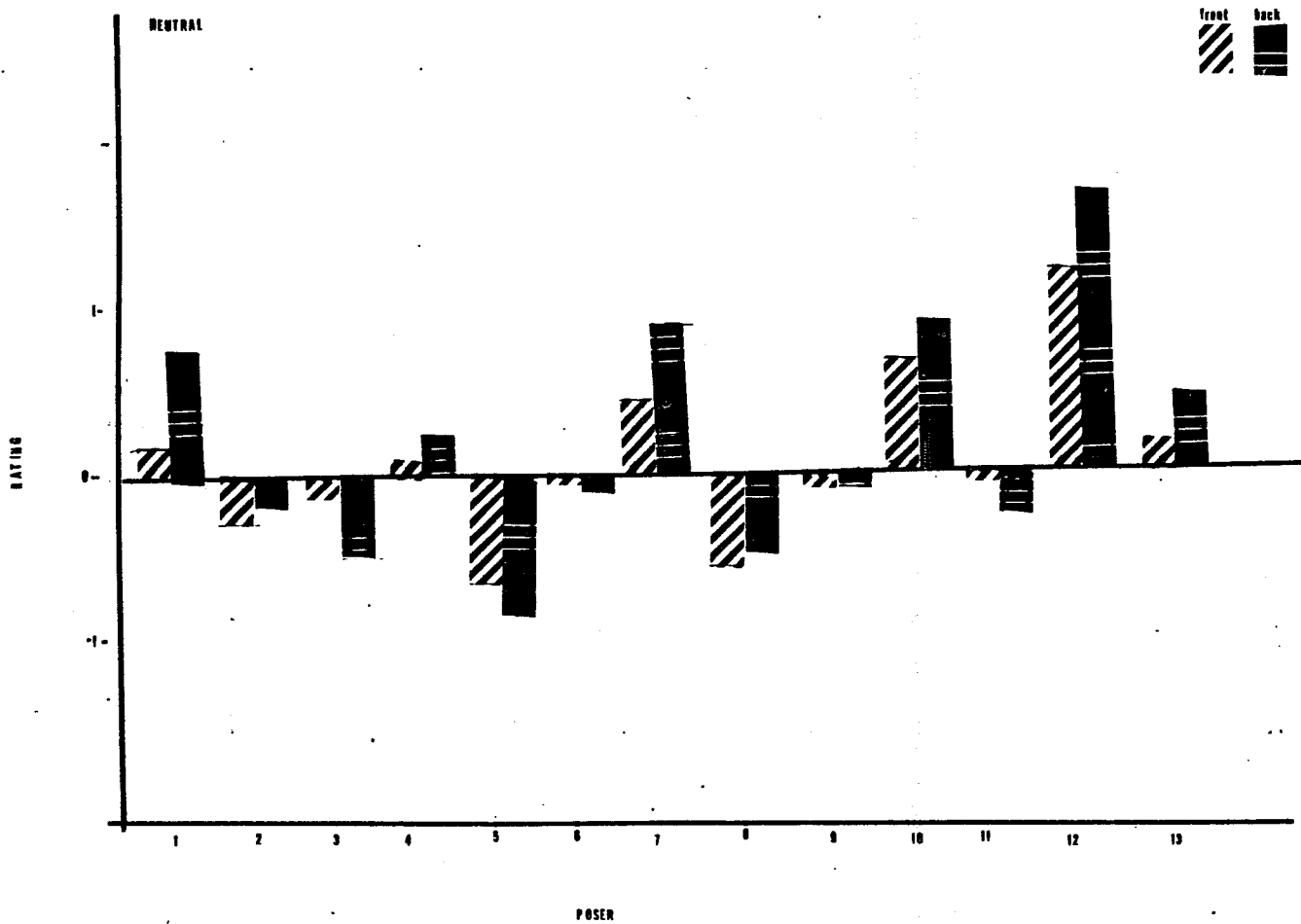


FIGURE 21

Mean Intensity Rating For Each Poser As A Function Of Stimulus Order

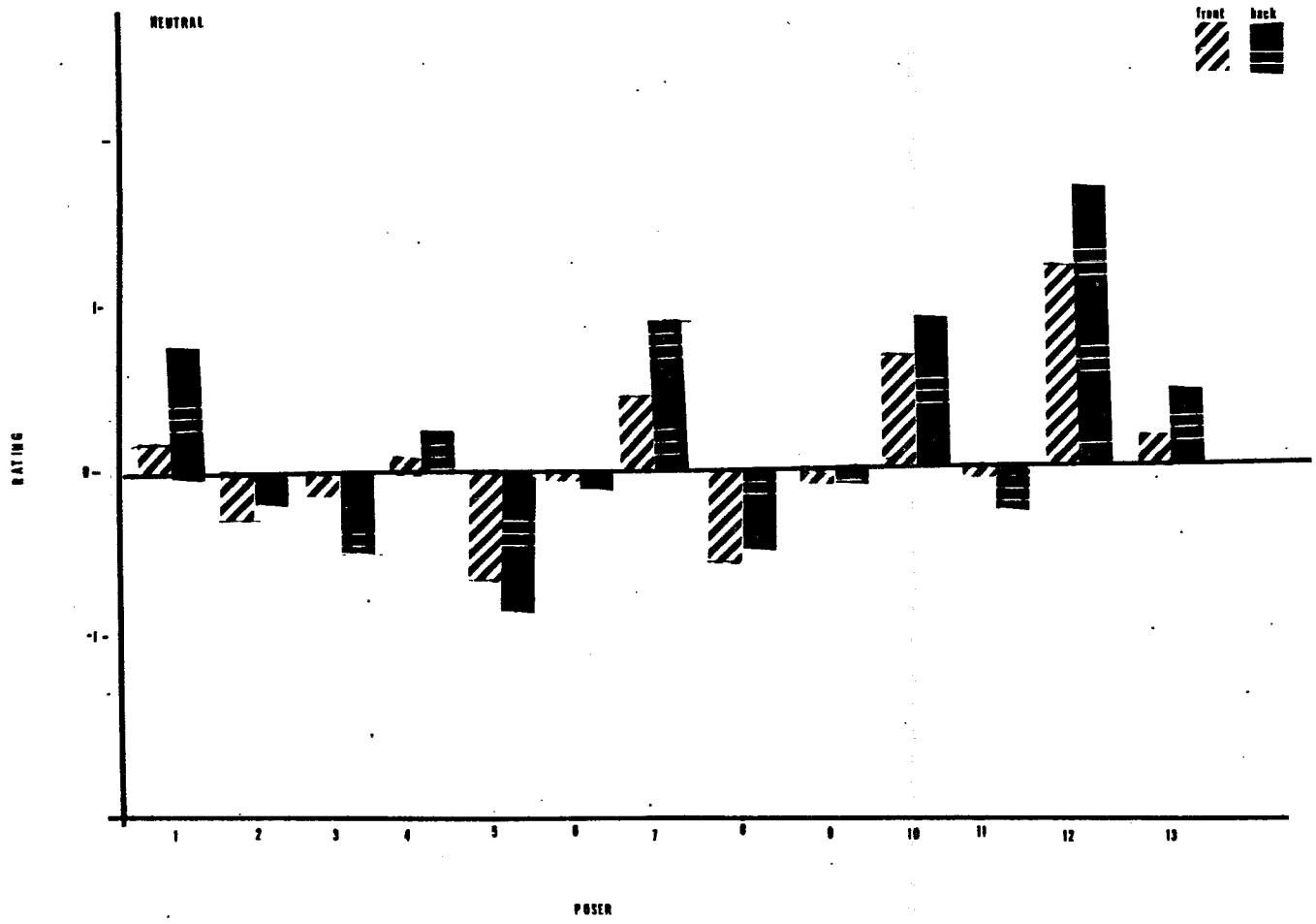
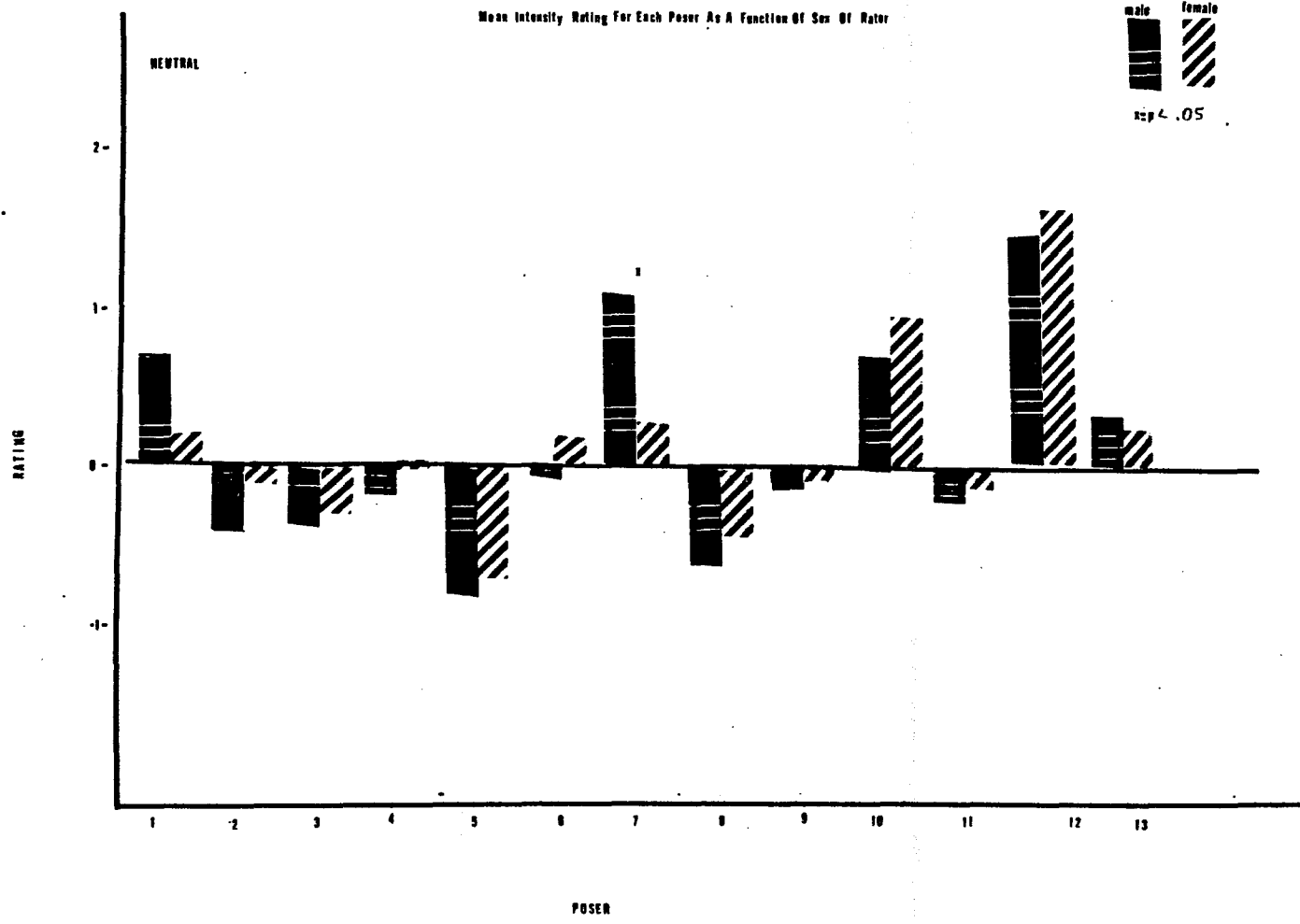


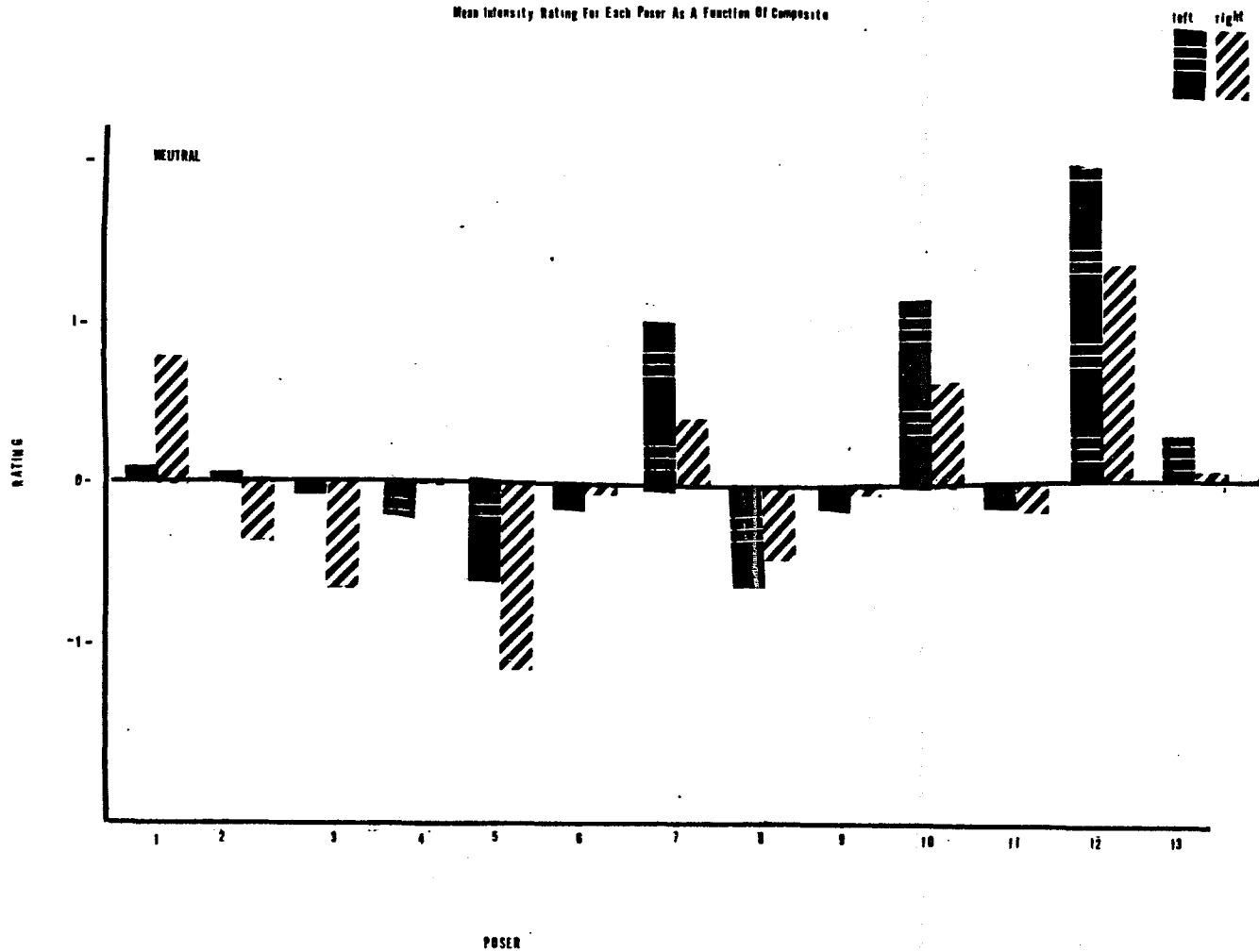
FIGURE 22
Mean Intensity Rating For Each Poser As A Function Of Sex Of Rater



174

1

FIGURE 23
Mean Intensity Rating For Each Poser As A Function Of Composite



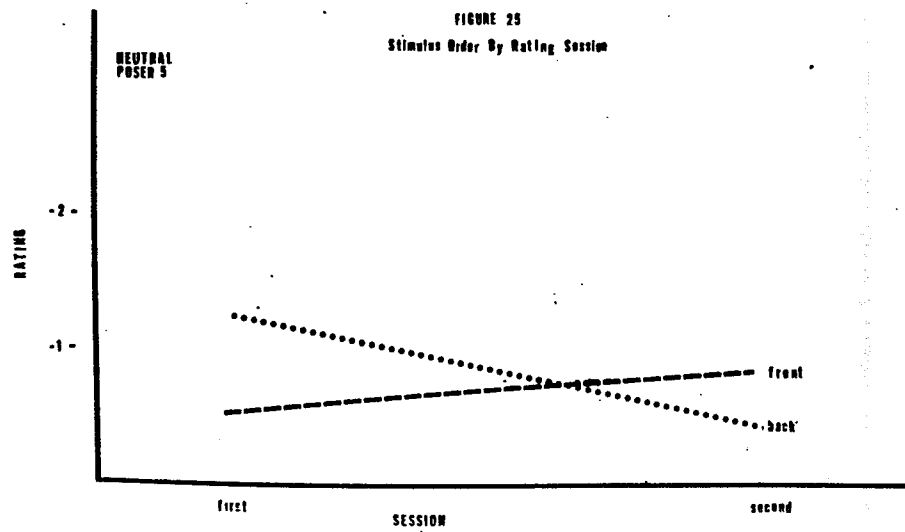
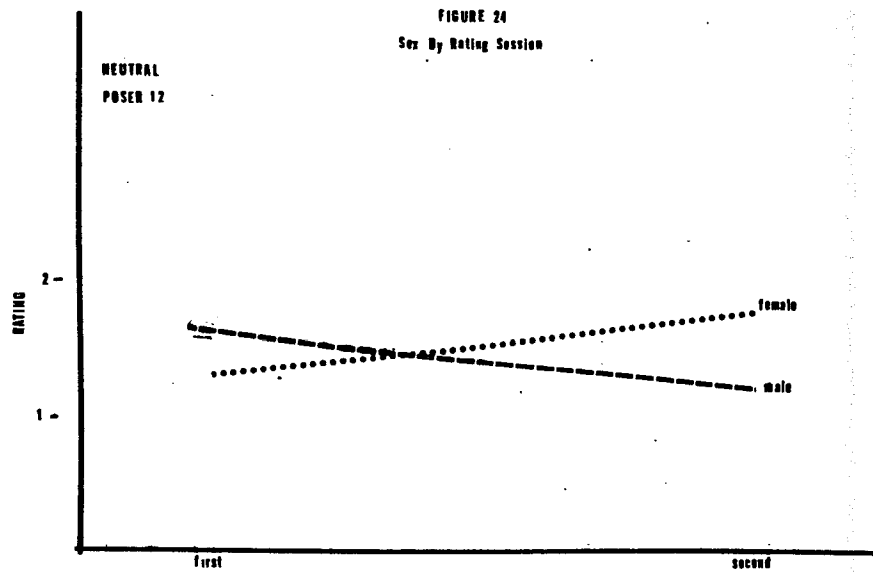


FIGURE 26
Stimulus Order By Composite

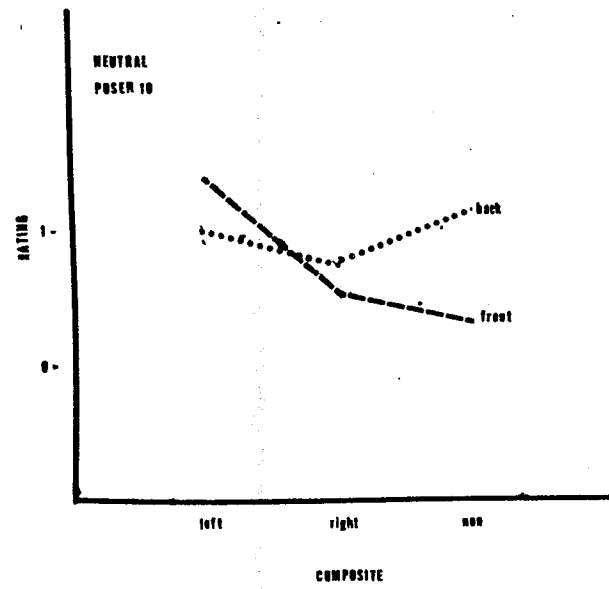
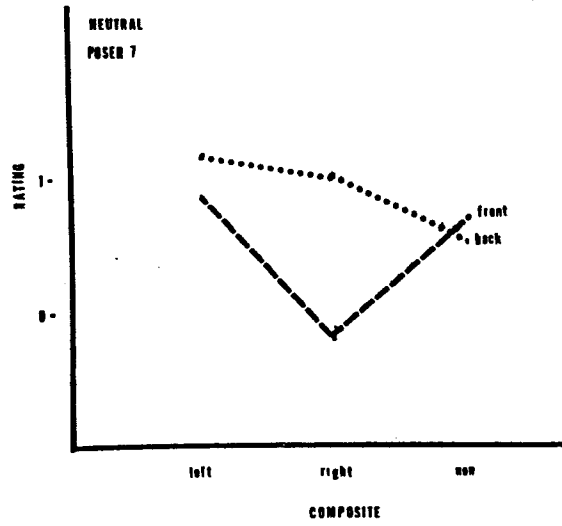


FIGURE 27
Sex By Composite

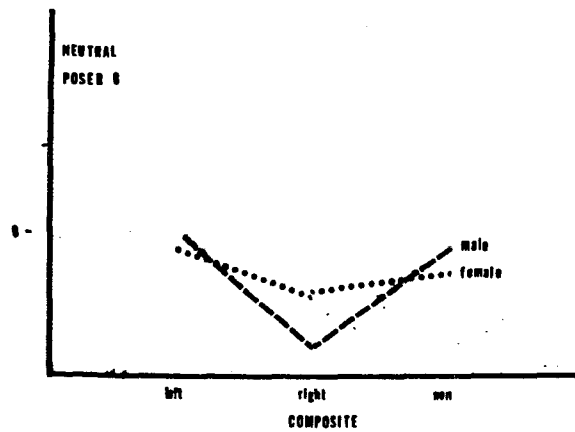


FIGURE 28
Rating Session By Composite

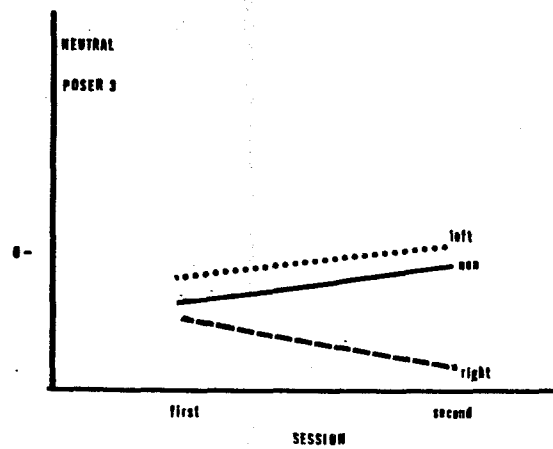
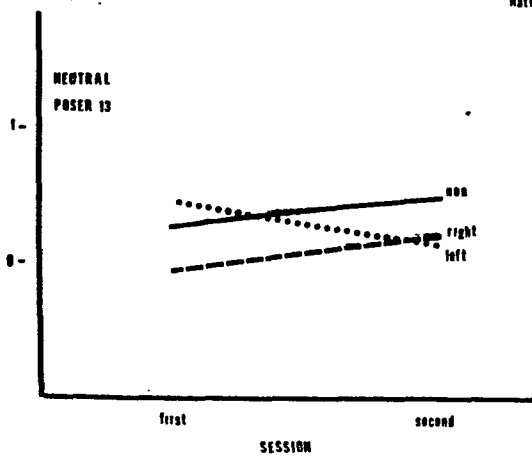


FIGURE 29
Stimulus Order By Composite By Rating Session

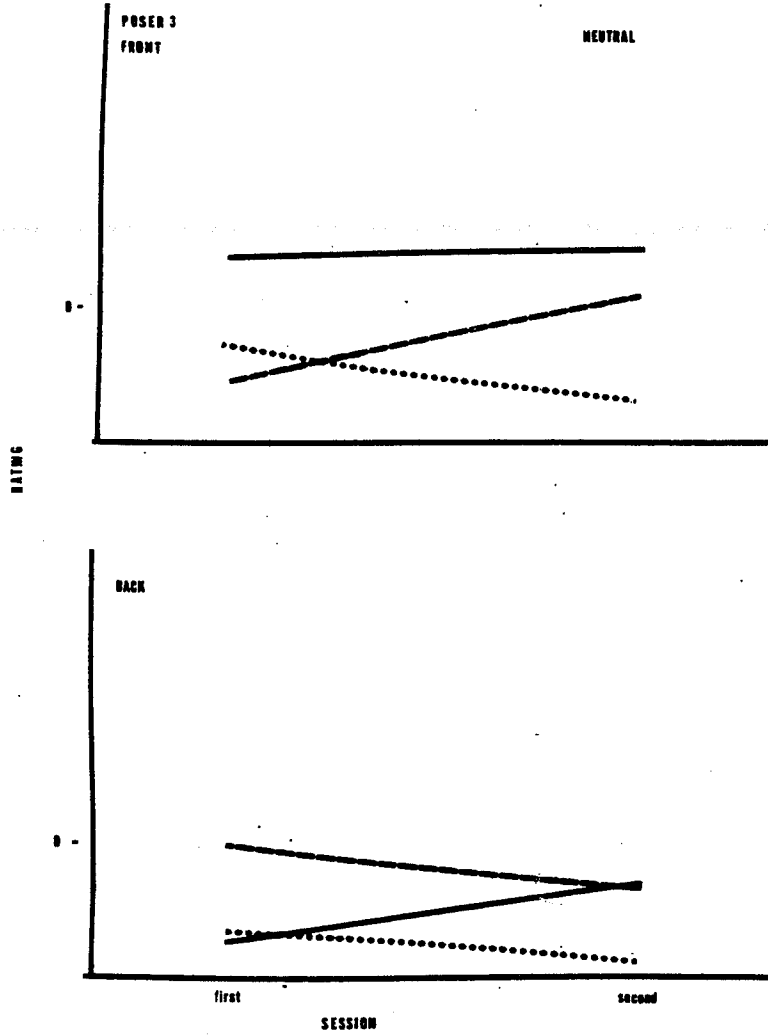


FIGURE 30
Sex By Stimulus Order By Composite By Rating Session

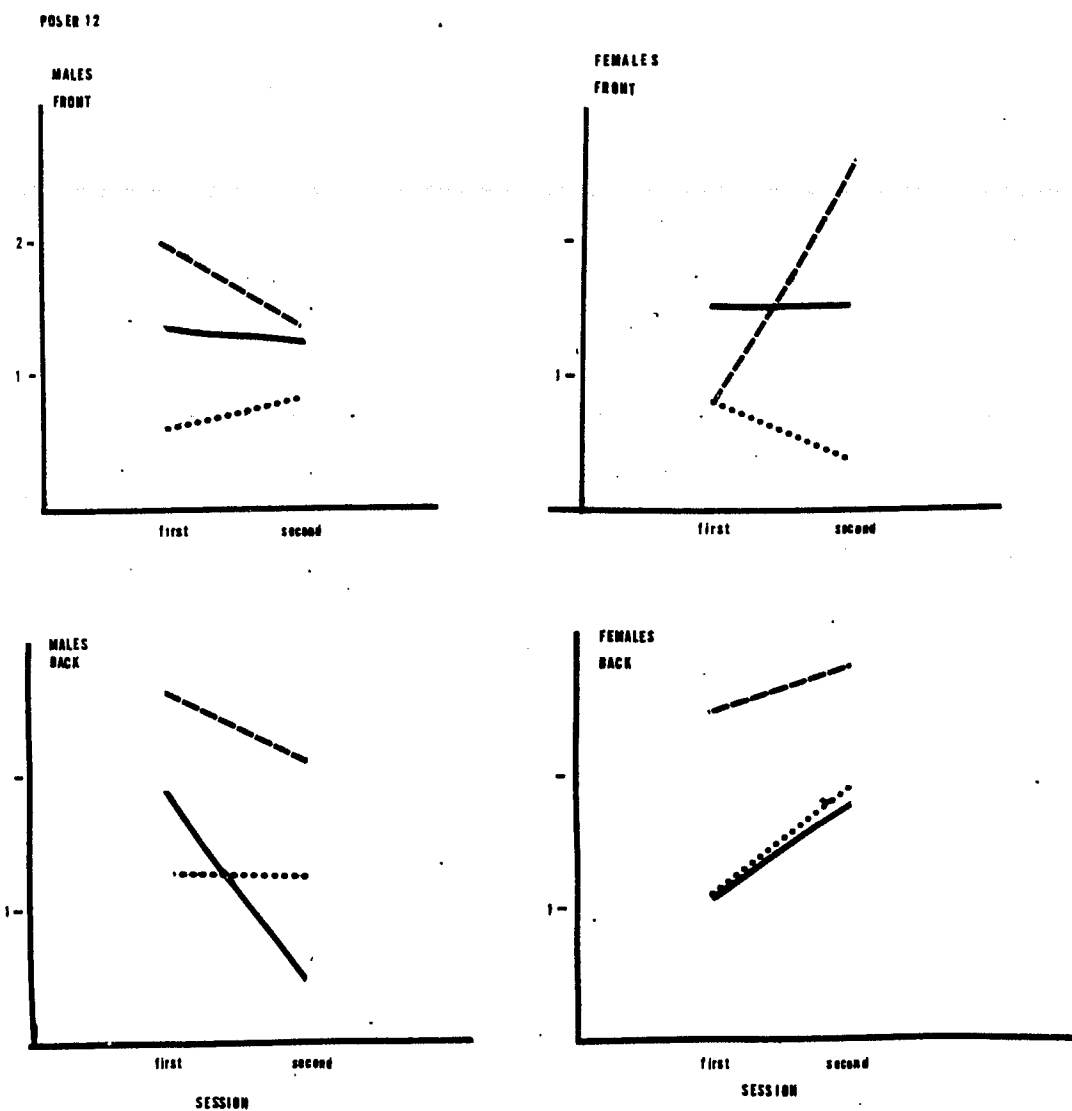


FIGURE 31
Mean RT As A Function Of Visual Field

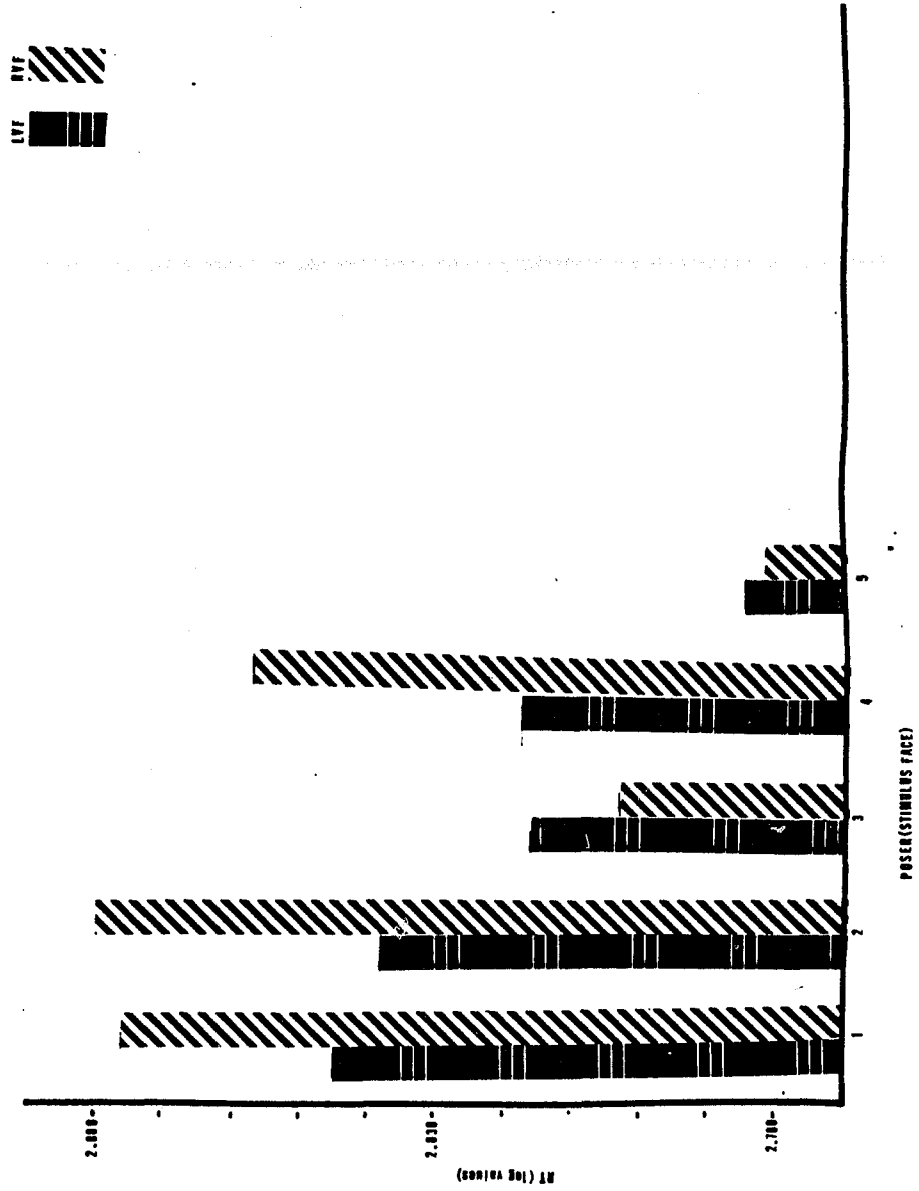


FIGURE 32
Comparison Of Faces Showing Different Patterns Of Asymmetry

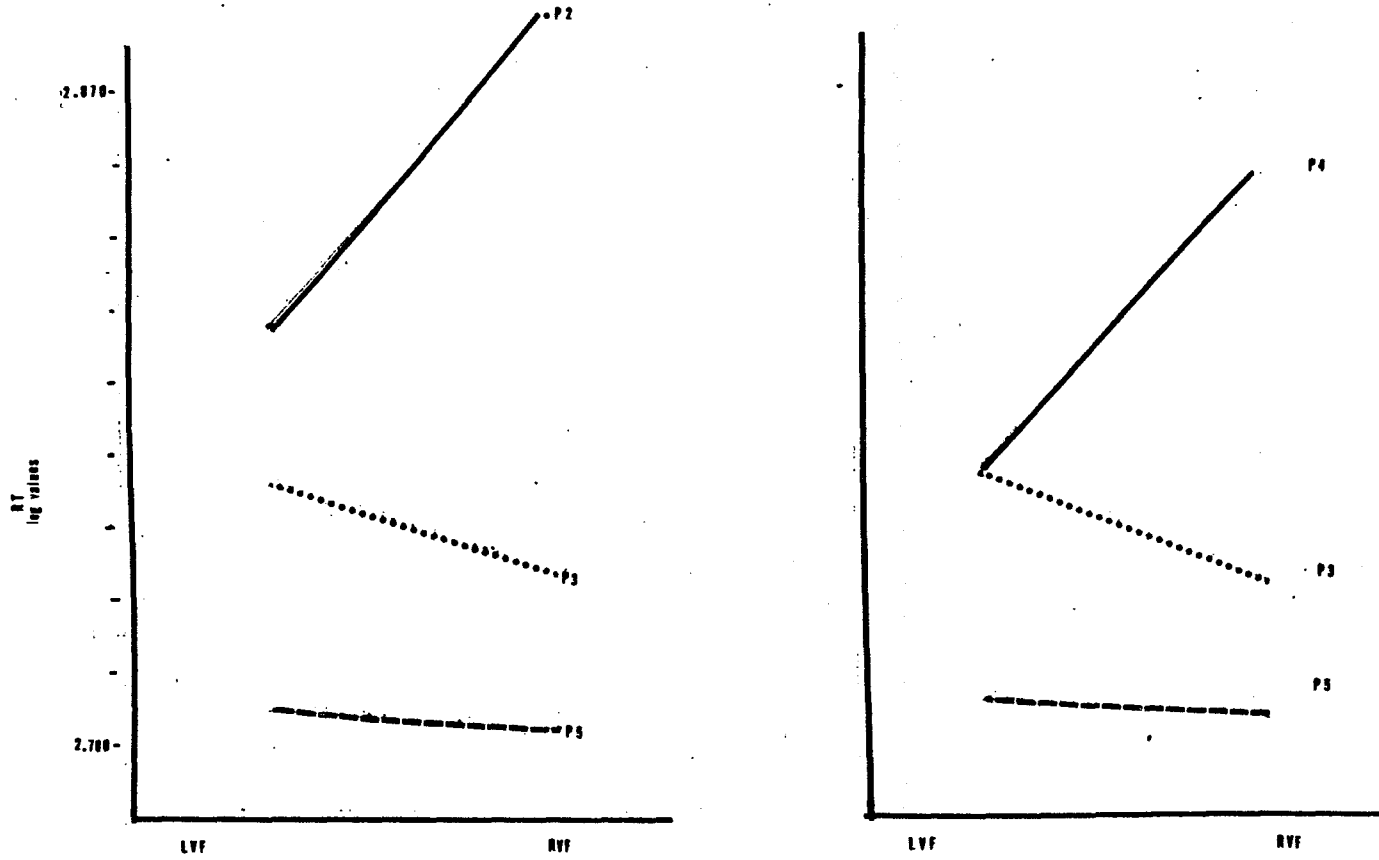


FIGURE 33
Field Asymmetry As A Function Of Intensity

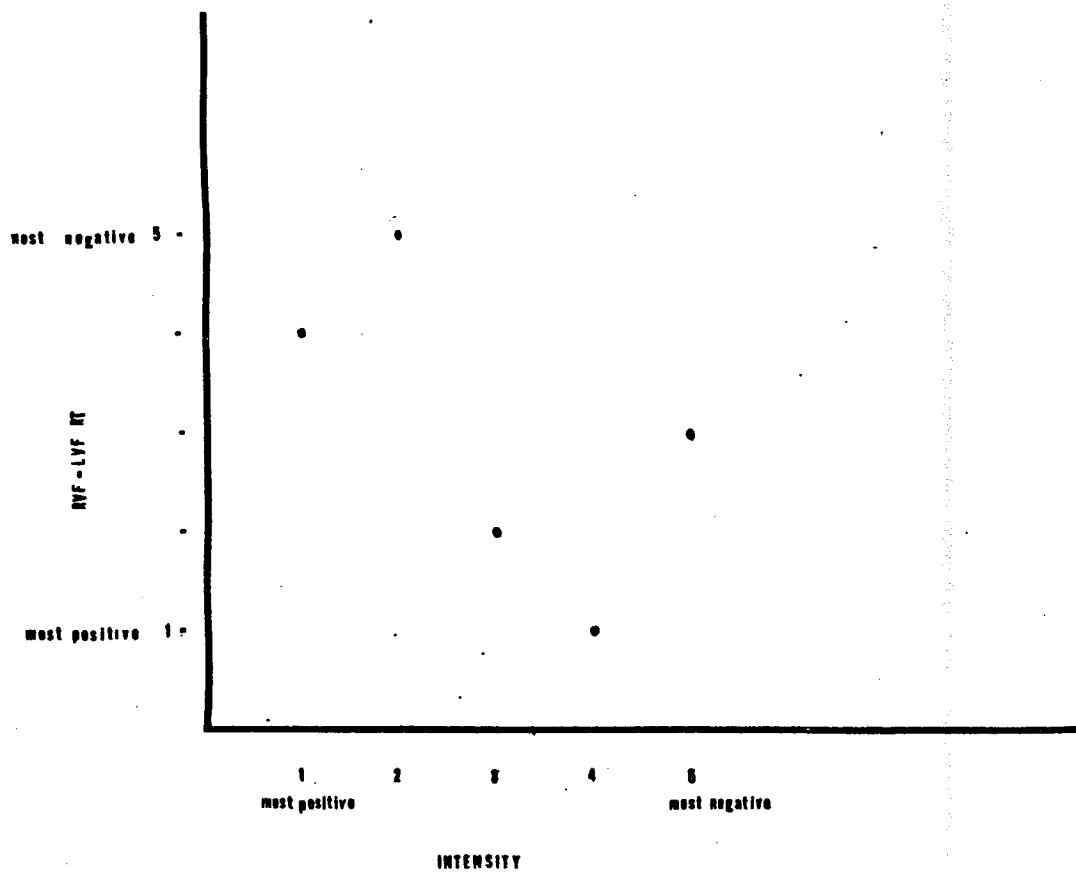


FIGURE 34
Field Asymmetry As A Function Of Overall Intensity Rating

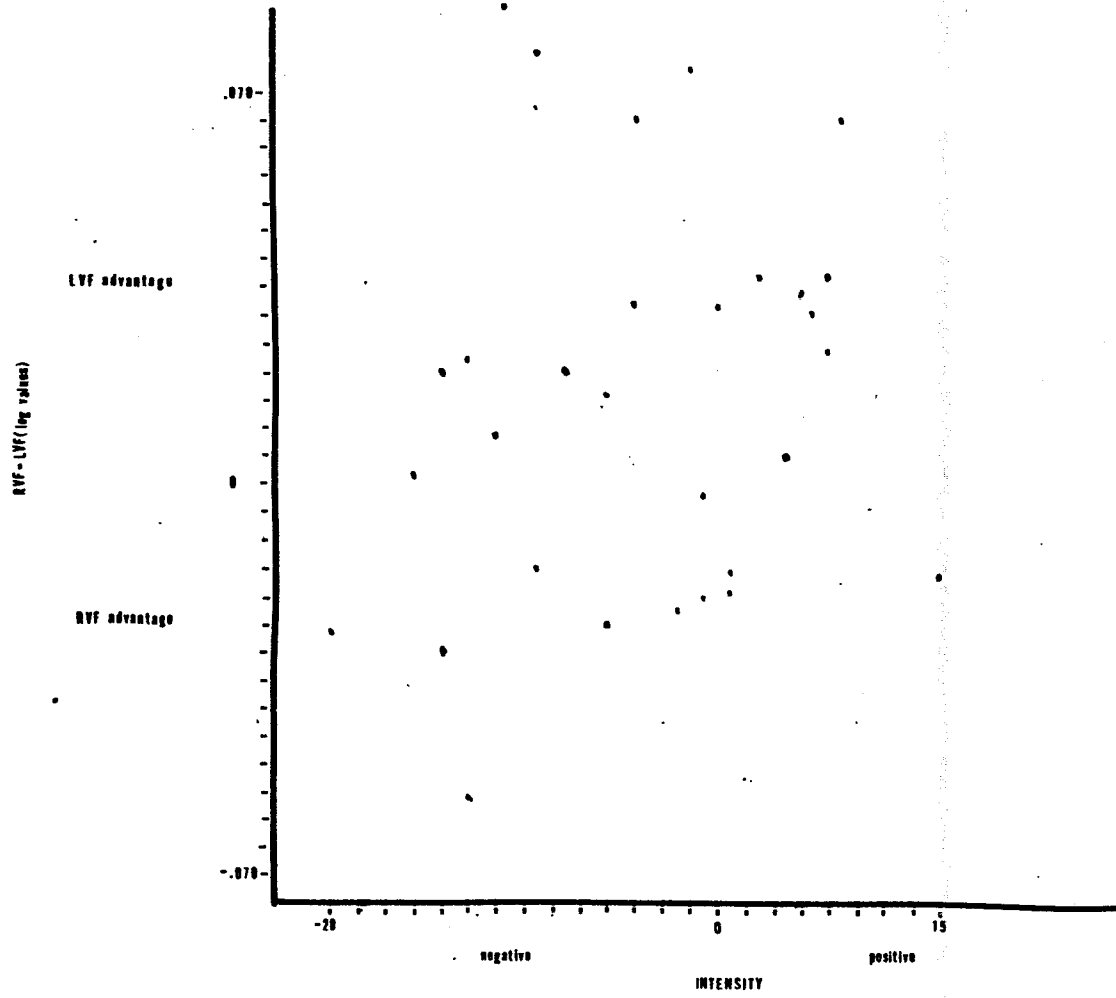
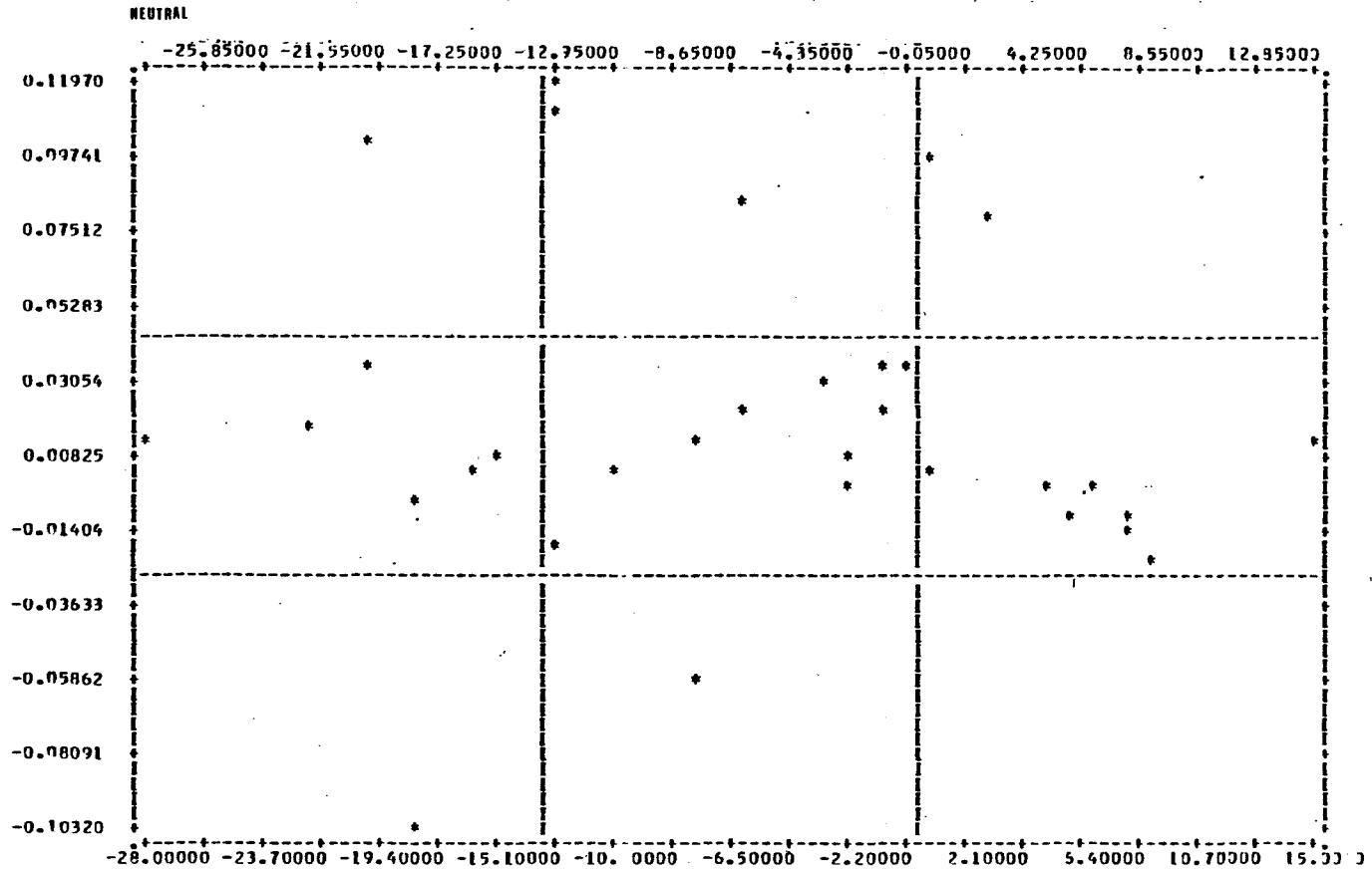


FIGURE 35
Visual Field Asymmetry As A Function Of Intensity Rating



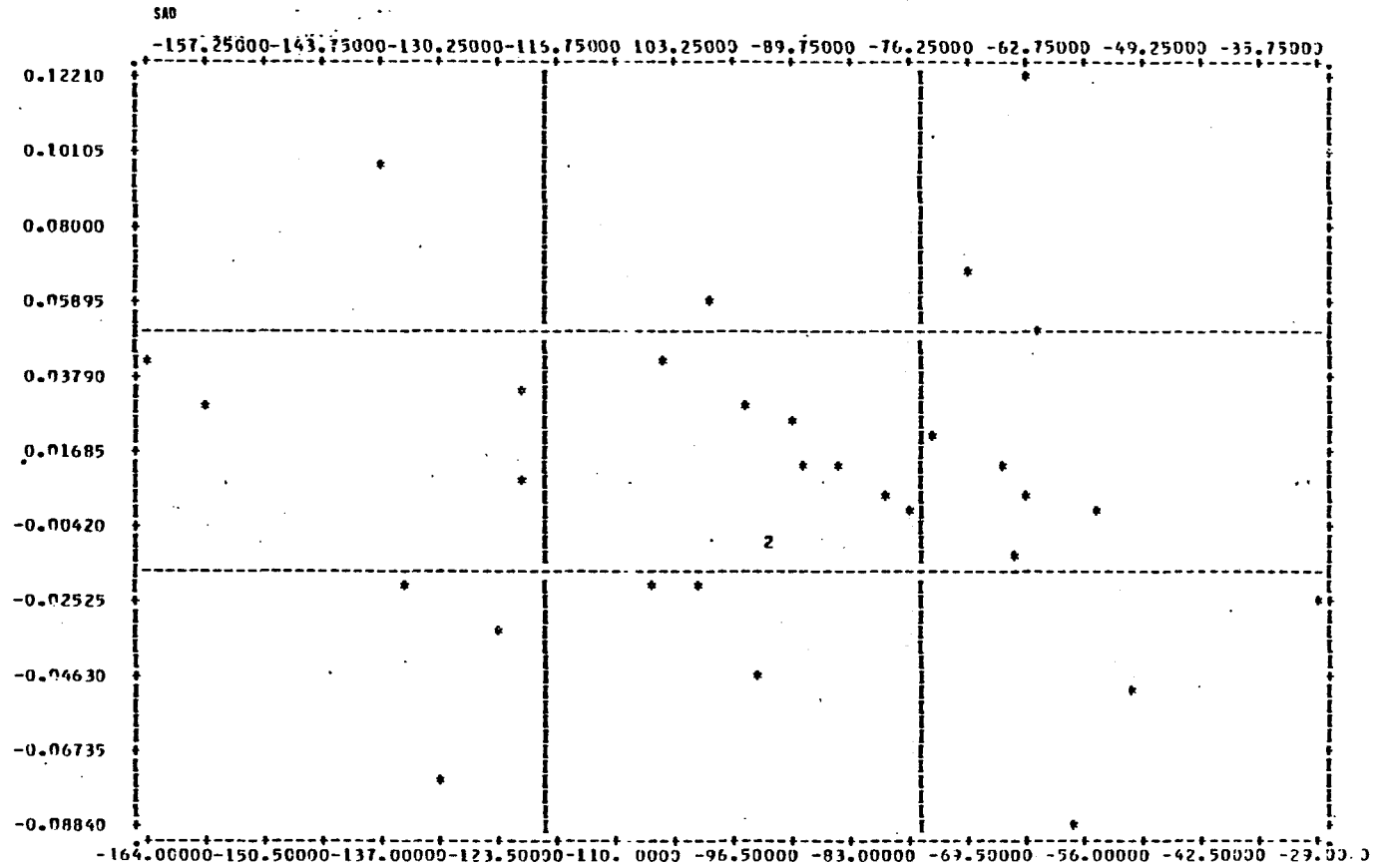
185

STATISTICS..

CORRELATION (R)-	-0.00468	R SQUARED -	0.00717	SIGNIFICANCE -	0.32247
STD ERR OF EST -	0.04815	INTERCEPT (A) -	0.01695	SLOPE (B) -	-0.00337
PLOTTED VALUES -	32	EXCLUDED VALUES-	0	MISSING VALUES -	0

FIGURE 36

Visual Field Asymmetry As A Function Of Intensity Rating

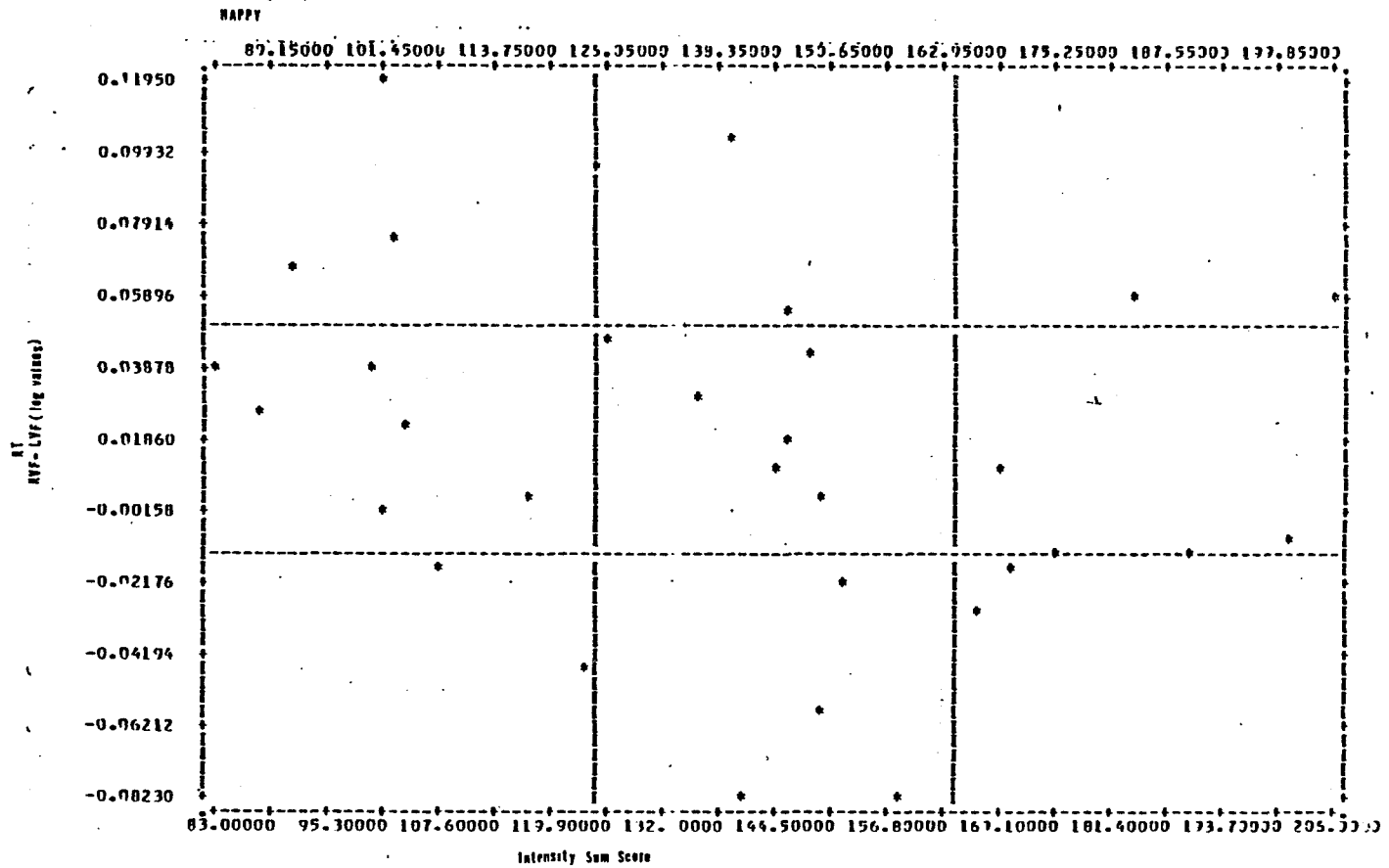


186

STATISTICS..

CORRELATION (R)-	-0.12720	R SQUARED	0.01618	SIGNIFICANCE	0.24331
STD ERR OF EST -	0.04543	INTERCEPT (A) -	-0.00825	SLOPE (B) -	-0.00310
PLOTTED VALUES -	32	EXCLUDED VALUES-	0	MISSING VALUES -	0

FIGURE 97
Visual Field Asymmetry As A Function Of Intensity Rating



187

CORRELATION (R)-	-0.28517	R SQUARED -	0.08132	SIGNIFICANCE -	0.3553
STD ERR OF EST -	0.04839	INTERCEPT (I) -	0.07517	SLOPE (B) -	-0.0034
PLOTTED VALUES -	32	EXCLUDED VALUES -	0	MISSING VALUES -	0

Reference Notes

1. Zeidler, D. K., & Rosen, J. J. Laterality and facial affect. Unpublished manuscript submitted to NIMH as the basis for this thesis and supported by grant 1 f1 MH08597-01.
2. Davidson, R. J. Emotion and cerebral asymmetry. Paper presented at City College colloquia, 1983.
3. Zeidler, D .K., Brozgold, A., Rosen, J. J., & Gerstman, L. J. Perceptual factors affecting asymmetries of emotional facial expressions. Paper presented at INS, Pittsburg, 1982.
4. Borod, J. C., & Koff, E. Facial asymmetry and lateral dominance in normal and brain-damaged adults. Paper presented at INS, Pittsburg, 1982.
5. Rinn, W.E. An investigation of personality correlates of lateral gaze preference and facial asymmetry. Paper presented at INS, Pittsburg, 1982.

References

- Annett, M. The distribution of manual asymmetry. British Journal of Psychology, 1972, 63, 343-358.
- Benton, A. L. Visuoceptive, visuospatial and visuoconstructive disorders. In K. Heilman & E. Valenstein (Eds.), Clinical neuropsychology. New York: Oxford University Press, 1979.
- Benton, A. L. The neuropsychology of facial recognition. American Psychologist, 1980, 35, 176-186.
- Benton, A. L., & Van Allen, M. W. Impairment in facial recognition in patients with cerebral disease. Cortex, 1968, 4, 344-458.
- Berlin, C. Hemispheric Asymmetry in auditory tasks. In S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes & G. Krauthamer (Eds.), Lateralization in the nervous system. New York: Academic Press, 1977.
- Bogen, J. E. The other side of the brain. II. An appositional mind. Bulletin of the Los Angeles Neurological Societies, 1969, 34, 135-162
- Borod, J. C., & Caron, H. S. Facedness and emotion related to lateral dominance, sex and expression. Neuropsychologia, 1980, 18, 237-242.
- Bradshaw, J. L., & Nettleson, N. C. The nature of hemispheric specialization in man. The Behavioral and Brain Sciences, 1981, 4, 51-91.
- Buck, R. Nonverbal communication of affect in children. Journal of Personality and Social Psychology, 1975, 31, 644-653.
- Campbell, R. Asymmetries in interpreting and expressing posed facial expression. Cortex, 1978, 14, 327-342.
- Carmon, A., & Nachson, I. Ear asymmetry in perception of emotional non-verbal stimuli. Acta Psychologica, 1973, 37, 351-357.

- Carpenter, M. B. Core text of neuroanatomy. Baltimore: Wilkins & Wilkins, 1978.
- Cione, M., Wapner, W., & Gardner, H. Sensitivity to emotional expressions and situations in organic patients. Cortex, 1980, 16, 145-158.
- Damasio, A. A., Damasio, H., & Van Hoesen, G. W. Prosopagnosia: Anatomic basis and behavioral mechanisms. Neurology, 1982, 32, 231-241.
- Dekofsky, S. T., Heilman, K., Bowers, D., & Valenstein, E. Recognition and discrimination of emotional faces and pictures. Brain & Language, 1980, 9, 206-214.
- Denny-Brown, D., Meyer, J. S., & Hornstein, S. The significance of perceptual rivalry resulting from parietal lesion. Brain, 1952, 75, 433-471.
- DeRenzi, E., & Spinnler, H. Facial recognition in brain damaged patients. Neurology, 1966, 26, 144-152.
- DeRenzi, E., Faglioni, P., & Spinnler, H. The performance of patients with unilateral brain damage on facial recognition tasks. Cortex, 1968, 4, 17-34.
- DeRenzi, E. Hemispheric asymmetry as evidenced by spatial disorders. In M. Kinsbourne, (Ed.), Asymmetrical Function of the brain. Cambridge: Cambridge University Press, 1979.
- Dimond, S. J., & Farrington, L. Emotional response to films shown to the right and left hemisphere of the brain measured by heart rate. Acta Psychologica, 1977, 41, 255-260.
- Dimond, S. J., & Farrington, L., & Johnson, P. Differing emotional response from right and left hemispheres. Nature, 1976, 261, 690-691.
- Ekman, P. Darwin and cross-cultural studies of facial expression. In P. Ekman (Ed.), Darwin and facial expressions: A century of research in review. New York: Academic Press, 1973.

- Ekman, P., Hager, J. C., & Friesen, W. V. The symmetry of emotional and deliberate facial actions. Psychophysiology, 1981, 18, 101-106
- Ellis, H. D., & Shepard, J. Recognition of upright and inverted faces presented in the left and right visual field. Cortex, 1975, 11, 3-6.
- Gainotti, G. Emotional Behavior and hemispheric side of lesion. Cortex, 1972, 8, 41-56.
- Galin, D. Implications for psychiatry of left and right cerebral specialization. Archives of General Psychiatry, 1974, 31, 572-581.
- Galper, R. E., & Costa, L. Hemispheric superiority for recognising faces depends upon how they are learned. Cortex, 1980, 16, 21-38.
- Geffen, G., Bradshaw, J. L., & Wallace, G. Interhemispheric effects on reaction time to verbal and nonverbal visual stimuli. Journal of Experimental Psychology, 1971, 87, 415-422.
- Goldberg, E., & Costa, L. D. Hemisphere differences in the acquisition and use of descriptive systems. Brain & Language, 1981, 14, 144-173.
- Goldstein, K. The organism: A holistic approach to biology derived from pathological data in man. New York: American Books, 1939.
- Goodglass, H., & Kaplan, E. Assessment of cognitive deficit in the brain-injured patient. In M. Gazzaniga (Ed.), Handbook of behavioral neurobiology. New York: Plenum Press, 1979, 3-25.
- Gur, R., & Gur, R. Correlates of conjugate lateral eye movements in man. In S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes & G. Krauthamer (Eds.), Lateralization in the nervous system. New York: Academic Press, 1977.

- Haggard, M. P., & Parkinson, A. M. Stimulus and task factors as determinants of ear advantage. Journal of Experimental Psychology, 1971, 23, 168-177.
- Harnad, S., Doty, R. W., Goldstein, L., Jaynes J., & Kauthamer, G., (Eds.), Lateralization in the nervous system. New York: Academic Press, 1977.
- Hamsher, K. DeS., Levine, H. S., & Benton, A. L. Facial recognition in patients with focal brain lesions. Archives of Neurology, 1979, 36, 837-839.
- Heller, W., & Levy, J. Perception and expression of emotion in right-handers and left-handers. Neuropsychologia, 1981, 19, 263-272.
- Heilman, K., Scholes, R., & Watson, R. T. Auditory affective agnosia. Journal of Neurology, Neurosurgery, & Psychiatry, 1975, 38, 69-72.
- Hirschman, R. S., & Safer, M. A. Hemispheric differences in perceiving positive and negative emotions. Cortex, 1982, 18, 569-580.
- Hilliard, R. D. Hemispheric laterality affects on a facial recognition task in normal subjects. Cortex, 1973, 9, 246-258.
- Kimura, D. Functional asymmetry of the brain in dichotic listening. Cortex, 1967, 3, 163-178.
- Kimura, D. Cerebral dominance and the perception of verbal stimuli. Canadian Journal Of Psychology, 1961, 15, 166-171.
- Kinsborne, M. Asymmetrical function of the brain. Cambridge: Cambridge University Press, 1979.
- Kolb, B., & Taylor, L. Affective behavior in patients with localized cortical excisions: Role of lesion site and side. Science, 1981, 214, 89-91.
- Levy, J., Trevarthan, C., & Sperry, R. W. Perception of bilateral chimeric figures following hemisphere disconnection. Brain, 1972, 95, 61-78.

- Ley, G., & Bryden, M. P. Hemispheric differences in processing emotions and faces. Brain & Language, 1979, 7, 129-141.
- Luria, A. R. Higher cortical functions in man (2nd ed.). New York: Basic Books, 1980.
- McGlone, J., & Kertesz, A. Sex differences in cerebral processing of visuospatial tasks. Cortex, 1973, 9, 313-320.
- McKeever, W. F., & Dixon, M. S. Right-hemisphere superiority for discrimination memorized from nonmemorized faces: Affective Imagery, sex, and perceived emotionality effects. Brain & Language, 1981, 12, 246-260.
- McKeever, W. F., & VanDaventer, A. D. Visual and auditory language processing asymmetries: Influences of handedness, familial sinistrality and sex. Cortex, 1977, 13, 225-241.
- Milner, B. Visual recognition and recall after right temporal-lobe excision in man. Neuropsychologia, 1968, 6, 191-209.
- Moscovitch, M. Information processing and the cerebral hemispheres. In M. Gazzaniga, (Ed.), Handbook of behavioral neurobiology. New York: Plenum Press, 1979.
- Moscovitch, M., Scullion, D., & Christie, D. Early vs. late stages of processing and their relation to functional hemispheric asymmetries in face recognition. Journal of Experimental Psychology: Human Perception and Performance, 1976, 2, 401-416.
- Natale, M., Gur, R. C., & Gur, R. E. Hemispheric asymmetries in processing emotional expressions. Neuropsychologia, 1983, 21, 555-565.
- Nebes, R. D. Hemispheric specialization in commissurotomed man. Psychological Bulletin, 1974, 81, 1-13.

- Patterson, K., & Bradshaw, J. Differential hemispheric mediation of nonverbal visual stimuli. Journal of Experimental Psychology: Human Perception and Performance, 1975, 1, 246-252.
- Pizzamiglio, L., Zoccolotti, P., Mammucari, A., & Cesaroni, R. The independence of face identity and facial expression recognition mechanisms: Relationship to sex and cognitive style. Brain & Cognition, 1983, 2, 176-188.
- Proudfoot, R. E. Hemispheric asymmetry for face recognition: Some effects of visual masking, hemiretinal stimulation and learning task. Neuropsychologia, 1982, 20, 129-143.
- Reuter-Lorenz, P., & Davidson, R. J. Differential contributions of the two cerebral hemispheres to the perception of happy and sad faces. Neuropsychologia, 1981, 19, 609-613.
- Reuter-Lorenz, P., Givis, R. P. & Moscovitz, M. Hemispheric specialization and the perception of emotion: Evidence from right-handers and from inverted and non-inverted left-handers. Neuropsychologia, 1983, 21, 687-692.
- Rizzolatti, G., Umiltà, C., & Berlucchi, G. Opposite superiorities of the right and left cerebral hemispheres in discriminatory reaction time to physiognomical and alphabetical material. Brain, 1971, 94, 431-442.
- Sackeim, H., & Gur, R. Lateral asymmetry in intensity of emotional expression. Neuropsychologia, 1978, 16, 473-481.
- Safer, M. Individual differences in the metacontrol of lateralization for recognizing facial expression of emotion. Cortex, 1984, 20, 19-25.
- Safer, M., & Leventhal, H. Ear differences in evaluating emotional tones of voice and verbal content. Journal of Experimental Psychology: Human Perception & Performance, 1977, 3, 72-82.

- Sergent, J. About face: Left-hemisphere involvement in processing physiognomies. Journal of Experimental Psychology: Human Perception and Performance, 1982, 8, 1-14.
- Sergent, J. Role of the input in visual hemispheric asymmetries. Psychological Bulletin, 1983, 93, 481-512.
- Sergent, J., & Bindra, D. Differential hemispheric processing of faces: Methodological considerations and reinterpretation. Psychological Bulletin, 1982, 89, 541-554.
- Springer, S. Tachistoscopic and dichotic listening investigations of laterality in normal human subjects. In S. Harnad, R. W. Doty, L. Goldstein, J. Jaynes, & G. Krauthamer, (eds.), Lateralization in the nervous system. New York: Academic Press, 1977.
- Strauss, E., & Moscovitch, M. Perception of facial expressions. Brain & Language, 1981, 13, 308-332.
- Suberi, M. & Mckeever, W. F. Differential right hemispheric memory storage of emotional and nonemotional faces. Neuropsychologia, 1977, 15, 757-768.
- Tucker, D. M., Watson, R. G., & Heilman, K. Affective discrimination and evocation in patients with right parietal disease. Neurology, 1976, 26, 354.
- Umilta, C., Brizzolara, D., Tabossi, P., & Fairweather, H. Factors affecting face recognition in the cerebral hemispheres: Familiarity and naming. In J. Requin (Ed.), Attention and Performance VII. New Jersey: Erlbaum, 1978.
- Warrington, E. K. & James, M. An experimental investigation of facial recognition in patients with unilateral lesion. Cortex, 1967, 3, 317-326.

- Weinstein, S. Functional cerebral hemispheric asymmetry. In M. Kinsbourne, (Ed.), Asymmetrical function of the brain. Cambridge: Cambridge University Press, 1979.
- White, M. J. Laterality differences in perception: A review. Psychological Bulletin, 1969, 72, 387-405.
- Witelson, S. F. Early hemisphere specialization and interhemispheric plasticity. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977, 213-289.
- Zaidel, E. Auditory vocabulary of the right hemisphere following brain bisection or hemidecortication. Cortex, 1976, 12, 191-211.
- Zaidel, E. Unilateral auditory language comprehension of the Token Test following cerebral commissurotomy and hemispherectomy. Neuropsychologia, 1977, 15, 1-18.