8119672

PIASETSKY, EUGENE B.

A STUDY OF PATHOLOGICAL ASYMMETRIES IN VISUAL-SPATIAL ATTENTION IN UNILATERALLY BRAIN-DAMAGED STROKE PATIENTS

City University of New York PH.D. 1981

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

A STUDY OF PATHOLOGICAL ASYMMETRIES IN VISUAL-SPATIAL ATTENTION IN UNILATERALLY BRAIN-DAMAGED STROKE PATIENTS

by

Eugene B. Piasetsky

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

1981

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.

date | Chairman of Examining Committee

date | Executive Officer

Professor Jeffrey Rosen

Professor Louis J. Gerstman

Professor Steven Mattis

Supervisory Committee

The City University of New York

Abstract

A STUDY OF PATHOLOGICAL ASYMMETRIES IN VISUAL-SPATIAL ATTENTION IN UNILATERALLY BRAIN-DAMAGED STROKE PATIENTS

by

Eugene B. Piasetsky

Advisor: Professor Jeffrey Rosen

Despite ample documentation, the relationship between inattention and disturbances in visual-spatial functioning among brain-damaged adults continues to engender controversy. There is substantial disagreement among researchers as to the relative incidence and severity of inattention following damage to the left versus right hemisphere and as to the extent to which inattention contributes to evidenced disorders in visual-spatial functioning. On the basis of recent studies which have documented the extent to which overt evidence of inattention varies considerably as a function of the task used and criteria employed, the possibility is raised that studies of inattention have been adversely influenced by problems in assessment (detection).

The present study sought to resolve some of the controversy surrounding the occurrence and impact of inattention in unilaterally brain-damaged stroke patients. In recognition of the varying nature of inattention and the problems involved in its assessment, a special task was constructed incorporating those characteristics of task demand and face construction reported to elicit most reliably evidence of inattention. The new task was found to have detected all instances of inattention revealed on any of five commonly used measures

(copying-drawing, reading, visual cancellation of a single target, visual cancellation of two targets, and position preference on Raven's Colored Progressive Matrices). Moreover, the new task was found to have detected several instances of inattention not revealed on any of the commonly used measures.

The presence of inattention, as defined by performance on the new task, was found to be associated with performance decrements on a variety of visuo-cognitive tasks in both left and right brain-damaged patients. Significantly, inattention on the new task was found to be related to decreased performance levels on Raven's Colored Matrices (RCPM) even when such inattention was not evidenced on the RCPM itself.

These findings are seen as providing evidence for the argument that more subtle forms of attentional asymmetry contribute to the deficits in visual-spatial functioning found in brain-damaged adults.

Acknowledgments

I am most grateful to Jeffrey Rosen, not only for the guidance and assistance he provided in the preparation of this manuscript, but also in recognition of his seemingly inexhaustible patience.

Special thanks to Leonard Diller for providing a hospitable and most supportive atmosphere in which to conduct this research.

Sincere thanks to Louis J. Gerstman for the benefit of his concern over any and all matters attendant to the completion of this work.

Finally, and with the greatest of affection, I wish to acknowledge the significant contribution made by my wife, Sheryl Piasetsky; her indispensable assistance in capacities ranging from discussant to stenographer was only exceeded in contribution by her unswerving support, constant encouragement, and well-timed prodding.

Table of Contents

Page

Abstract iv

Acknowledgments vi

List of Tables viii

List of Figures x

Chapter

I Introduction 1

Phenomenology and Occurrence of Neglect:
The Case Studies 5
The Group Studies 19

II Research Design and Methodology 27

Task Construction 28
Methods 39
Procedures 51

III Results 53

IV Discussion 95

The Varying Nature of Inattention and the Problem
of Detection 95
The Determinants of Inattention 98
The Nature of Patient Performance on the Newly
Constructed Task 101
The Impact of Disordered Visuo-Spatial Attention
on the Performance of Patients on Tests of
Higher Visuo-Cognitive Function 107
The Differential Impact of Asymmetries in
Attention and Visual Field Defects on
Patient Performance 112

Appendix A 117

Reference Note 118

References 119

List of Tables

Table		Page
1	Subject Demographics	43
2	Motor Status of Brain-Damaged Subjects	45
3	Sensory Status of Brain-Damaged Subjects	47
4	Language and Speech Status of LBD Subjects	48
5	Performance of Subjects on the New Task	54
6	Analysis of the Performance of the Three Experimental Groups on the Four Trials of the Newly Constructed Task	55
7	Presentation of Significant Findings from the Three-Way Analysis of Variance on the Scores Attained by Each Experimental Group on the Newly Constructed Picture-Matching Task	57
8	Mean Number of Detail Errors Overlooked	64
9	Two-Way Analysis of Variance of Detail Errors	66
10	Analysis of Simple Main Effects of Interaction of Error Location	68
11	Mean Number of Detail Errors Overlooked (Recast to Reflect Delineation of Brain-Damaged Subjects by Gross-Spatial Bias)	70
12	Estimated Incidence of Inattention in Brain-Damaged Subjects as a Function of Different Task-Related Criteria	73
13	The Distribution of Subjects from Each Brain-Damaged Group Across Three Subgroups of Inattention	76
14	Performance of the Three RBD Subgroups on Raven's Colored Progressive Matrices	78
15	Analysis of the Performance of Three RBD Subgroups on Raven's Colored Progressive Matrices	79
16	Performance of the Two LBD Subgroups on Raven's Colored Progressive Matrices	81

Table		Page
17	Performance of the Three RBD Subgroups on Four Specific Tasks	83
18	Analysis of the Performance of the Three RBD Subgroups on Similarities	85
19	Performance of the Two LBD Subgroups on Three Specific Tasks	86
20	Status of Motor Function of Affected and Unaffected Brain-Damaged Subjects	88
21	Status of Sensory Function of Affected and Unaffected brain-Damaged Subjects	90
22	Locus of Lesion for Affected and Unaffected Subjects Based on CAT Scan Findings	92
23	Language Impairments of Affected LBD Subjects	94
24	Partial Correlation Coefficients for Trial Conditions with Tests of Visuo-Cognitive Function	112
25	The Distribution of RBD Subjects by Visual Field Defect and Severity of Attentional Asymmetry	114
26	Performance of the Three RBD Subgroups on Raven's Colored Progressive Matrices as a Function of Whether a Visual Field Defect Had Been Sustained	115

List of Figures

Figure		Page
1	Basic Layout of Individual Plates	29
2	Illustrating Layout When Correct Response Is in Left Third-Field	31
3	Illustrating Layout When Correct Response Is in Right Third-Field	32
4	Illustrating Layout When Correct Response Is in Center Third-Field	33
5	Duplication of Sample Plate A	36
6	Duplication of Sample Plate B	37
7	Response Biases Averaged Across Four Administrations of the Newly Constructed Picture-Matching Task	59
8	Response Biases Averaged Across Two Match-to-Sample Administrations	61
9	Response Biases Averaged Across Two Match-from-Memory Administrations	62

CHAPTER I

INTRODUCTION

Evidence linking disorders in visually bound behavior in brain-damaged individuals to pathological asymmetries in visual-spatial attention (e.g., unilateral neglect of space; inattention[1]) has been building over the past 20 to 25 years. Numerous studies have implicated visuo-spatial inattention (or the more severe disorder, neglect) as a contributory factor in a wide range of diagnostic entities associated with damage to one or both cerebral hemispheres. These have included: (1) disturbances in constructional praxis (Arrigoni & DeRenzi, 1964; Costa et al., 1969; Gianotti & Tiacci, 1970; Gianotti et al., 1972; McFie, Piercy, & Zangwill, 1950); (2) disorders in route finding in the absence of a loss of topographic memory (Brain, 1941; Humphrey & Zangwill, 1952; McFie et al., 1950); (3) reading disturbances (Benson & Geschwind, 1969; Lawson, 1962; Weinberg et al., 1977); (4) difficulties in performing written arithmetic (Hecaen, 1962; Humphrey & Zangwill, 1952); (5) disorders in visual scanning and visual search (Chedru et al., 1973; Weinberg et al., 1977); and (6) performance deficits on tasks

---

[1]For purposes of clarity and consistency, the terms <u>inattention</u> and <u>visuo-spatial inattention</u> will be used interchangeably throughout this text. The neurologic finding of one stimulus being obliterated by the presence of another will be referred to as <u>extinction</u>. In reviewing relevant literature, when the term <u>visual inattention</u> has been used by an author to define extinction in the visual modality, it will be further qualified in this text by the phrase "to visual confrontation."

involving complex visual discriminations (Gianotti & Tiacci, 1971), visual matching (Campbell & Oxbury, 1976), disembedding of overlapping figures (Critchley, 1953; Denny-Brown et al., 1952; Gianotti & Tiacci, 1971), and visual-spatial reasoning (Costa et al., 1969; Gianotti et al., 1977).

Despite ample documentation, the relationship between inattention and disturbances in visual behavior among brain-damaged adults continues to engender controversy. There is disagreement concerning the relative incidence and severity of inattention following damage to the left versus right hemisphere, with most researchers contending that right hemispheric lesions are associated with greater incidence and more pronounced manifestations of inattention than left hemispheric lesions. There is further disagreement as to the extent to which inattention contributes to evidenced disorders in visual behavior, even when those disorders follow damage to the right hemisphere. Negative evidence (disorders occurring in the absence of inattention) has been cited by several researchers (Ettlinger et al., 1957; Masure & Tzavaras, 1976; Warrington et al., 1966), while other authors have reported a persistence in performance deficits even when the presence of an attentional disorder has been statistically (Basso et al., 1973) or methodologically (Faglioni, Spinnler, & Scotti, 1971; Kinsbourne & Warrington, 1962) isolated.

Assessing this body of research findings is further complicated by studies which have revealed that the detection of pathological asymmetries in attention is often dependent upon the construction of the tasks employed and the qualitative criteria selected. Certain tasks have been found to elicit overt evidence of attentional asymmetries (i.e., attentional biases, vis-a-vis unilateral omissions and response-choice position preferences) more readily than others (Campbell & Oxbury, 1976; Colombo et al., 1976). Diagnostic determinations based upon less sensitive tasks would likely underestimate the prevalence of inattention. Moreover, on specific tasks (e.g., drawing and drawing-copying), the occurrence of biases in attention has been found to vary as a function of whether gross or fine errors of omission served as the criterion (DeRenzi & Faglioni, 1967; Gianotti & Tiacci, 1970, 1972; Gianotti, Messerli, & Tissot, 1972). It would follow, then, that milder forms of spatial inattention would have gone undetected in studies employing overly gross criteria and/or relatively insensitive tasks.

It is the present author's contention that:

1. The controversy surrounding the contribution of spatial inattention to aberrant visual behavior has, in part, resulted from spuriously contradictory findings. Artificial differences are seen as having resulted from a lack of consensus as to what criteria constitute evidence of an impairment in spatial attention.

2. The contribution of disturbances in spatial attention to aberrant visual behavior has been significantly underestimated. Empirically, this is seen as having resulted from the use of overly gross diagnostic criteria. Theoretically, established classes of diagnostic criteria often reflect (what is felt by this author to be) an overly narrow conceptualization of attentional disturbances, so that they are expressed in terms of a dichotomy (i.e., drawn/not drawn; perceived/not perceived). The sensitivity of these criteria would be

limited to instances of absolute deficit (i.e., a breakdown in attention) and consequently inadequate with respect to detection of instances of relative deficit (i.e., fluctuations in attention).

3. The prevalence of disturbances in spatial attention has been significantly underestimated. This is seen as having resulted from the inadequate sensitivity of available diagnostic instruments to more subtle forms of inattention. Existing instruments have not sufficiently incorporated those qualities of task demand and face construction to maximize sensitivity to spatial inattention.

This study proposes to:

1. Construct a task incorporating those parameters of task demand and face construction which are found to elicit most reliably evidence of spatial inattention;

2. Utilize the newly constructed task to document the prevalence of spatial inattention among unilaterally brain-damaged adults;

3. Utilize the newly constructed task to explore the relationship between spatial inattention and performance deficits on established tests of visual-perceptual and visuo-spatial functioning. Particular emphasis will be focused on those performance deficits for which an absolute deficit in attention is not implicated (i.e., no evidence of errors of omission or response-position preference).

Background

The occurrence and phenomenology of spatial inattention are presented in two segments: (1) examination of case studies, and (2) review of statistical (group) reports. The case studies serve to highlight and dissect specific instances of visuo-spatial inattention. While individual cases are not likely to coincide exactly with respect to behavioral properties, certain principles underlying the interrelationships among these properties should be discernible. The statistical reports serve to document the prevalence of spatial inattention and its behavioral manifestations.

In addition to a general review of the literature, individual topics of relevance to this proposed study are discussed. These include findings which offer potential support for the occurrence of relative deficits in spatial attention, and findings related to issues surrounding the construction of a sensitive metric.

Phenomenology and Occurrence of Neglect

The case studies. Holmes (1918a) presented case histories of bilaterally brain-damaged gunshot wound patients, all of whom exhibited a disorder in spatial orientation. In reviewing these cases, Holmes (1919) delineated nine component visual disturbances which characterized these patients. Included among these was a disturbance in visual attention. This disturbance, to the extent to which it was explored, was not a unilateral one. It was, rather, observed to affect both lateral visual fields similarly, and was depicted as occurring in contradistinction to preserved central (foveal) attention. In describing these patients, Holmes noted that "every object in central vision seemed to absorb attention . . . [which] was incapable of noticing two or more visible objects at the same time" (p. 232). Holmes (1918b) reported one case (Pvt. A) of unilaterally impaired visual attention. This patient was found not to exhibit disordered spatial orientation, although he reportedly experienced difficulty in recognizing objects appearing in his left (inattended) visual field. The patient, having suffered a missile wound to the right parietal cortex, was also reported, when tired, to have exhibited intermittent failure in noticing objects to his left.

Holmes and Horrax (1919) presented a case of disordered spatial orientation, (restricted to the visual modality) with a loss of stereoscopic vision, who also exhibited a disturbance in visual attention. The patient had suffered a bilateral parietal lobe injury, and, much like the cases reported by Holmes (1918a), he exhibited reduced attention in both lateral fields and became somewhat transfixed with objects viewed centrally. Further examination revealed, however, that the patient did not suffer from a uniform bilateral decrement in peripheral attention. Rather, his disturbance was characterized by an attentional decrement which vacillated between the left and right peripheral fields:

> When the observer's two hands were held up, one on either side of his visual axes and at equal angles from them, he could always perceive the slightest movement of either when it alone was moved, but failed constantly to recognize the simultaneous movement of both hands and saw indiscriminately that to his right or left only. . . . In one test, while he fixed his eyes on a needle which was stuck in a table, two pencils, a red and a yellow one, were placed 5 cm. on each side of it, at a distance of 50 cm. from him; then while gazing at the needle he could see one pencil only, and indiscriminately that to his right or left. (Holmes & Horrax, 1919, p. 389)

These observations were noteworthy in that they appear to reflect not a single bi-peripheral disturbance in attention, but rather two component unilateral disturbances. It is not clear, however, that this patient's attentional disturbance was truly different (i.e., related to the loss of stereoscopic vision) from those of the cases reported earlier by Holmes. Subtler aspects may have been revealed in this case by virtue of a more intensive investigation.

While Holmes did not consider disturbed visual attention to be requisite to disordered spatial orientation per se, he noted its apparent association with certain deficits in visually bound behavior. Included among these were impairments in visual recognition, navigation through space, reading, and estimation of length and size. In only one case, however, that secondary to a right hemispheric lesion, was the attentional disturbance (and associated recognition difficulty) clearly unilateral in nature.

Scheller and Seidemann (1932) described a patient who, secondary to a right CVA, exhibited topographic disorientation and a tendency to visually ignore the left half of space. However, inasmuch as the patient frequently failed to note objects and landmarks situated to his right, the authors concluded that visual neglect was not a primary factor in his topographic disorientation. They reasoned, rather, that the patient experienced a constriction in visual attention so that individual elements of his visual environment, though separately perceived, could not be integrated into a single spatial framework. The authors did consider, however, that visual neglect was likely contributory to the patient's oculo-motor symptoms. Volitional eye movements during visual exploration, the authors asserted, achieve direction through a moment-to-moment representation of the texture of the external visual environment. As such, Scheller and Seidemann drew a distinction between disordered visual scanning (affecting what is perceived) and disordered spatial synthesis (affecting how percepts are organized). Neglect of space was depicted as debilitating to the former, but inconsequential to the latter.

Riddoch (1935) presented two cases of unilaterally disordered spatial orientation secondary to space-occupying lesions. One of these, with surgically verified unilateral involvement of the left parietal cortex, also exhibited a unilateral disturbance in visual attention (to confrontation testing). Both the visual disorientation and visual inattention were evidenced in the patient's right visual field preoperatively. Only the visual disorientation, however, persisted beyond a few weeks postoperatively. Riddoch took this as supporting Holmes' contention that disturbed visual attention was not an essential factor in spatial disorientation. It should be noted, however, that, because of the limited scope of Riddoch's examination of this patient, it is not clear to what extent, if any, visual inattention was manifest in the patient's general visual behavior.

Brain (1941), in studying the phenomenology of spatial disorientation, noted a distinction between that reflected in defective localization of objects in space and that reflected in a route-finding disorder based in a marked tendency to neglect the left half of space. The former, termed "agnosia for spatial relations," was evidenced primarily in defective judgment of relative distance; the latter, termed "agnosia for the left half of space," was evidenced in neglect of space and a persistent tendency to make right-hand turns during exploratory ambulation.[2] Three cases were presented as exemplars of each disorder. The three patients exhibiting neglect of space were all right-hemispheric-damaged, densely hemianopic, and, in some way, disturbed in somato-sensory awareness. Brain rejected the primacy of a hemianopic defect in the pathogensis of neglect, noting that many hemianopic patients bump into obstacles but rarely, if ever, become lost in familiar surroundings. As Brain's choice of nomenclature would suggest, he ascribed neglect solely to instances of damage to the right hemisphere. Brain distinguished unilateral neglect of space from visual inattention (as revealed in confrontation testing) as occurring at the level of awareness of external space. As such, Brain characterized neglect as being inexorably connected to an underlying disorder in body scheme, and not strictly a visual phenomenon.

Patterson and Zangwill (1944) refuted two of Brain's contentions concerning unilateral neglect of space: (1) that it necessarily manifested in a route-finding disorder characterized by exclusive right-turnings, and (2) that it was inexorably associated with a disturbance in body scheme. These authors were among the first to employ a wide range of verbal and visuo-cognitive "intelligence" tests in their examinations. Both of the cases they presented had right brain damage and had sustained a partial hemianopic defect. Unequivocal evidence of unilateral neglect was obtained for one of the cases (Case #1). The other case displayed severe oculo-motor symptoms and was only

[2] Brain likened this visuo-motor component of spatial agnosia to sensory alloesthesia.

suspected of exhibiting occasional neglect. Neither patient displayed a route-finding disorder (as described by Brain), was disturbed in somato-sensory awareness, or was particularly impaired in judging relative distance. Both patients did exhibit deficits in drawing, block design construction, and stick design construction, and were similarly impaired on a visually bound test of analytic reasoning (Raven's Standard Progressive Matrices). The breadth of tasks employed by Patterson and Zangwill and the detail with which they reported their patient's performance provided a well delineated picture of each patient's spatial functioning. The findings reported on Case #1 were particularly revealing because of the considerable variance displayed in spatial awareness. Numerous inconsistencies in the patient's tendency to neglect were evidenced. These included: (1) varied presence of neglect in everyday activities; (2) varied presence of neglect on tasks requiring passive visual search; (3) varied presence of neglect on drawing tasks, as a function of complexity of design and whether it was to be copied or drawn from memory; (4) varied quality of neglect on drawing and size estimation tasks. The patient was also reported to be unquestionably aware of the nature of his problem, and in fact complained of a tendency to neglect objects on his left side. These findings are particularly meaningful inasmuch as they shed considerable light on the complex nature of disturbances in visuo-spatial attention and illuminate the problems associated with their diagnosis. For this reason, a more detailed examination of Patterson and Zangwill's findings on Case #1 are offered here.

In general behavior: "The patient often collided with objects on his left which he had clearly perceived a few moments before. He was liable at table to knock over dishes on his left-hand side and occasionally missed food on the left side of his plate" (Patterson & Zangwill, 1944, p. 339). While the patient could accurately count small objects distributed randomly in front of him, he exhibited left neglect in attempting to count the number of cubes in a three-dimensional configuration. When asked to point to objects situated in a semi-circle in front of him, he accurately localized the objects with his eyes open. With his eyes closed, however, he exhibited "a general shift to the right." A comparable displacement also occurred when he was asked, with eyes closed, to point straight ahead. These observations were significant on two accounts:

1. While the patient had evidently sustained a visuo-spatial impairment, this impairment was not a static feature of his visual behavior. The occurrence of neglect in this patient appeared, then, to ascribe best to a dynamic interaction between visuo-spatial attention and other functional entities.

2. The patient's accuracy at visually localizing objects in space was in sharp contract to his implied kinesthetic-proprioceptive representation of space. This evidenced dissociation, between appreciation of space mediated visually and that mediated via kinesthetic-proprioceptive mechanisms, is consistent with a differential disturbance to two separate functional systems, and largely incongruent with the principles defining a core agnosia.

Inconsistencies in the patient's tendency to neglect were also observed in his performance on drawing tasks. He reportedly copied simple geometrical designs "quickly and easily," though in copying complex designs, he frequently omitted the left side and was otherwise disoriented in his representation of individual features. He reportedly had no difficulty in drawing simple geometrical designs from memory. His drawings (from memory) of common objects, though fragmented and disorganized, were not typically characterized by left-side omissions. These citings further reflect the dynamic nature of the processes underlying unilateral neglect of space. At least three factors affecting the spatial integrity of the patient's drawings are discernible: stimulus complexity, stimulus familiarity, and the explicit demand for visual exploration.

The last of the inconsistencies in the patient's tendency to neglect was a qualitative one. Rather than involving the occurrence of neglect, it was reflected in a variability in the character of that symptom. An example of this was the seemingly paradoxical spatial error the patient committed in bisecting horizontal lines. While he reportedly bisected oblique lines correctly, horizontal lines were bisected as if the <u>right</u> side had been underestimated. Similarly, paradoxical errors were discernible in two of the patient's drawings, presented by the authors as examples of disorientation and fragmentation in the absence of neglect:

1. In copying a Snellen Chart the patient compressed all of his letters into the left half of the chart frame (which he had previously drawn). Two of the letters fell outside (to the left) of the frame altogether.

2. In drawing a horse, the patient conspicuously dislocated the horse's head from the right-hand side of an otherwise continuous drawing.[3]

These productions would not have been relatively remarkable had they come from a patient (presumably LBD) with an otherwise confirmed right neglect of space. From this patient, however, they were perplexing. Patterson and Zangwill chose to view them within the context of a generally fragmented and disoriented style of drawing, which they ascribed to an independent pathology in spatial synthesis (i.e., the "restricted attention" of Scheller and Seidemann). Such a pathology notwithstanding, however, the overall spatial disposition of errors in these drawings and in line bisection bore a highly suggestive similarity. The authors might well have considered this similarity in relation to the patient's general behavior (in which neglect was episodic rather than constant), and in light of his expressed insight into the problem. In this regard, the patient's paradoxical performance could have been taken to reflect a limited attempt at compensation, thus revealing yet another potential factor in the dynamic equation--that of the organism's response to a disrupted state.

---

[3]The patient's rendition of a horse was most striking. The body was a crude rectangle drawn open at the right. The left side of the rectangle, though closed, appeared choppy and indistinct. A small nub extended from the upper left corner and two pairs of legs were drawn extending from the lower surface. The two legs on the right were of equal length and longer than the legs on the left. The leftmost leg (extending from the lower left corner) was noticeably the shortest (giving the impression of an oblique perspective). Only the head was clearly dislocated (up and to the left of the opened right side). The drawings were reproduced in Patterson and Zangwill, 1944, pp. 340-341.

Similar evidence of the variable nature of visuo-spatial inattention was demonstrated by McFie et al. (1950). These authors reported eight cases of visual-spatial "agnosia" characterized by a similar fragmentation and disorientation in drawings as described by Patterson and Zangwill. While these patients were predominately right hemisphere damaged, most suffered malignant expanding lesions and evidenced some involvement (direct or referred) of the left hemisphere. Unilateral neglect of space was reported in six of the eight cases. One of these, Case #4, with verified direct bilateral involvement, reported the tendency to miss things on his left side yet failed to evidence this on formal testing. This same patient was minimally impaired in drawing a map or ground plan, yet reported numerous instances of having become lost in familiar surroundings. Other noteworthy observations included: one case (#5) of left neglect on counting scattered objects and copying complex figures, in the absence of difficulty in copying simple designs or drawing a ground plan (he was an engineer!); one case (#3) of left neglect in reading printed text and describing pictures, with no difficulty in counting scattered objects. This case also omitted features from the left-hand side of a drawn ground plan of his house, even after having correctly recounted those features verbally. In Case #5 the effects of inattention were apparently negated by a presumed high degree of familiarity with task demands (drawing ground plans would be second nature to an engineer). The positive effects of such familiarity, however, are limited. Where task demands are sufficiently complex (e.g., playing chess), inattention may persist (Cherington, 1974). In Case #3 inattention persisted during task execution (drawing), despite the verified accuracy of internal representation (verbal report). As such, inattention had had an impact on topographic behavior with no discernible effect on topographic recall. This is not, however, always the case.

Denny-Brown et al. (1952), in presenting their model of amorphosynthesis, reported a case of unilateral spatial neglect with a peculiar discrepancy between gross topographic behavior and topographic recall. The patient, having suffered a right parietal infarction, reportedly experienced no difficulty in finding her way around the hospital ward and could locate her room even when diverted (by the authors). In a postdischarge follow-up examination, when she was asked to describe her ward from memory, she presented a very "one-sided" picture:

> She began by describing all the patients and the windows which had been on her right, mentioning them from right to left. She made no mention of the patients on the left until pressed and then was able to recall 2 out of 5. In a similar manner when asked if there were not more windows or a door on her left, she was able to describe them together with a washbowl and a television set that had been on her left. When asked about the corridor from the ward she mentioned the rooms and the nurse's desk on her right but only mentioned the staircase and the rooms on the left when asked "what did you pass of your left?" She was able to find her way round her own apartment, could indicate correctly where various rooms were without looking, and could indicate their layout correctly, on a rough diagram. (pp. 438-439)

Her memory of the ward apparently included both left-side and right-side elements (though one might conjecture that she incorporated two right sides--one coming, one going); yet she freely recalled only the right-side elements. Amorphosynthesis notwithstanding, it would be tempting to ascribe such performance to the effects of inattention on incorporating or retrieving spatially bound information. Similar instances of unilateral omissions in topographic recall have since been reported by Ettlinger et al. (1957) (Case #10) and Bisiach and Luzatti (1978). The latter authors ascribed this performance to a neglect of representational space.

Lawson (1962) described two cases of visual neglect secondary to a right CVA. In each case inattention was found to vary in presence and nature as a function of the task undertaken. One patient, a former art student, was unimpaired in copying simple geometric figures and could trace out patterns in the Gottschaldt Test. With respect to the latter, however, she was observed to hesitate over the left-hand side of the figures. In reading she omitted the first words on a line and "accepted without question the text as it appeared," despite noting its lack of coherence. Her drawings of portraits were generally displaced to the right side of the page and, on full face views, were insufficiently detailed on the left side. In contrast, her drawings of profile views (including those facing leftward) were fully detailed. Lawson introduced trials of verbal cuing ("look to the left") to assist the patient in overcoming her inattention during reading. Cuing proved to be successful for reading of structured meaningful passages (where the patient learned to self-cue upon encountering incoherency), but had no appreciable impact on her drawings. On three-month follow-up the patient was found to have no difficulty in performing any of the "special" tests Lawson administered, and could read accurately (though she often hesitated at the beginning of a line of print). Her drawings of full-face views, however, remained insufficiently detailed on the left side.

Lawson's second case, a retired nursing Sister, presented with a massive left neglect of space. She exhibited "classic" omissions of the left sides of drawings, and could read only a narrow strip of words down the right side of a page. Lawson noted, however, that in drawing a cartwheel, the patient omitted the left side only when she started by drawing the inside of the wheel (hub and spokes). When she began by drawing the circumference of the wheel, her subsequent placement of internal details was adequate on the left as well as on the right. Lawson also attempted the verbal cuing technique with this patient, but with only limited success. Her reading improved greatly on the materials used in training, but she lapsed into neglect when new materials were introduced.

On the basis of his observations, Lawson concluded that neglect would be most likely manifested on tasks involving visual search or on tasks requiring careful visual control. He characterized neglect as being conditional upon the nature of the materials used and the demands of the tasks presented. Lawson further concluded that neglect could not be considered an absolute deficit. He determined that neglect was least likely to occur when stimulus materials or drawings contained a high degree of linear continuity or were enclosed within well defined borders. His study was further significant in that it demonstrated the potential for remediation in cases of visual neglect (a finding which has since been verified by Diller et al. [1974] and Weinberg et al. [1977]).

Notably absent among these cases have been instances of neglect secondary to a left hemispheric lesion. Head (1926) described the drawings of "semantic" aphasics with terminology (i.e., fragmented; piecemeal) almost identical to that used by Patterson and Zangwill (1944) and McFie et al. (1950) to define visual-spatial agnosia in right-brain-damaged (RBD) cases. Neglect of space, however, was not specifically mentioned by Head. Among Brain's (1941) cases of "agnosia for spatial relations" was one left-brain-damaged patient (LBD) whose behavior was consistent with a neglect syndrome (i.e., bumping into things, dressing disturbance, unilateral disturbance in body awareness), though a distinct visual component was not ascertained. (Her visual problems were attributed to a marked teleopsia in her right visual fields.) Denny-Brown and Banker (1954) presented a case of right-sided somato-sensory neglect with visual inattention to confrontation testing, but without frank evidence of visuo-spatial inattention. It was note-worthy, however, that the patient was observed to shave only the left side of his face (presumably looking in a mirror). One clear case of right visual neglect secondary to a left hemispheric lesion was described by Battersby et al. (1956). The patient was observed to bump into objects on his right side and reportedly made numerous right-sided omissions on Gottschaldt figures, manikin assembly, and block designs. Battersby et al. reported, but did not describe, three other similarly impaired cases.

McFie and Zangwill (1960) reported one case of mild visual neglect in an LBD constructional apractic, where the deficit was suggested in drawings and design construction but not in unguided visual exploration (Case #6). Among the other patients they studied, however, occasional instances of difficulty were noted in negotiating the right-hand sides of various visually bound tasks: a consistent error in reproducing block designs, which was restricted to the top right-hand block (Case #7); leaving open the right-hand side of an otherwise correct stick reproduction of a star (Cases #3 and #5)[4]; counting hours on a clock in a counterclockwise manner (Case #1).

In all, few clear-cut cases of visual neglect secondary to left hemispheric damage have been described. This, it has been argued, however, may not truly reflect the incidence of visuo-spatial inattention among the left brain damaged. Battersby et al. (1956) and Zarit and Kahn (1974) have suggested that those LBD patients with the greatest likelihood of exhibiting frank visual neglect (those having sustained parieto-temporo-occipital lesions) were generally precluded from study, because of the severity of their receptive language problems. In support of this, Battersby et al. (1956) noted that nearly all of the patients in their study who were unable to address the tasks they were presented were LBD aphasics with posterior parietal or posterior temporal lobe lesions.

The group studies. As reflected in the preceding review of case studies, instances of visual-spatial neglect were predominantly associated with damage to the right hemisphere. Similarly, where larger groups of patients have been studied, visual neglect has typically been found to occur more frequently and with greater severity following right, as opposed to left, hemispheric lesions (Faglioni et al., 1971; Hecaen, 1962; Gianotti, 1968; Oxbury, Campbell, & Oxbury, 1974; Piercy et al., 1960). However, as was evident in the case studies reviewed, detecting

---

[4] Patients' efforts were reproduced in McFie and Zangwill, 1960, p. 255.

the incidence of visual-spatial inattention is often complicated by issues of criteria and task selection. For this reason studies bearing upon the incidence of neglect in brain-damaged patients must be considered within the context of which criteria were employed and on which tasks! In this regard defining the incidence of neglect has been inextricably interwoven with the degree of severity of absolute deficits (errors of omission) manifested.

The argument raised by Battersby et al. (1956) and Zarit and Kahn (1974) is at least as relevant to the severity of symptoms as it is to the incidence of same. It is recalled that Battersby et al. (1956) advanced the original argument at a time when clinicians were reporting cases of frank neglect (evidenced in general behavior or in gross manifestations on "special" tests) among RBDs but rarely among LBDs. As a result, reports relating the incidence of neglect in RBDs to locus of lesion were, more accurately, relating the incidence of a relatively severe neglect to the brain region damaged (i.e., parieto-temporo-occipital area). In suggesting that LBDs with comparable lesions would be too aphasic to be examined, Battersby et al. were, in essence, accounting for the absence of severe neglect in these patients. For this reason such an argument is more appropriately applicable to the current consensus that neglect is more severe among right brain-damaged patients than among left. With respect to incidence, however, it follows that milder forms of inattention are not decidedly related to damage in one hemisphere as opposed to the other. With this in mind, the body of research data bearing upon incidence and severity of neglect is examined.

The case studies reviewed were particularly valuable in illustrating the degree to which detecting the presence of visuo-spatial inattention was confounded by both task selection and operational criteria. While each of these factors might well have influenced the findings related to incidence of neglect, some interaction between the two cannot be overlooked. Potential interactions, however, would not be open to retrospective examination, and, therefore, the present discussion is limited to issues of task selection and operational criteria, separately.

1. Task Selection--It has often been the case that, where researchers have employed a variety of tasks in their examinations, visuo-spatial attention in both LBD and RBD groups has been shown to be dynamically interrelated with visual-perceptual, visuo-motor, and visuo-cognitive functions. Battersby et al. (1956) reported that among the hemianopic patients they examined (18 LBD, 42 RBD), 48% of the RBDs evidenced neglect in general behavior, as compared to only 22% of the LBDs; however, an additional 28% of the patients in each brain-damaged group evidenced neglect on the "special" tests which were administered. The "special" tests included: visual searching, copying-drawing, figure disembedding, locating cities on a map, reading, and copying the position of randomly placed crosses. The authors did not delineate the incidence of neglect on each of these tasks. Piercy et al. (1960) found that 29% of their RBD cases evidenced neglect during reading, counting, or in general behavior. None of these cases, however, showed neglect on copying-drawing. They further reported that an additional 29% of their RBD cases exhibited neglect on copying-

drawing but not on any other tasks. Neglect among LBD cases (11%) was only evidenced on copying-drawing.

Leicester et al. (1969) found the presence of neglect to be related to the difficulty a task posed for their patients. Using a single multiple choice match-to-sample paradigm with several classes of stimuli (i.e., letters, words, consonant trigrams, pictures, ellipses, etc.), the authors found significant response-position preferences in 14 of 18 LBDs (left-side preference) and in 6 of 6 RBDs (right-side preference). Most notably, they found that their patients evidenced marked preferences primarily on trials where they found the required discrimination difficult to perform. For easy discriminations patients were typically able to locate the correct choice regardless of where it appeared. One illuminating exception to this, however, was described. One LBD patient (A.E.F.) was biased to the left (as expected) on trials involving difficult discriminations, yet showed a right-side response preference for a particularly easy discrimination trial. On easy discriminations this patient found the correct choice whenever it appeared on the left side of the disolay. When the correct choice did not appear on the left side of the display, however, she randomly selected responses (mostly incorrect) from the right side of the display. The authors posited five different types of neglect, identified by their association with different cognitive demands. This interpretation seems overly concrete, however, and could readily mushroom into a veritable dictionary of task-related attentional disorders. These data are seen by the present author as reflecting the organism's capacity for overcoming a weakened function (visuo-spatial attention) under conditions where other weakened functions or the cognitive apparatus as a whole is not severely taxed. Moreover, as reflected in patient A.E.F.'s performance, certain face aspects of individual tasks might offer cues to assist in overcoming such a weakness.

Colombo et al. (1976) found the differential presence of visual neglect in LBD and RBD patients to be related to whether a task inhered with explicit demands for thorough visual exploration. They based their interpretation on the following findings: (1) only RBDs (15% of sample) made two or more contralateral (re side of lesion) errors of omission on a copying-drawing task; (2) RBDs and LBDs were indistinguishable with respect to the presence of significant response-position preferences on Raven's CPM (31% of the RBDs, 32% of the LBDs); (3) LBDs and RBDs showed an indistinguishable tendency to utilize the side of space ipsilateral to their side of lesion in a ball-placing task (with no feedback); (4) when visual feedback (which holes have already been used) was added to the ball-placing task, only RBD's (4% of sample) failed to fill all the holes.

The authors contended that copying-drawing <u>demands</u> a thorough visual exploration, while the Raven's CPM merely implies same. It is equally true, however, that copying-drawing involves active manipulation and therefore provides an additional source of cuing (kinesthetic-proprioceptive feedback). Some additional observations on these authors' findings are pertinent to this discussion: (1) the simple incidence of visual neglect in LBD and RBD patients increased markedly on Raven's CPM as compared to that on copying-drawing; (2) the number of RBD and LBD patients exhibiting neglect on Raven's CPM (17 RBDs, 16 LBDs) was almost identical to the number of patients in each group who fell below cutting score for accuracy of drawing reproductions (21 RBDs, 16 LBDs). With respect to this latter finding, it is unfortunate that the authors did not investigate the possibility that the presence of a response bias on Raven's CPM might have differentiated those patients who were unable to draw the model accurately from those who were successful.

Campbell and Oxbury (1976), in a 6-month follow-up study of six RBD neglectors, found that only two patients continued to commit gross errors of omission on a copying-drawing task (the original criterion for neglect). They also found, however, that all six of the patients showed no appreciable change from their baseline tendency to prefer right-side responses on a multiple choice visual matching task, and remained significantly impaired, relative to controls, on several tests of spatial analysis and visual perception. These findings prompted Campbell and Oxbury to question the adequacy of omissions in copying-drawing as a criterion of neglect, and to further speculate that:

> the resolution of neglect in drawing may simply reflect the development of strategies to overcome a flagrant disability of which the patient has become aware through much practice, rather than recovery from the underlying disorder giving improved performance generalized to a number of different situations. (p. 311)

2. Objective Criteria--Several researchers have noted that, while gross omissions on copying-drawing tasks (i.e., half-completed drawings) are almost exclusively associated with instances of right brain damage, omissions of small peripheral figures may be encountered in RBDs and LBDs alike (Arrigoni & DeRenzi, 1964; DeRenzi & Faglioni, 1967;

Gianotti & Tiacci, 1970, 1972). Gianotti et al. (1972) reported that, while the frequency of occurrence of half-finished drawings and omissions of large laterally placed figures was significantly greater among RBDs than LBDs, patients in both groups tended to omit small peripheral figures with similar frequency (29% of RBDs, 21% of LBDs).

Criteria based upon drawing performance have almost always involved evidence of an absolute deficit (errors of omissions). It has often been the case, however, that researchers have reported a peculiar tendency among brain-damaged patients to be unilaterally inaccurate in their drawings. The inaccuracy has been typically restricted to the side of the drawing contralateral to the side of the patient's lesion. Hecaen (1962) viewed such performance as the antithesis of visual-spatial neglect. However, as evidenced by Leicester et al.'s (1969) patient A.E.F., addressing one half of space in a careless or unproductive manner is no less symptomatic of the underlying disorder than neglecting that half of space altogether. In the case of A.E.F., it is recalled, her excessive right-sided responding was not truly elicited by information originating on that side, but, rather, was cued by the information she obtained from the left side of space! While presentation of evidence of inaccurate or impeded performance with respect to one half of space is germane to a discussion of objective criteria, it is of greater relevance to a discussion of relative deficits in visuo-spatial attention.

Hecaen (1962) reported that, while LBD patients were rarely found to omit features in their drawings, they would occasionally demonstrate a difficulty in "closing" their drawings on the right side.

Hecaen contended, however, that "far from neglecting this side, [the patient] is particularly persistent in drawing the extreme right, without managing to execute it correctly" (p.231). To depict this behavior as wholly dissociated from spatial neglect would be, in the present author's opinion, to confuse the symptom with the underlying disorder. Gianotti et al. (1972) confirmed Hecaen's observations, noting that such performance was characteristic of nearly one-fifth of the LBDs they sampled. These authors, while not rejecting some underlying connection between visuo-spatial neglect and this spatially bound inaccuracy, were uncertain as to how to interpret it.

Accuracy of performance is not always the case at issue. A relative deficit in visuo-spatial attention might result in impeded, if not impaired, performance. It is recalled that Lawson's (1962) Case #1, while having ostensibly compensated for her earlier evidenced spatial inattention, was observed to hesitate in tracing the left sides of hidden figures and upon returning to the left border of a line of print. It would appear that compensation, while successful in preventing an absolute failure, was associated with evidence of a relative reduction in efficiency with respect to one side of space. Under conditions of inordinate time pressure, or under conditions of considerable cognitive load, it might be expected that such a relative deficit would evolve into an absolute failure.

CHAPTER II

RESEARCH DESIGN AND METHODOLOGY

This study was designed to examine the incidence and impact of disturbed visuo-spatial attention in right brain-damaged stroke patients. Particular interest was directed at uncovering those instances of failure on complex visuo-cognitive tasks which may be related to relative, rather than absolute, deficits in visuo-spatial attention. In recognition of the complex and dynamic nature of disturbances in visuo-spatial attention, a special task was constructed which incorporated many of those parameters of task demand and face construction reported to elicit most reliably evidence of spatial inattention. It was anticipated that such a task would serve to tease out the more subtle attentional components of anomalous visual behavior. A second aim of this study was to explore the possible involvement of subtle attentional disturbances in the failure of more mildly impaired left brain-damaged stroke patients on complex visuo-cognitive tasks. The study was performed in two phases: (1) construction of the new task, and (2) study of brain-damaged and normal aged adult controls.

Task Construction

General Considerations

The task was constructed to be sufficiently demanding so as to engage a high level of perceptual activity in patients, while reducing potential cues which might aid patients' compensation for existing pathological attentional asymmetries. A multiple-choice, match-to-sample format was adopted, employing certain special features described below. Two types of stimuli were generated: silhouetted drawings of easily recognizable common objects and animals (Familiar Figures) and silhouetted drawings of nonsense shapes with moderate association value (Unfamiliar Figures). The face construction of individual plates mimicked that employed by Raven in constructing the Colored Progressive Matrices.

A figure, drawn centered in the upper half of a sheet of 8½ x 11" unlined white paper, served as the target. An array of six choices, arranged in two evenly spaced rows of three choices each, was centered in the lower half of the sheet (see Figure 1). Two separate subtasks were constructed: one employing Familiar figures, one employing Unfamiliar Figures. For each set of figures correct choices appeared in each response-position four times, resulting in two 24-item forms (24 plates of Familiar Figures, 24 plates of Unfamiliar Figures).

Special Features

Components of difficulty were introduced so as to be linked to the spatial configuration of individual plates. This was accomplished at two levels:

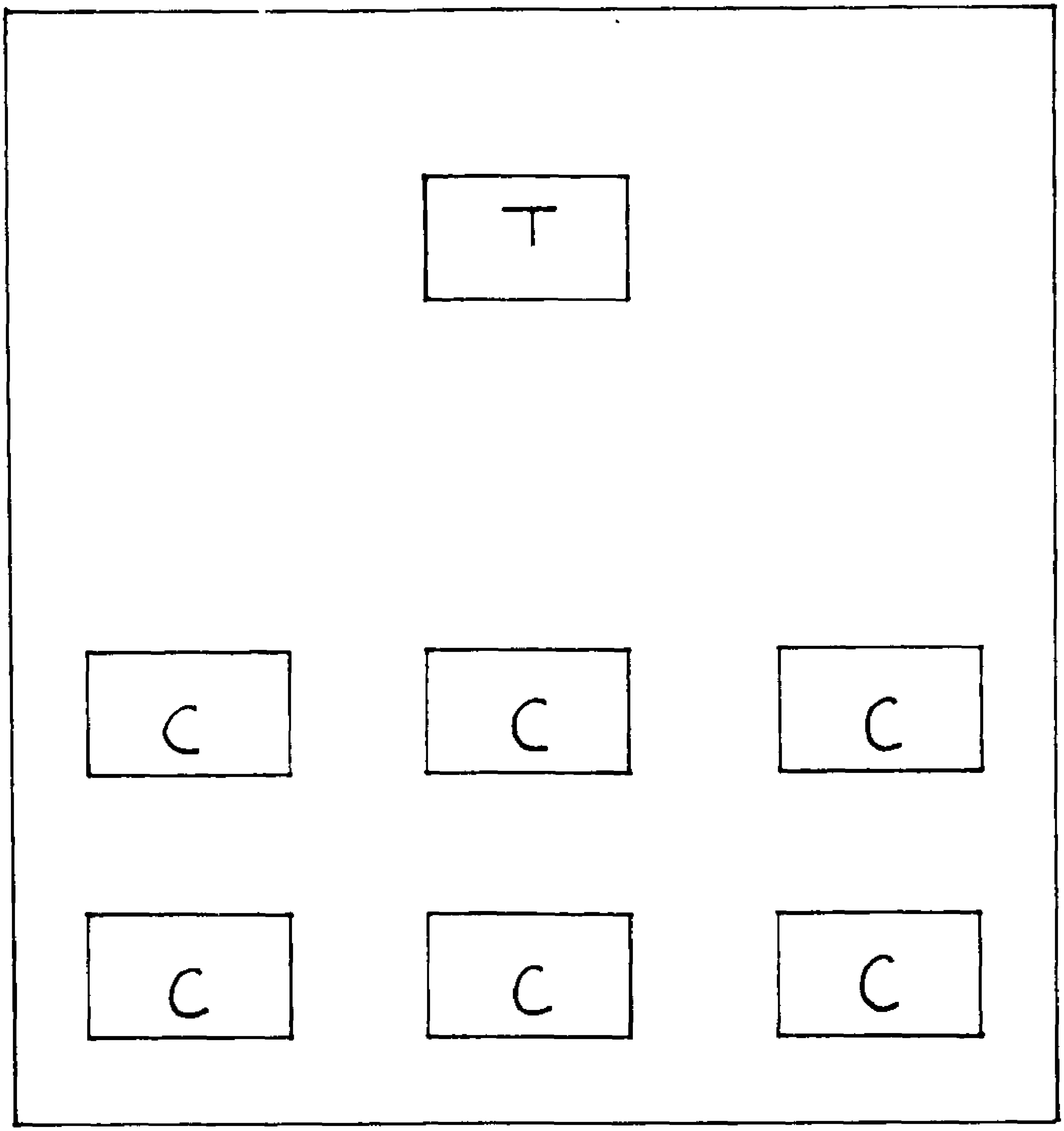

Figure 1. Basic layout of individual plates.

1. Gross space--Sufficiently compelling response choices appear in both lateral third-fields;

2. Fine space--Two choices on each plate were drawn identical to the target with the exception of one readily discernible detail error (distractors). One of these two distractors was so errored on the right side, the other on the left side.

Each 24-item form (Familiar Figures, Unfamiliar Figures) was comprised of three types of plates:

1. Eight plates on which the identical match appeared in positions 1 or 4 (left third-field). Distractor choices on these plates appeared in positions 3 and 6 (right third-field), counterbalanced between the two positions with respect to the location of their respective detail error (see Figure 2);

2. Eight plates on which the identical match appeared in positions 3 or 6 (right third-field). Distractor choices on these plates appeared in positions 1 and 4 (left third-field), counterbalanced with respect to detail error (see Figure 3);

3. Eight plates on which the identical match appeared in positions 2 or 5 (center third-field). Distractor choices on these plates appeared, one in each lateral third-field. To maximize the distracting potential of these choices, the distractor situated in the left third-field contained a right-sided error; the distractor situated in the right third-field contained a left-sided error (see Figure 4).

The six-choice array for all plates was completed by the inclusion of one multiply errored choice and two irrelevant choices (bearing only minimal resemblance to the target).

FAMILIAR FIGURES--Plate 1

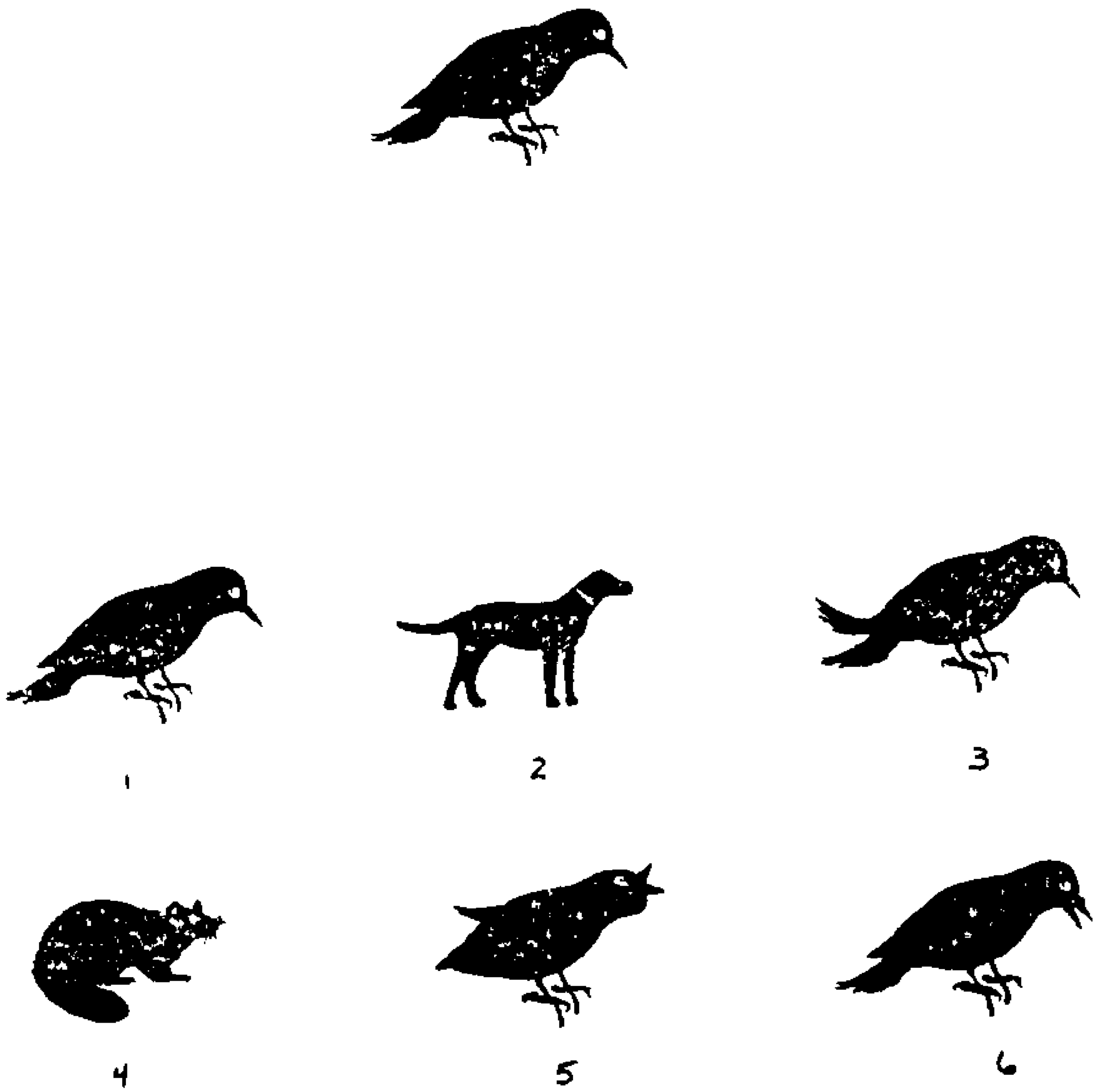

Figure 2. Illustrating layout when correct response is in left third-field. Shown 75% of actual size.

11

UNFAMILIAR FIGURES--Plate 11

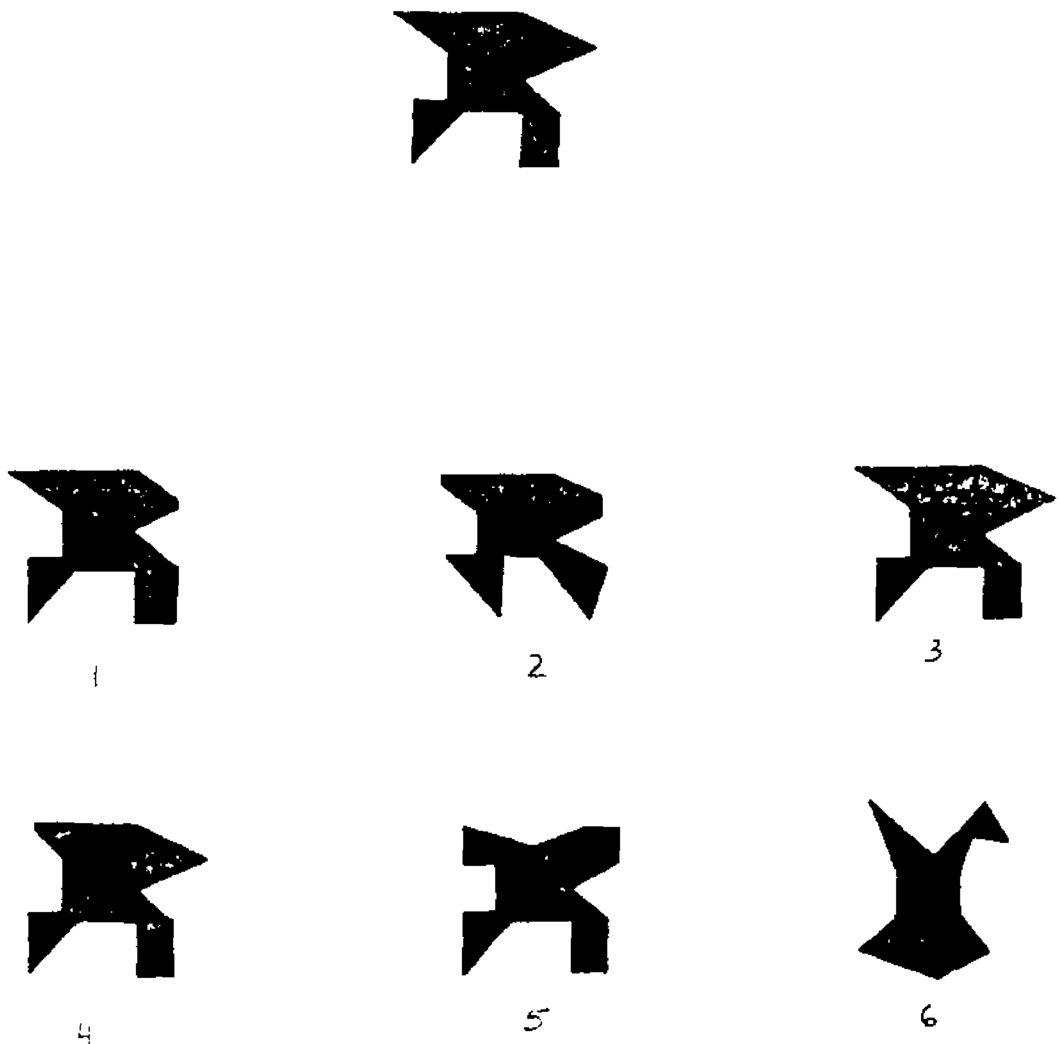

Figure 3. Illustrating layout when correct response is in right third-field. Shown 75% of actual size.

15

UNFAMILIAR FIGURES--Plate 15

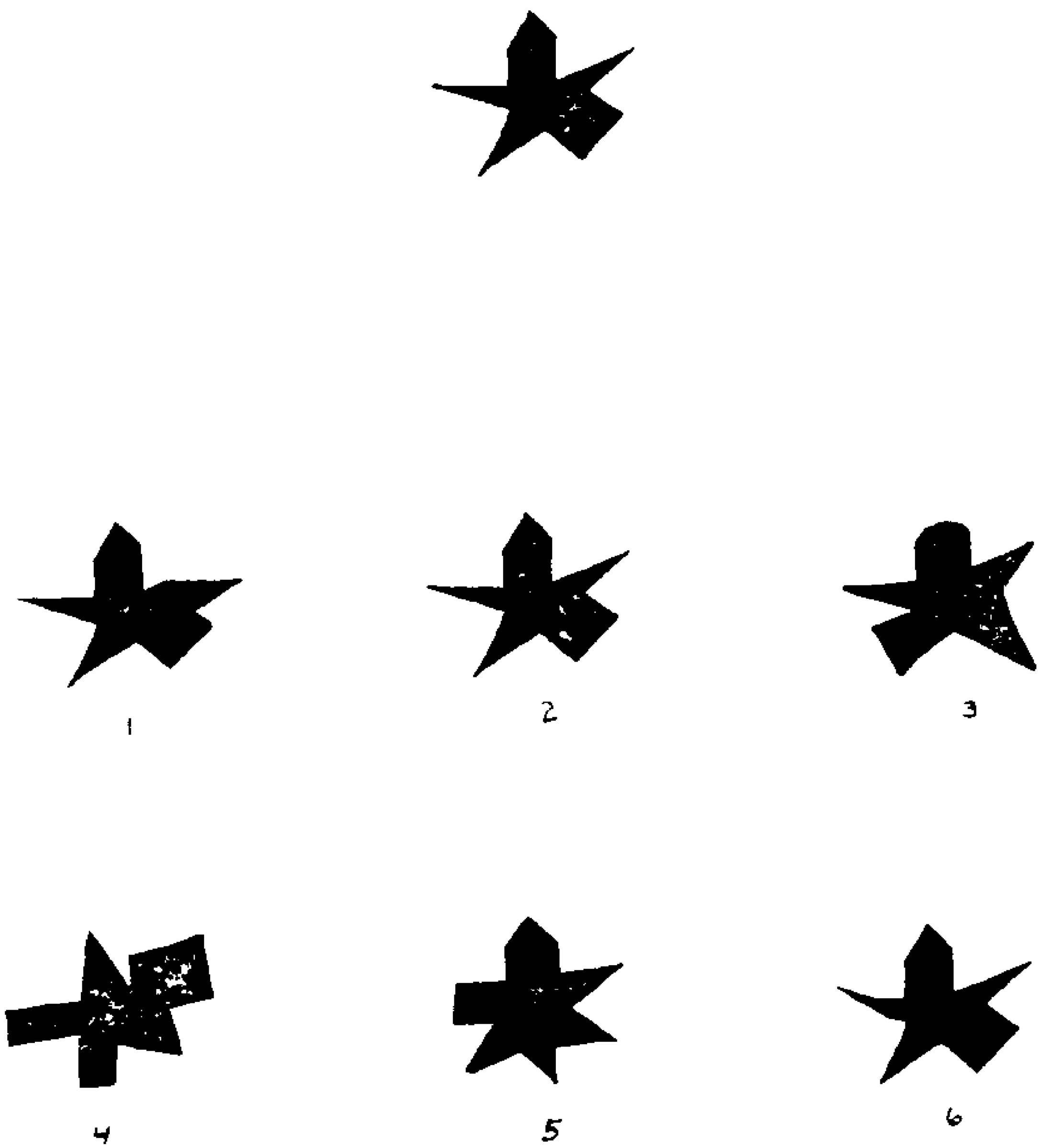

Figure 4. Illustrating layout when correct response is in center third-field.

For those 16 plates in each form containing a laterally placed correct match, errors in gross spatial attention (side of page from which an incorrect choice was selected) and errors in fine spatial attention (errored side of distractor selected) were independent. For those eight plates in each form containing a centrally situated correct match, errors in gross spatial attention and errors in fine spatial attention were correlated. In any case fine spatial errors could only be ascribed to instances where one of the distractor choices was selected (as opposed to the multiply errored or irrelevant choices).

Item Selection

Pools of Familiar Figures and Unfamiliar Figures were generated along with two distractors for each. A small sample of normal controls (members of the staff at the Institute of Rehabilitation Medicine and graduate students) were asked to rate each item as to ease of determining a correct match and the relative discriminability (from the target) of each distractor. Where indicated, distractors were modified to achieve a greater degree of comparability, and ratings were resolicited. This process was carried out until the respective item-pools were reduced to 24 Familiar Figures items and 24 Unfamiliar Figures items (with distractors). Individual plates were then constructed in accordance with procedures previously described. Items considered by the sample of normal controls to be particularly difficult (with respect to discriminating distractors from the correct match) were divided evenly among the three types of plates (defined by the third-field in which the correct choice appeared).

Administration Modes

Each 24-item form was adapted to accommodate a match-from-memory administration. For memory administrations the target and its respective response-choice array appeared on separate sheets of paper but without any alteration in their relative placement on the sheet. Match-from-memory trials were fashioned after administration "A" of the Benton Visual Retention Test, Revised Edition (Benton, 1974). Each target remained exposed for 10 seconds and then was immediately replaced by the response-choice array. No other time constraints were imposed.

Basic Instructions for Administration

A basic set of instructions was used during administration of the newly constructed task. In addition, two relatively simple task items were constructed (Figures 5 and 6) for use in orienting severely impaired patients or patients with receptive language disorders to the demands of the new task. These simple items were also available for use in practice trials with patients who were unable to comprehend what was being asked of them.

Match-to-sample administrations. The first plate of Familiar Figures or Unfamiliar Figures (depending on the sequence assigned to the patient) was placed before the patient, centered on his/her body midline. The examiner pointed to the target figure and said:

> Look at this picture. Down here are six pictures [examiner slowly pointed to each choice in the array]. One of these is exactly like the picture at the top; your job is to find it. Be careful, some of the pictures will look similar to the one at the top, but only one is an exact copy. Now before making your decision, point to each of the choices.

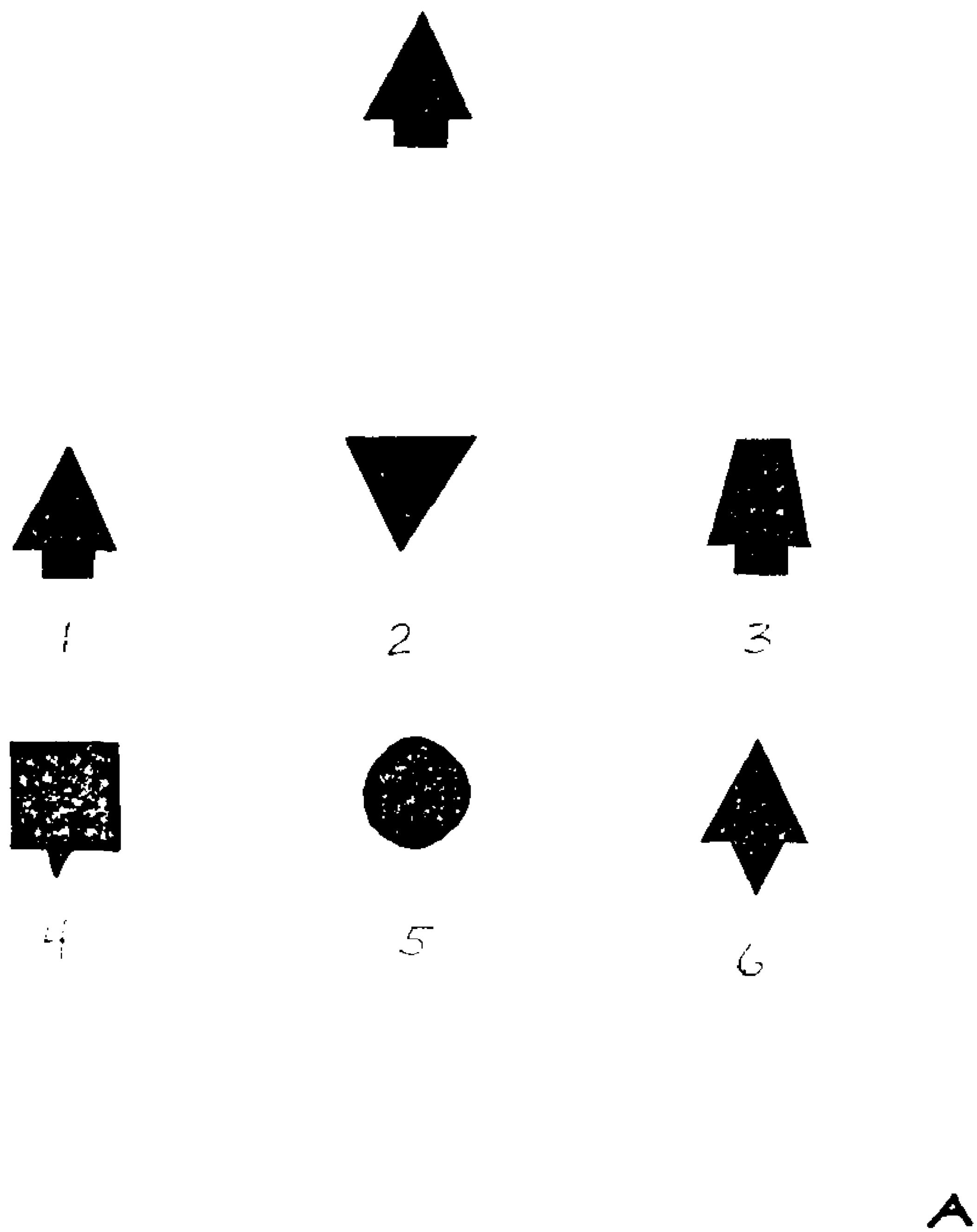

Figure 5. Duplication of Sample Plate A, used to orient more severely impaired patients to the task. Shown 75% of actual size.

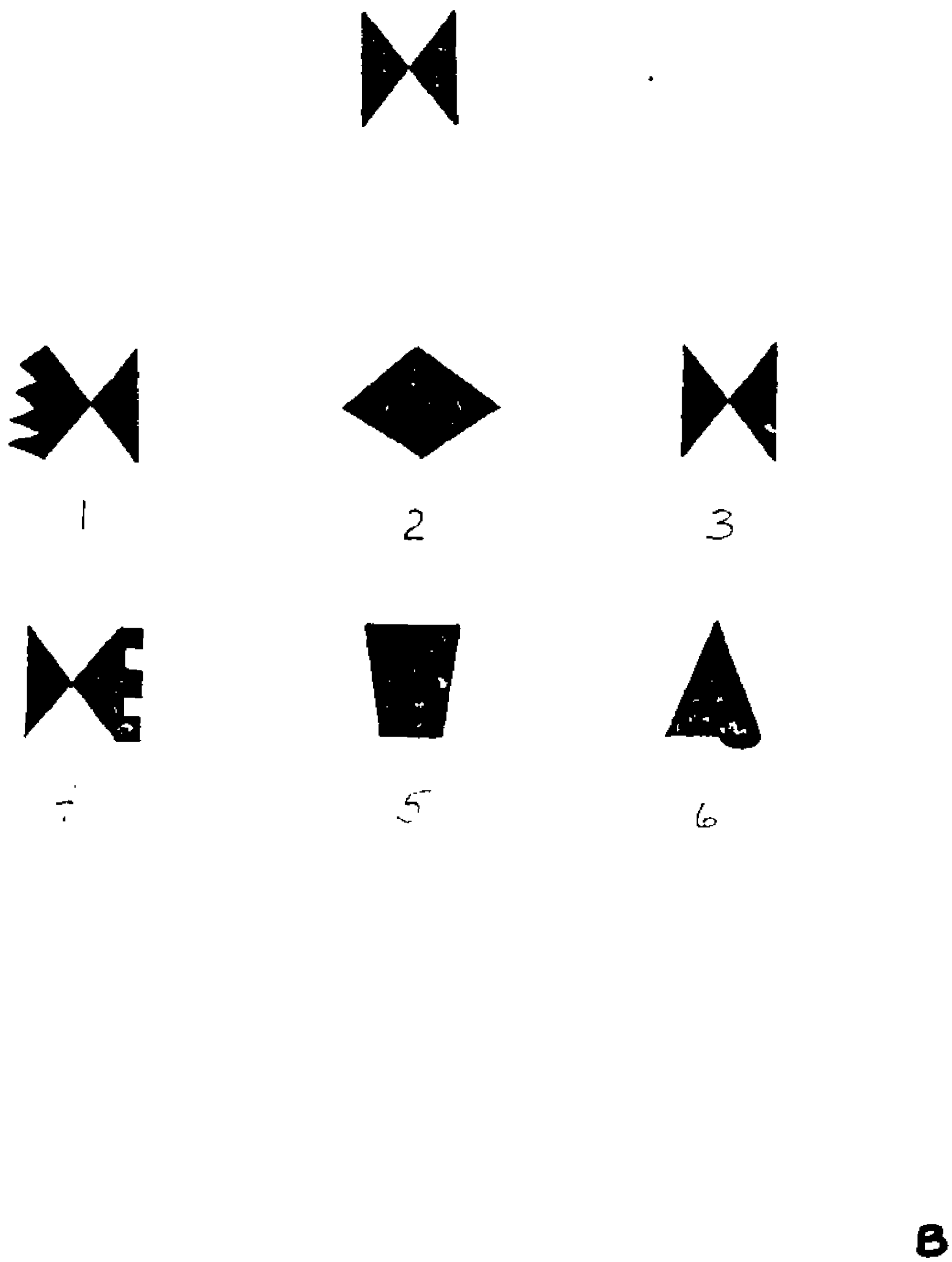

Figure 6. Duplication of Sample Plate B, used to orient more severely impaired patients to the task. Shown 75% of actual size.

> [If any choices were missed, examiner pointed to each choice asking the patient to point with him.] Now, which picture is just like the one at the top?

If the patient were unable to find an acceptable response (the correct one or a distractor) or appeared baffled by the task, one or both of the simple plates were employed to orient the patient to the task. In using these practice plates the instructions were repeated and the examiner demonstrated selecting a response-choice (using gesture and narrative to reflect decisions on each of the six choices). A sample narrative for demonstrating the selection process is provided in Appendix A.

Match-from-memory administrations. If the patient had already received one match-to-sample administration, the instructions indicated below were employed. If the match-from-memory administration were the first exposure the patient had to the task, a practice plate was used to familiarize the patient with the layout of target and responses (also used with patients who report no recollection of the match-to-sample administration). Prior to exposing the first target figure, the examiner said:

> I am going to show you a picture. Examine it carefully for 10 seconds. When the 10 seconds are up, I'll take the picture away and show you six pictures. You are to find the one which looks exactly like the one you examined. [The patient was reminded of the match-to-sample administration and/or was shown a practice item alternately covering the top or bottom to prepare the patient for what he/she would see.] Remember, look at all six pictures before you make your decision; some of them will look similar to the one you examined but only one is an exact match. [If this were the patient's first exposure to the task, he/she was asked to point to each choice on the sample item as per the instructions for match-to-sample administration.]

While presenting the first target figure, the patient was reminded to study it carefully. As the page was turned to reveal the choices, the examiner said: "Now find it here." The patient was further reminded to consider all six choices.

Methods

Subjects

Normal controls. Thirty normal aged right-handed adults participated in this study. Handedness for the control sample was assessed with a 10-activity checklist, including: writing, throwing, brushing teeth, eating with a spoon, carrying a suitcase, drawing, using a scissors, combing hair, unscrewing a bottle cap, and dealing cards; (if subject never played any card games, they were given a deck and asked to hand out cards one at a time to three imaginary people). Subjects indicating the use of their right hand only for 8 of the 10 activities were designated right-handed. Subjects were drawn from the following sources: (1) intermediate players at the Manhattan Bridge Club, (2) family members of the author or the author's friends, (3) volunteers from the Katherine Engel Senior Citizens Center, and residents at a cooperative apartment complex in which a friend of the author resides.

All controls were informed at the time they were solicited for participation of the purpose of the study and its potential implications (diagnostic and treatment) for people who have suffered strokes. Prior to testing, no information was provided as to what the task was designed to test, beyond the obvious demands for visual examination and memory. Debriefing was performed, however, following completion of testing.

In addition to the requirement that all controls be right-handed, volunteers were required to meet the following criteria:

1. No history suggestive of brain injury;

2. No history of excessive drinking (alcoholism);

3. No significant history of major systemic failure (coronary, kidney, or liver, or any condition likely to be correlated with extended periods of reduced blood supply or hemotoxicity);

4. No history of psychiatric disturbance;

5. No signs of incipient senility;

6. No history of diabetes melitus with onset greater than 2 years prior to the date of participation in the study.

Inasmuch as the patient population at the Institute of Rehabilitation Medicine (IRM) from which brain-damaged subjects were obtained, was expected to have educational levels above the national average (prior studies suggested educational levels in the range of 12 to 14 years), solicitation of volunteers was restricted to settings (as previously described) in which controls with similar educational levels might be found.

Right brain-damaged subjects. Fifty-one unilaterally right brain-damaged, right-handed adult stroke patients participated in this study. Subjects consisted of a subset of all in-house stroke patients undergoing active rehabilitation programs at the IRM who met the following criteria:

1. Verifiable (clinical neurological examination, electroencephalographic, or radiological findings) lesions restricted to the right hemisphere as a result of a CVA;

2. No prior history suggestive of brain injury;

3. No history of significant CNS disorder;

4. Other than the CVA, no significant medical history (see criteria for normal controls);

5. No history of excessive drinking (alcoholism);

6. No history of psychiatric disturbance;

7. Sufficiently free of mental confusion so as to be appropriately oriented to the tasks to be administered.

Subjects were, further, selected from those being screened for participation in an experimental program of cognitive/perceptual remediation. As a result, all subjects received a neurological examination within one week prior to their entry into this study. This examination was performed in conjunction with their participation in the experimental remediation program and, as a result, provided a comparable neurologic data base for all brain-damaged participants in this study (a standard set of neurologic criteria obtained by a single practitioner). Patients exhibiting severe symptomatology and, therefore, not acceptable for entry into the experimental remediation program, were, nonetheless, retained in the present study. All formal testing, performed in conjunction with the present study, was completed prior to patients' onset of experimental remediation.

Left brain-damaged subjects. Twenty-eight unilaterally left brain-damaged, right-handed stroke patients participated in this study.

Subjects consisted of a subset of all in-house stroke patients undergoing active rehabilitation programs at the IRM who met the criteria delineated for RBDs (however, with verifiable lesions restricted to the left hemisphere). In addition, all LBDs were required to demonstrate adequate comprehension of task demands.

These subjects were selected from those being screened for participation in the experimental remediation program previously referenced. The Speech Department at the Institute of Rehabilitation Medicine was consulted as to classification of speech and language disorders in these patients.[5]

Subject Characteristics.

Demographics. No statistically reliable differences among the three experimental groups was found with respect to age or education (median tests). As anticipated, median levels of education for the two patient groups were higher than would be expected from a sampling of the general population (see Table 1). The two patient groups were predominantly comprised of patients seen at between 1 month and 3 months postonset of CVA (see Table 1). Approximately 20% of the stroke patients were more than 3 months postonset at the time they participated in this study. No statistically reliable differences in time-since-onset of CVA were found between the two patient groups (median split).

Neurologic status of brain-damaged subjects. All brain-damaged subjects were examined by a neurologist and rated as to degree of sensory deficit (light touch, pain, joint position sense, and visual

[5] Sincerest thanks to Mrs. Martha Sarno for graciously providing me with classifications of aphasia for the LBD sample.

Table 1

Subject Demographics

Group	Norm[a]	RBD[b]	LBD[c]
Median age	66.5	65.7	63.0
Age range	48 - 84	32 - 84	44 - 83
Median education	14.0	12.4	13.5
Education range	4 - 20	5 - 20	3 - 20
Median time onset (in weeks)	-	8.8	7.7
Chronicity (in weeks):			
4 - 12	-	38	25
13 - 24	-	7	2
> 24	-	6	1

[a] *n* = 30.

[b] *n* = 51.

[c] *n* = 28.

field integrity) and motor deficit (upper and lower extremities). Light touch, pain, and joint position sense were rated on a 3-point scale: normal, decreased (with respect to the unaffected side), absent. Visual field integrity was assessed using the method of confrontation with single- and double-simultaneous presentations. Patients were rated on a 3-point scale: normal, extinction to double-simultaneous presentations, complete field cut. Due to the relative crudeness of the method of confrontation as a measure of visual field integrity, it was considered prudent by the present author not to distinguish instances of visual extinction from minor field defects. Motor deficit was rated on a 5-point scale: 0 = normal, 1 = minimal deficit (less than full strength), 2 = moderate deficit (movement against gravity), 3 = marked deficit (movement, but not against gravity), 4 = very marked (no movement).

1. Motor Status--Due to the nature of the admissions criteria employed by the IRM, all patients admitted to the facility are, to some degree, motorically impaired. Relative incidence of the five levels of impairment assigned by the neurologist in the two brain-damaged groups is depicted in Table 2. Upon collapsing the two most extreme categories of impairment (normal with minimal, very marked with marked), no statistically reliable differences in severity of motor deficit were found between the two groups (upper extremity: $\chi^2 = 5.52$, $df = 2$, $.10 > p > .05$; lower extremity: $\chi^2 = 4.97$, $df = 2$, $.10 > p > .05$). There was, however, a tendency for the RBD group to be somewhat more impaired.

Table 2

Motor Status of Brain-Damaged Subjects[a]

Severity Rating	Upper Extremity		Lower Extremity	
	RBD	LBD	RBD	LBD
Norm	0	0	1	0
Min	6	6	5	9
Mod	11	11	22	10
Marked	9	6	13	7
Very marked	25	5	10	2

[a]The number of patients in each group receiving the indicated severity rating.

2. Sensory Status--The relative incidence of the three levels of impairment across sensory domains in the two brain-damaged groups is depicted in Table 3. Upon collapsing the two abnormal ratings (decreased with absent, extinction with full field cut), a statistically reliable difference in degree of impairment between the two groups was found to exist in joint position sense ($\chi^2 = 5.47$, $\underline{df} = 1$, $\underline{p} < .02$) and in perception of pain ($\chi^2 = 3.84$, $\underline{df} = 1$, $\underline{p} < .05$). Light touch perception and visual field integrity were not found to be differentially impaired in the two groups (light touch: $\chi^2 = 1.7$, $\underline{df} = 1$, $\underline{p} < .10$; visual fields: $\chi^2 = 1.43$, $\underline{df} = 1$, $\underline{p} < .20$). These results would be consistent with greater posterior and subcortical involvement among the RBDs, as well as greater degree of severity of sensory impairment among these patients.

Language impairments among LBDs. As anticipated, the majority of LBD patients exhibiting a language disorder was of the Non-Fluent type (Speech Department employs the nomenclature and respective criteria of Goodglass and Kaplan, 1972). Additionally, patients are routinely rated as to their ability to engage in meaningful communication, regardless of degree and classification of aphasia (Functional Communication Profile, Taylor [1965]). This assessment depicts the patient's skill at communicating as a percentage of their estimated premorbid level. The incidence of three aphasia types (Fluent, Non-Fluent, Mixed/Global) in the current sample and their respective Overall Functional Communication Profile ratings are depicted in Table 4.

Table 3

Sensory Status of Brain-Damaged Subjects[a]

	RBD	LBD
Light Touch:		
Norm	27	19
Decr	19	9
Abs	5	0
Pain:		
Norm	22	19
Decr	25	9
Abs	4	0
Joint Position:		
Norm	21	20
Decr	15	4
Abs	15	4
Visual Fields:		
Norm	28	20
Ext	6	4
HH	17	4

[a]The number of patients in each group receiving the indicated severity ratings.

Table 4

Language and Speech Status of LBD Subjects

	n	Median FCP
Aphasic:		
Nonfluent	14	58.0%
Fluent	3	54.0%
Mixed/Global	2	23.5%
Nonaphasic:		
Dysarthric	6	-
Unimpaired	2	-

Note. One subject was judged to be questionably literate in English and was, therefore, not classified with respect to aphasia or functional communication.

Materials

Control subjects received only the newly constructed picture-matching task. Brain-damaged subjects received the newly constructed task in addition to the following tests:

1. WRAT Reading Test--Rows of irregularly spaced words, selected as a reading-related measure of inattention;

2. Bender Visual Motor Gestalt Test--A nine-item copying-drawing task, used as a measure of inattention. A positive finding with respect to inattention was designated as any partially completed drawing (excluding designs 2 and 3) or an indistinct completion of a design which was restricted to one side (that contralateral to the patient's lesioned hemisphere--excluding designs 2 and 3). Additionally, patients were rated on their general success at performing the task (adequate, barely adequate/inadequate, grossly inadequate);

3. Cancellation of H--The letters A through H were distributed randomly across six rows of letters (total 312 letters) printed in normal type and with normal spacing between letters. The subject was instructed to line out the letter H (total of 102) each time it appeared. This task was selected as a measure of spatial attention during visual search in a highly structured stimulus field. Inattention on this task was defined as the occurrence of five or more errors of omission, of which not less than 67% were in the left third-field (Weinberg, Note 1);

4. Cancellation of C and E--A task similar in construction to cancellation of H. The subject was instructed to line out the letters C and E (105 total) each time they appeared. This was selected as a

measure of spatial attention during visual search in a highly structured stimulus field under increased cognitive load. Inattention on this task was defined as the occurrence of 10 or more errors of omission, of which not less than 67% were in the left third-field, or five to nine errors of omission, of which all were in the left third-field (Weinberg, Note 1);

5. Raven's Colored Progressive Matrices--A complex visuo-cognitive task often used as a measure of visual-perceptual function and visuo-spatial reasoning. In addition to number correct, a bias score was calculated by subtracting the number of left-side responses (1 and 4) from the number of right-side responses (3 and 6). A bias score equal to or in excess of ±7 was taken to reflect inattention (Costa et al., 1969);

6. WAIS Block Designs--a widely used test of visuo-motor constructional ability;

7. WAIS Object Assembly--a set of four jigsaw tasks with accepted sensitivity to spatial organization;

8. WAIS Picture Completion--a test sensitive to attention to detail;

9. WAIS Similarities--selected as a measure which was not expected to be related to specific deficits in visuo-spatial attention in RBDs. The last three tasks (numbers 7 - 9) were not routinely administered to the LBDs.

Procedures

All subjects received two administrations (match-to-sample, match-from-memory) of each form of the newly constructed picture-matching task. As described in the section on task construction, a 10-second exposure time was employed during memory administrations, and subjects were permitted as much time as desired to find a match. Target figures during memory administrations were presented one time only. Order of administration of the new task trials is described below.

Normal Aged Controls

One administration sequence of the four newly constructed task trials was employed. The two memory administrations were always administered first (counterbalanced by form), followed no less than 1 hour and up to 1 day by the matching administrations (also counterbalanced by form). This procedure was adopted to minimize learning effects which were anticipated with the normal aged subjects. Early pilot work suggested that these subjects were more likely to recall incorrect choices as being incorrect on memory administrations, if those choices had previously been selected but reconsidered on matching administrations.

Brain-Damaged Subjects

Four administration sequences were independently applied to the LBD and RBD groups separately, alternated on a subject-to-subject basis within each group. The four trials, consisting of Familiar Figures match-to-sample (F_{mat}), Familiar Figures match-from-memory (F_{mem}), Unfamiliar Figures match-to-sample (U_{mat}), and Unfamiliar Figures match-from-memory (U_{mem}), were administered in the following sequences:

Sequence 1. F_{mat} followed by U_{mem} / 1-day / F_{mem} followed by U_{mat}

Sequence 2. U_{mat} followed by F_{mem} / 1-day / U_{mem} followed by F_{mat}

Sequence 3. F_{mem} followed by U_{mat} / 1-day / F_{mat} followed by U_{mem}

Sequence 4. U_{mem} followed by F_{mat} / 1-day / U_{mat} followed by F_{mem}

Subjects in each brain-damaged group were randomly assigned to one of the test sequences indicated. Test sessions were typically 1 day apart, but no more than 3 days apart (Friday to Monday). The full battery of tests was usually completed over a maximum of five contiguous sessions.

CHAPTER III

RESULTS

Performance of the Three Experimental Groups on the Specially Constructed Picture-Matching Task

The mean scores obtained by each of the three groups on the four administrations of the task are displayed in Table 5. In order to assess the relative performance of the three groups as a function of administration condition (match-to-sample, match-from-memory) and stimulus type (Familiar Figures, Unfamiliar Figures), the data were subjected to a three-way analysis of variance (mixed design) with repeated measures on administration condition and stimulus type. Due to the disparity in sample sizes, this analysis was carried out using an unweighted means analysis method (Kirk, 1968). Results of this analysis (see Table 6) revealed that the three groups performed significantly differently on the task ($F_{2,106} = 20.16$, $p < .001$). Examination of these differences via Duncan's multiple comparison method (adapted for unequal n) (Keppel, 1973) indicated that, while the RBD group performed significantly poorer on the task than both the LBD and aged control groups, the difference in performance between the LBD and control groups only approached significance (see Table 7). Subjects in all three groups were found to have performed worse on memory administrations than on matching administrations ($F_{1,106} = 173.82$, $p < .001$);

Table 5

Performance of Subjects on the New Task

Form	Control[a]	RBD[b]	LBD[c]
Familiar:			
Match	21.80	15.82	20.75
Memory	19.10	13.78	17.46
Unfamiliar:			
Match	22.77	16.86	20.71
Memory	17.87	13.53	15.86
Groups means across all four trials	20.38	15.00	18.70

[a] *n* = 30.

[b] *n* = 51.

[c] *n* = 28.

Note. Entries are mean number correct per trial (out of a possible 24).

Table 6

Analysis of the Performance of the Three Experimental Groups on Four Trials of the Newly Constructed Picture-Matching Task

Source	SS	*df*	MS	*F*
Groups	1990.27	2	995.13	20.16*
$\text{Error}_{\text{groups}}$	5232.89	106	49.37	-
Form (Fam./Unfam.)	4.06	1	4.06	.74
Groups × Form	25.07	2	12.54	2.29
$\text{Error}_{\text{groups × form}}$	579.92	206	5.47	-
Administration (match/memory)	1308.75	1	1308.75	173.82*
Groups × Administration	26.87	2	13.43	1.79
$\text{Error}_{\text{groups × administration}}$	798.12	106	7.53	-
Form × Administration	65.89	1	65.89	23.51*
Groups × Form × Administration	5.21	2	2.61	.93
$\text{Error}_{\text{groups × form × admin}}$	297.07	106	2.80	-

*$p < .001$.

and there was a significant interaction between stimulus type and administration condition ($\underline{F}_{1,106}$ = 23.51, $\underline{p}$ < .001), such that the Unfamiliar Figures were easier to match-to-sample than the Familiar Figures, but were more difficult to match-from-memory (see Table 7). With respect to this interaction, upon examination of the overall display of group means (Table 5), it appears that the interaction between stimulus type and administration condition was most evident in the control sample. The effect within the two brain-damaged groups, however, appeared to be differentially represented. LBDs seemed to be less sensitive to stimulus type during match-to-sample administrations, while RBDs seemed to be less sensitive to stimulus type during match-from-memory administrations.

Assessment of Gross Spatial Attention in the Three Experimental Groups

This is one of the analyses which is of primary interest to the current study. To evaluate whether the three groups differed with respect to direction and degree of errors in gross spatial attention, group distributions of response biases (differences in the number of responses selected from the left versus right third-fields) were examined. Response biases were computed in the following manner: For each of the four task administrations, the number of responses selected from the left lateral third-field (choices 1 and 4) was subtracted from the number of responses selected from the right lateral third-field (choices 3 and 6). A negative value for this computation indicates that more responses were chosen from the left third-field

Table 7

Presentation of Significant Findings from the Three-Way Analysis of Variance on the Scores Attained by Each Experimental Group on the Newly Constructed Picture-Matching Task

(a) Group Differences

	Contr.	LBD	RBD
Contr.	-	1.68	5.38*
LBD		-	3.70*
RBD			-

(b) Effect due to administration condition

Match	19.85
Memory	16.26

(c) Interaction between form and administration condition

	Familiar	Unfamiliar
Administration:		
Match	19.54	20.15
Memory	16.76	15.76

*$p < .01$; Duncan's Multiple Range statistic = 2.33.

than from the right; conversely, a positive value indicates a greater number of responses chosen from the right field. (This procedure is modeled after Costa et al. [1969] and is used to assess response symmetry on Raven's Colored Progressive Matrices.) Since correct choices were fully counterbalanced among the six choice positions, a perfect score on a trial of the task yielded a response bias of 0.

In order to enhance the reliability of computed response biases, four bias values for each subject (one based upon each of the four trials of the new task: F_{mat}, F_{mem}, U_{mat}, U_{mem}) were averaged to yield a single bias score. The respective group distributions of averaged response biases (see Figure 7) were then compared via a Kruskal-Wallace one-way analysis of variance (skewing precluded parametrics). The results of this analysis revealed that the group distributions differed significantly ($\underline{H}$ = 61.63, $\underline{df}$ = 2, $\underline{p}$ < .001). A second analysis was performed to examine this finding in the context of the hypothesis that brain-damaged subjects would exhibit attentional biases towards the visual field ipsilateral to their damaged hemisphere. LBD subjects, then, were expected to exhibit negative biases (more 1 and 4 responses than 3 and 6), while RBD subjects were expected to exhibit positive biases (more 3 and 6 responses than 1 and 4). Controls were not expected to exhibit biases in either direction. These hypotheses were tested via Kolmogorov-Schmirnov Two-Sample tests comparing LBDs with controls and controls with RBDs. The results of these comparisons strongly supported the stated hypotheses. The distribution of LBD response biases was found to be significantly shifted in a negative direction compared with that of the controls (D_{max} = -.52; χ^2 = 15.66, $\underline{df}$ = 2,

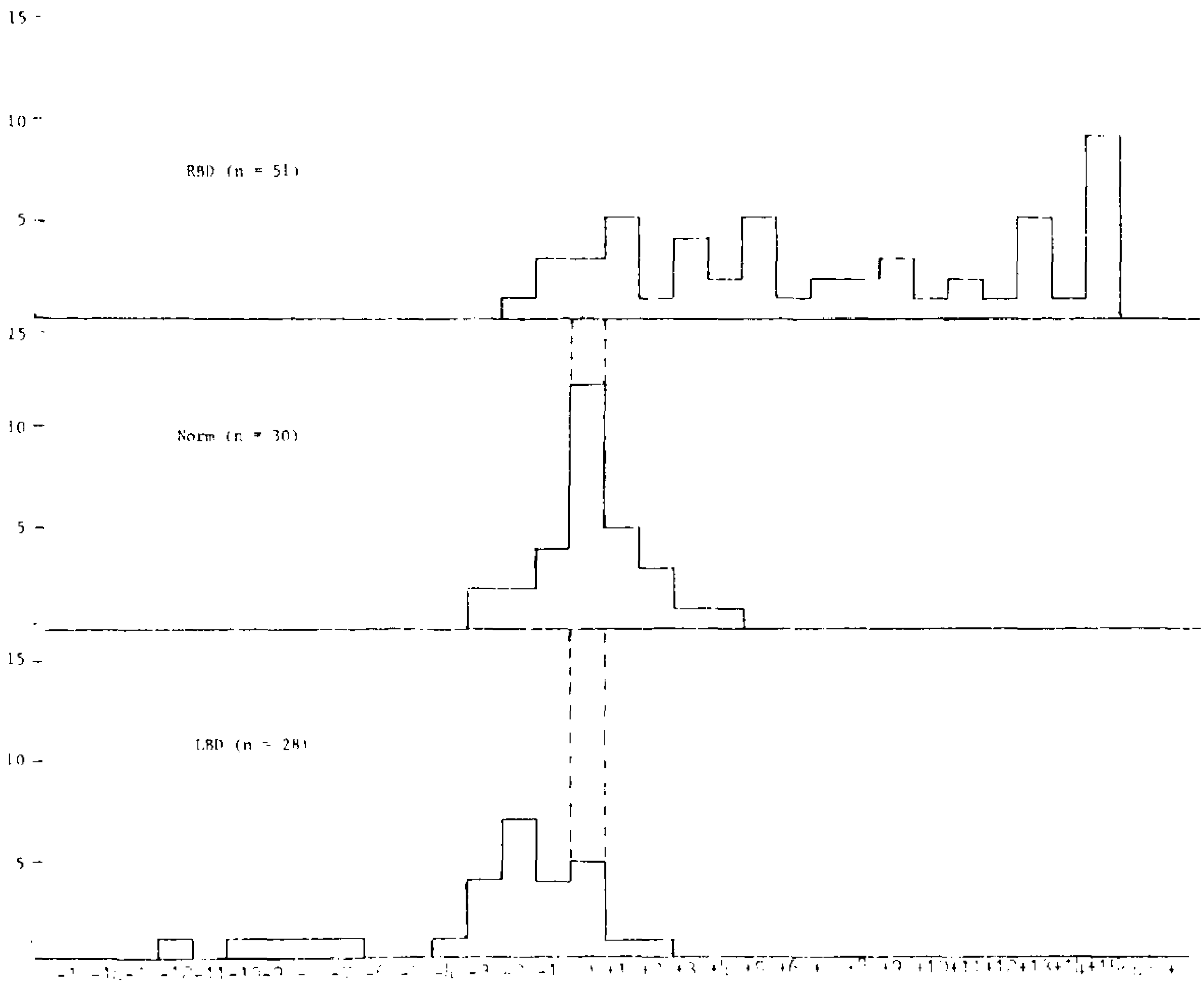

Figure 7. Response biases averaged across four administrations of the newly constructed picture-matching task.

$p < .001$ one-tailed). The latter distribution (controls) appeared to be essentially normally distributed about a bias of zero (Figure 7). The distribution of RBD response biases was found to be significantly shifted in a positive direction with respect to controls ($D_{max} = .68$; $\chi^2 = 34.94$, $df = 2$, $p < .001$ one-tailed).

While the technique of averaging response biases across four trials enhanced the reliability of the bias measurement, it may also have tended to constrict the magnitude of the biases obtained, particularly for the control sample. This constriction would have been due to a small number of overall errors committed by the aged controls on match-to-sample trials. Therefore, bias values for this group might have been spuriously reduced in magnitude because of the averaging of two values which, by virtue of a minimum of errors, could not have reached substantial levels.

To insure that the group differences obtained were not artifacts of a selective constriction of control biases, match-to-sample and match-from-memory trials were partitioned. Response biases were recomputed as separate averages of match-to-sample trials and match-from-memory trials. For match-to-sample trials (see Figure 8), the distribution of LBD response biases could not be reliably distinguished from that of the controls ($D_{max} = -.28$; $\chi^2 = 4.54$, $df = 2$, p = ns). The modal bias for both groups was zero; however, the LBD distribution was clearly negatively skewed. The RBD response bias distribution was remained significantly positively shifted with respect to controls ($D_{max} = .66$; $\chi^2 = 32.91$, $df = 2$, $p < .001$ one-tailed). For match-from-memory trials (see Figure 9), response bias distributions for both

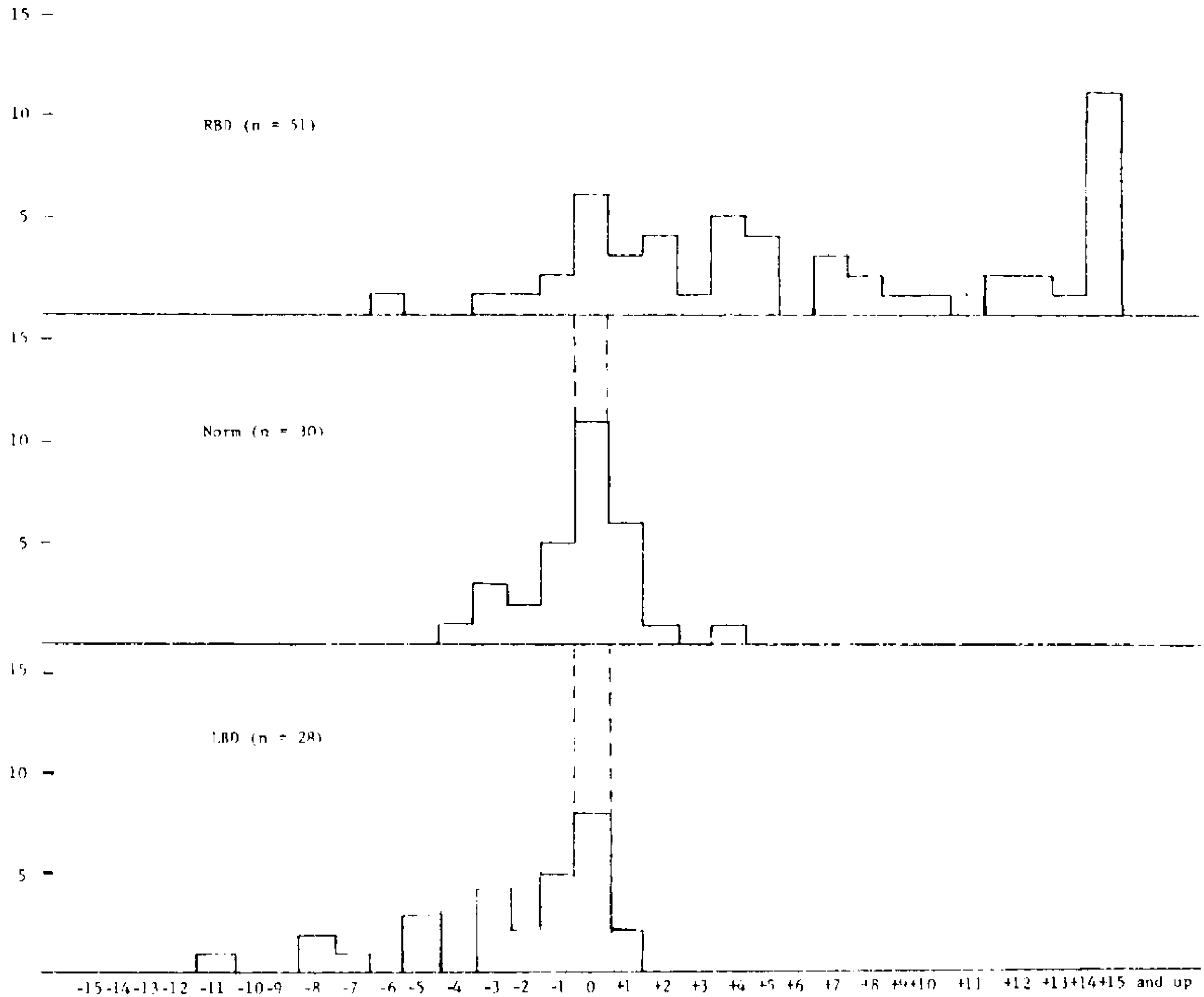

Figure 8. Response biases averaged across two match-to-sample administrations.

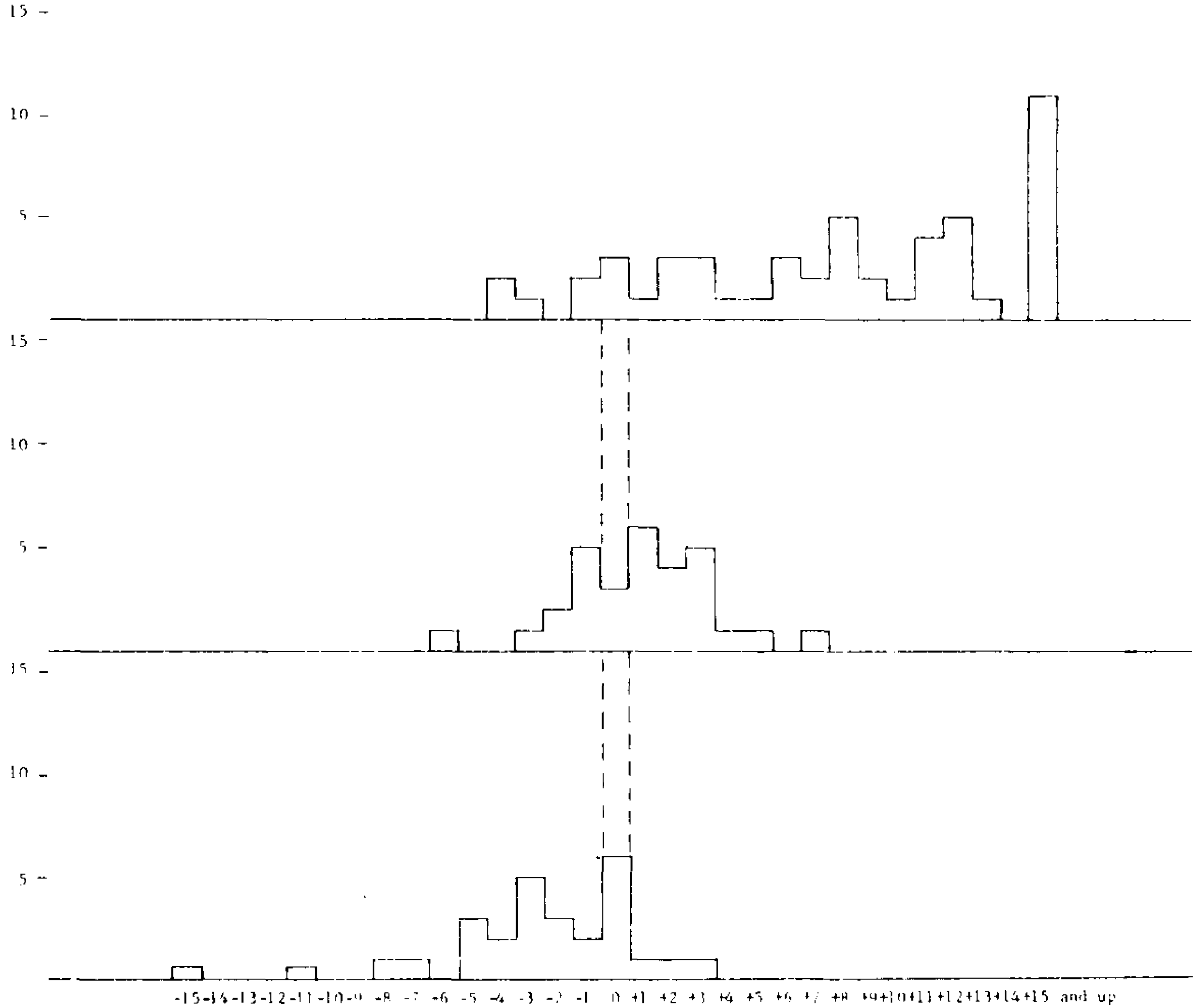

Figure 9. Response biases averaged across two match-from-memory administrations.

brain-damaged groups were found to be significantly shifted towards their respective sides of lesion, with respect to that of controls (LBD: $D_{max} = -.58$; $\chi^2 = 19.49$, $df = 2$, $p < .001$ one-tailed; RBD: $D_{max} = .65$; $\chi^2 = 31.92$; $df = 2$, $p < .001$ one-tailed).

These results are seen as confirming the directionality of response biases for the two brain-damaged groups as a whole, and are further seen as reflecting the stability of response bias directionality across administration conditions.

Assessment of Fine Spatial Attention

As previously indicated, errors in fine spatial attention (tendency to overlook a distortion when it appears unilaterally on the left or right side of response choices) are independent of errors in gross spatial attention (tendency to select responses from one side of the page) on 16 of the 24 plates comprising each form. When an error was committed which involved selecting one of the two distractor choices (unilaterally errored) on these 16 plates, presumably it involved overlooking the unilaterally situated distortion. A bias in fine spatial attention, then, would be evidenced in a tendency to overlook selectively distortions occurring on one side of a response choice as opposed to the other. To assess fine spatial attention in the three experimental groups, the total number of distractor choices selected by each subject (summed across trials) was divided into two categories: those containing a right-sided detail error, and those containing a left-sided detail error. The mean number of left- and right-sided errors for the three groups are displayed in Table 8.

Table 8

Mean Number of Detail Errors Overlooked
(Summed across Four Trials)

	Side of Choice Containing Detail Error	
	Left (LE)	Right (RE)
RBD[a]	13.80	7.35
LBD[b]	5.36	7.61
Norm	4.64	5.00

[a] n = 51.

[b] n = 28.

[c] n = 30.

It was reasoned that, if brain-damaged subjects exhibited a pathological asymmetry in attention within reduced space (a systematic tendency to overlook detail errors situated on one side of a distractor versus the other side), it would parallel, in nature, attentional asymmetries within gross space. As such, it was expected that RBDs exhibiting a fine-spatial asymmetry in attention would do so by systematically overlooking errors located on the left sides of distractors. Conversely, LBDs exhibiting an attentional asymmetry were expected to overlook systematically errors located on the right sides of distractors.

With these hypotheses in mind, detail-error data were subjected to a two-way analysis of variance (groups × location of detail error overlooked) with repeated measures on location of detail error overlooked. In view of the disparity in sample sizes, an unweighted means analysis method was employed. The results of this analysis (see Table 9) revealed that the groups differed significantly with respect to the total number of distractor choices selected ($\underline{F}_{2,106} = 20.67$, $\underline{p} < .01$) and that overall, more left-sided than right-sided detail errors were overlooked ($\underline{F}_{1,106} = 5.23$, $\underline{p} < .05$). More importantly, however, was the finding that the three groups differed significantly with respect to their relative tendencies to overlook errors on one side versus the other ($\underline{F}_{2,106} = 22.35$, $\underline{p} < .01$).

The presence of an interaction between group membership and distorted side overlooked permitted direct examination of the hypotheses advanced concerning the relationship between fine spatial attentional asymmetries and hemispheric locus of lesion. Three simple main effects of interaction (Keppel, 1973; Winer, 1971) were examined: side of

Table 9

Two-Way Analysis of Variance of Detail Errors (Unweighted Means Method), Repeated Measures on Side Distorted

	SS	*df*	*MS*	*F*
Groups[a]	1186.99	2	593.50	20.67**
$\text{Error}_{\text{groups}}$	3043.79	106	28.70	
Side distorted[a]	83.04	1	83.04	5.23*
Groups × Side[a]	708.72	2	354.36	22.35**
$\text{Error}_{\text{groups} \times \text{side}}$	1680.34	106	15.85	

[a]Computations made assuming each group contained 33.84 cases (the harmonic mean).

*$p < .05$.

**$p < .01$.

distortion at each level of independent groups. These analyses revealed that RBDs made significantly more mistakes involving overlooking a left-sided error than a right-sided one ($F_{1,106} = 44.41$, $p < .01$) and that LBDs made significantly more mistakes involving overlooking right-sided errors than left-sided ones ($F_{1,106} = 5.404$, $p < .05$). Controls exhibited no differential tendency to overlook one error location over the other ($F_{1,106} = .138$, p = ns). These results are summarized in Table 10. The error term is that used to test the interaction effect in the main analysis (Table 9).

These results support the hypothesis that pathological asymmetries in attention within reduced space among brain-damaged subjects parallel asymmetries found for these subjects witin gross space: RBDs tend to overlook left-sided distortions more so than right-sided ones; LBDs tend to overlook right-sided distortions more so than left-sided ones. A review of Table 8, however, suggests that the RBDs exhibited a more pronounced asymmetry than LBDs. This issue will be addressed later in this chapter.

Determining the Incidence of Significant Gross-Spatial Attentional Biases among Brain-Damaged Subjects

Response-position preferences, derived from four trials on the newly constructed task, were employed to identify those brain-damaged subjects exhibiting a pathological asymmetry in visuo-spatial attention. Inasmuch as the distribution of response biases for the control sample was essentially normally distributed (refer to Figure 5), a 99% confidence interval was constructed for the purpose of defining the extent

Table 10

Analysis of Simple Main Effects of Interaction of Error Location

Source	SS	df	MS	F
Side distorted	83.04	1		
Groups × Side	708.72	2		
Simple Main Effects:				
Side at RBD	703.91	1	703.91	44.41**
Side at LBD	85.66	1	85.66	5.40*
Side at Controls	2.19	1	2.19	.14
$\text{Error}_{\text{groups × side}}$	1680.34	106	15.85	

*$p < .05$.

**$p < .01$.

of variations in response bias not statistically different from what would be considered "normal."[6] The mean bias for the control sample was computed to be .207 with a standard deviation of 1.58 units. Accordingly, the confidence limits, rounded off to the nearest .25 units, were set at -4.00 to +4.25. Since no member of the control sample actually exceeded these limits, a significant response bias was adopted as being less than -4.00 or greater than +4.25. Thirty of the 51 RBDs (59%) and six of the 28 LBDs (22%) were found to exhibit significant response biases using these criteria. These subjects were classified as pathologically biased in visuo-spatial attention.

At this point it would be worthwhile to reconsider the data on fine spatial biases. Table 11 presents fine spatial errors (side of distractor overlooked) recast to reflect delineation of brain-damaged subjects into affected (those exhibiting gross-spatial biases) and unaffected categories. As can readily be seen, affected subjects in both groups accounted for the major portion of the respective asymmetries found. Of special interest is the right-left asymmetry (mean values) in errors of the affected LBDs ($\underline{n} = 6$). The apparent tendency for RBD asymmetries to be more pronounced, alluded to earlier, is far less distinct when compared with the asymmetries evidenced by the affected LBDs. Due to the exceptionally small $\underline{n}$ of the affected LBDs, statistical evaluation was not attempted.

Two of the major hypotheses underlying initiation of this study were:

---

[6]In view of the relatively small size of the control sample employed in the present study, the confidence interval (though statistically stringent) must be viewed as tentative pending the testing of a considerably larger sampling.

Table 11

Mean Number of Detail Errors Overlooked (Recast to Reflect Delineation of Brain-Damaged Subjects by Gross-Spatial Bias)

	Side of Choice Containing Detail Error	
	Left (LE)	Right (RE)
RBD (unaffected)[a]	7.13	4.78
RBD (affected)[b]	18.50	9.49
LBD (unaffected)[c]	4.79	5.48
LBD (affected)[d]	7.00	15.26

Note. Entries are mean number of distractor choices selected with respective right- or left-side errors (summed across four trials).

[a] *n* = 21.

[b] *n* = 30.

[c] *n* = 22.

[d] *n* = 6.

1. The lack of consensus among researchers as to which criteria constitute evidence of an impairment in spatial attention has led to spuriously contradictory findings concerning the role played by spatial inattention in the aberrant visual behavior observed to arise secondary to brain injury;

2. Existing diagnostic test instruments are not sufficiently sensitive to more subtle manifestations of spatial inattention and, therefore, fail to detect a meaningful number of instances of mildly impaired spatial attention.

With respect to the observed incidence of pathological asymmetries in visuo-spatial attention in the present study, these hypotheses, if supported, translate into the following findings:

1. Applying several of the more frequently used criteria of inattention to the present samples should yield differing estimates of the incidence of inattention;

2. The newly constructed task should have detected a greater incidence of disordered spatial attention than the frequently employed measures, including all instances detected by these latter measures;

3. For those instances of disordered spatial attention detected solely by the newly constructed task, some evidence of a reduced level of visuo-cognitive functioning should be discernible.

Estimating the Incidence of Inattention from Frequently Used Criteria

Five separate task-related criteria were used to estimate the incidence of inattention in the present brain-damaged samples: (1) partially completed copies of drawings/indistinct completion of one side of copied drawings (Bender Visual Motor Gestalt Test, not including cards 2 or 3); (2) in reading, omission of words (or misreadings) restricted to one side of the page (WRAT); (3) an asymmetry in errors of omission on a simple visual-cancellation task (clinically derived cut-offs noted previously under Materials); (4) an asymmetry in errors of omission on a double-target visual cancellation task (clinically derived cut-offs noted previously under Materials); and (5) response-position preference derived from performance on Raven's Colored Progressive Matrices (cut-offs as defined in Costa et al., 1969).

As depicted in Table 12, estimates of the relative incidence of inattention in the present samples varied considerably as a function of different task criteria. Also reflected in Table 12, the greatest incidence of inattention was associated with average response-position preferences on the newly constructed task. Upon construction of a Guttman Scalogram based upon the RBD frequency counts, it was noted that all subjects exhibiting a significant response bias on Raven's CPM were also found to exhibit a significant average response bias on the new task. Moreover, it was found that for RBDs exhibiting inattention on two or more criteria ($n = 23$), a new-task bias was one of them. Seven RBDs exhibited a significant average bias on the task, yet showed no other signs of inattention. Three subjects not exhibiting inattention on the new task reached criteria for inattention on simple cancellation or multiple cancellation (only one of the two tasks and on no others).

Analysis of the Scalogram revealed that the observed detection hierarchy was not particularly internally consistent (Coefficient of Scalability = .63; Coefficient of Reproducibility = .889; Improvement

Table 12

Estimated Incidence of Inattention in Brain-Damaged Subjects as a Function of Different Task-Related Criteria

Task-Related Criteria	RBD[a]	LBD[b]
Reading	9 (18%)	0 (0%)
Drawing	10 (20%)	1 (3%)
Simple cancellation	12 (24%)	0 (0%)
Multiple cancellation	14 (28%)	0 (0%)
Resp bias, RCPM	15 (30%)	0 (0%)
Average R-B, new task	30 (59%)	6 (22%)

Note. Relative percentage of the respective brain-damaged sample appears in parentheses.

[a] $n = 51$.

[b] $n = 28$.

of the Coefficient of Reproducibility over the Minimum Marginal Reproducibility = .189).[7] Scalability was adversely affected, mostly by the lack of internal consistency among the two cancellation tasks and Raven's CPM response bias. Were the new task not used, no single task-related criterion would have captured more than 15 cases of inattention; no combination of task-related criteria would have accounted for more than 23 cases of inattention.

Within the LBD sample, only one subject exhibited inattention on a measure other than the new task. That subject, however, was found to be significantly biased on the new task as well. Clearly, the newly constructed task was the only measure sensitive to inattention among these subjects.

It appears, then, that with respect to detection of pathological asymmetries in attention:

1. the five frequently used indices were often in disagreement with each other, and produced varied estimates of the incidence of inattention among brain-damaged individuals;

2. the newly constructed task was effective in identifying nearly all instances of inattention which were revealed on the other measures;

3. the newly constructed task was sufficiently sensitive to have detected instances of pathological asymmetries in attention not revealed on any other measure.

---

[7]Tests of statistical significance are not available for the Guttman Analysis. A perfectly internally consistent hierarchy would yield Coefficients of Scalability and Reproducibility of 1.00. Accepted critical values for the purpose of interpretation are Scalability well above .60 and Reproducibility greater than .90 (assuming this reflects a 25% increment over the Minimum Marginal Reproducibility) (Manual for the SPSS, 3rd edition).

These findings would be of questionable value, however, were they to be devoid of clinical meaning. It was reasoned that a pathological asymmetry in attention, as determined on the new task, should be associated with a decrement in visuo-cognitive functioning in affected subjects.

Examining Visuo-Cognitive Functioning in the Two Brain-Damaged Samples as a Function of the Presence/Absence of a Pathological Asymmetry in Visuo-Spatial Attention

Raven's Colored Progressive Matrices

The subjects in each brain-damaged group were separately divided into three subgroups for the purpose of analysis: Group 0, not found to be significantly biased in response-position preference on either the RCPM or the new task; Group 1, significantly biased on the new task but not on the RCPM; Group 2, significantly biased on both the RCPM and the new task. (This last group should correspond to those reported to have exhibited inattention by Gianotti et al. [1977] and Costa et al. [1969].) Groups 0 and 1, in the absence of the new task, would have been combined and classified as free of inattention were this solely a study involving Raven's Colored Progressive Matrices (as has frequently been the case). Table 13 depicts the distribution of subjects across the three subgroups.

These groupings were retained for the entire series of analyses on visuo-cognitive functioning.[8] It was anticipated that, inasmuch

---

[8] A more desirable breakdown of the respective samples would have been to classify subjects by the number of measures on which they exhibited inattention (i.e., task independence of the impairment). Unfortunately, for the sample sizes employed in this study, this would have resulted in a serious watering-down of subgroup sizes and would have precluded any meaningful analysis.

Table 13

The Distribution of Subjects from Each Brain-Damaged Group Across Three Subgroups of Inattention

	Subgroup[a]		
	0	1	2
RBD[b]	21	15	15
LBD[c]	22	6	0

[a]Group 0: Absence of a significant response-position preference on either the RCPM or the new task;

Group 1: Significant response bias on the new task but not the RCPM;

Group 2: Significant response biases on both the new task and the RCPM.

[b]$\underline{n}$ = 51.

[c]$\underline{n}$ = 28.

as these subgroupings are seen as representing differing levels of impairment in visuo-spatial attention, the performance of the three subgroups on tests of visuo-cognitive functioning should reflect a rough hierarchy of visuo-cognitive impairment. Group 0, considered to be free of an attentional bias, should be least impaired in functioning. Group 1, considered to have sustained a subtle bias in attention, should perform somewhat worse than Group 0 yet better than Group 2. Group 2, considered to have sustained a clear attentional bias, should perform the worst. All analyses were carried out with these hypotheses in mind.

RBD subjects. Mean RCPM scores for the three subgroups are presented in Table 14. The distributions of scores within these subgroups were judged sufficiently consistent with a normal distribution so as to permit parametric evaluation. These data were, therefore, subjected to a one-way analysis of variance with preformulated planned comparisons designed to test the hypotheses stated above. An unweighted means analysis method was employed because of the disparity in sample sizes.

The results of the analysis (see Table 15) strongly supported the hypotheses advanced concerning differences in performance on the RCPM among the three subgroups. Group 2 was found to have performed worse than Group 1 ($F_{1,48} = 14.41$, $p < .01$); Group 1, in turn, performed worse than Group 0 ($F_{1,48} = 14.92$, $p < .01$). It is recalled that Groups 0 and 1 were distinguished solely on the basis on the latter's being comprised of subjects exhibiting significant attentional biases on the new task.

Table 14

Performance of the Three RBD Subgroups on Raven's Colored Progressive Matrices

Group	Mean	*SD*
0[a]	27.38	5.80
1[b]	20.53	5.09
2[c]	13.80	3.91

[a] *n* = 21.

[b] *n* = 15.

[c] *n* = 15.

Table 15

Analysis of the Performance of Three RBD Subgroups on Raven's Colored Progressive Matrices

Source	*SS*	*df*	*MS*	*F*[a]
Groups[b]:	1528.76	2	764.38	29.32**
G2 v. G1	375.44	1	375.44	14.41*
G1 v. G0	388.94	1	388.94	14.92*
$Error_{groups}$	1251.09	48	26.06	

[a]An overall *F* was obtained inasmuch as the comparisons planned were nonorthogonal.

[b]The analysis was carried out on the assumption that each group contained 16.578 subjects (the harmonic mean).

*$p < .01$.

**$p < .001$.

LBD subjects. Inasmuch as no LBD subject evidenced a significant response-position bias on the RCPM, only two subgroups could be formed: Group 0 (free of any response bias), and Group 1 (biased on the new task but not on the RCPM). Mean RCPM scores for the two groups are presented in Table 16. Due to the extreme disparity in sample sizes, an analysis of these data were carried out via the Mann-Whitney U test (nonparametric analysis). The results of this analysis revealed that, consistent with the hypotheses advanced, Group 0 performed significantly better on the RCPM than Group 1 ($U_{6,22} = 15$, $z_{equivalent} = -2.85$, $p < .005$ one-tailed).

WAIS Performance Scale Subtests: Block Designs, Object Assembly, Picture Completion

Each brain-damaged subject's score on the three WAIS Performance subtests was converted to an age-corrected scale score for the purpose of analysis. As hypothesized with respect to subject performance on the RCPM, it was expected that subgroups within each brain-damaged sample would perform systematically differently on these tests as well. Additionally, the WAIS Similarities subtest was administered to subjects in the RBD sample (precluded for LBDs due to the incidence of expressive language problems in that group) as a test, on which performance should be unrelated to the presence or severity of impairment in visuo-spatial attention. (Grossly disoriented patients who might be expected to exhibit deficits in all spheres were not used in this study.) It was anticipated that the absence of systematic subgroup differences on this test would serve to highlight the expected relationship between disturbed visuo-spatial attention and performance on visuo-cognitive tasks.

Table 16

Performance of the Two LBD Subgroups on Raven's Colored Progressive Matrices

	Mean	*SD*
Group 0[a]	29.41	4.54
Group 1[b]	20.17	5.53

[a] *n* = 22.

[b] *n* = 6.

RBD subjects. The conversion of raw scores to age-corrected scale scores for these subjects failed substantially to alter the tendency for subgroup scores (typically those of Group 2) to be bimodally distributed or grossly skewed. Accordingly, a nonparametric strategy of analysis was adopted for these data. It is noteworthy that a comparable problem was not encountered with respect to the age-corrected Similarities scores. An analysis of variance of these data was carried out in a manner similar to that used to evaluate the RCPM data for these subjects. Performance of the three subgroups is summarized in Table 17.

1. Block Designs--Age-corrected scale scores were analyzed via a Kruskal-Wallace one-way analysis of variance. The results of this analysis indicated that the three groups differed significantly in their performance on Block Designs ($H = 33.11$, $df = 2$, $p < .001$). Subsequent analyses (Mann-Whitney U tests) further revealed that, as hypothesized, Group 1 performed significantly better than Group 2 ($U_{15,15} = 28$, $p < .001$ one-tailed), and Group 0 performed significantly better than Group 1 ($U_{15,21} = 104.5$; $z_{equivalent} = -1.70$, $p < .05$ one-tailed).

2. Object Assembly--Age-corrected scale scores were analyzed via a Kruskal-Wallace one-way analysis of variance. The results of this analysis indicated that the three groups differed significantly in their performance on Object Assembly ($H = 24.14$, $df = 2$, $p < .001$). As was found for Block Designs, Group 1 performed significantly better than Group 2 ($U_{15,15} = 41$, $p < .01$ one-tailed), and Group 0 performed significantly better than Group 1 ($U_{15,20} = 97$, $p < .05$ one-tailed).

Table 17

Performance of the Three RBD Subgroups on Four Specific Tasks

	Group 0	Group 1	Group 2
Block Designs:			
Mean	9.23	7.67	3.80
Median	9.00	8.16	4.00
SIQR	2.10	1.62	2.74
n	21	15	15
Object Assembly:			
Mean	8.95	7.27	3.67
Median	9.06	7.50	4.00
SIQR	1.60	1.90	2.88
n	20	15	15
Picture Completion:			
Mean	12.36	10.76	8.15
Median	13.00	10.00	8.50
SIQR	2.60	2.55	2.00
n	19	13	13
Similarities:			
Mean	12.70	11.79	12.07
SD	3.66	3.29	3.89
n	20	14	14

Notes. Means and medians are based on age-corrected scale scores. Semi-interquartile range is provided as an estimate of dispersion for the three WAIS Performance Scale subtests. Occasional instances of missing data were the result of time constraints attendant to patients' schedule at IRM, and were not unusual to any of the three groups.

3. Picture Completion--Results of a Kruskal-Wallace analysis of variance indicated that the three groups differed significantly in their performance on Picture Completion (H = 12.48, df = 2, $p < .01$). The differences between adjacent groups, though significant in the predicted direction, were somewhat less distinct on this test as opposed to the preceding ones: Group 1 performed better than Group 2 ($U_{13,13}$ = 48, $p < .05$ one-tailed), and Group 0 performed better than Group 1 ($U_{13,19}$ = 79, $p < .05$ one-tailed).

4. Similarities--As noted earlier, the distribution of age-corrected Similarities scores within each of the subgroups was sufficiently approximate to normal to permit parametric analysis. Planned comparisons similar to those performed on the RCPM data were intended for this analysis of variance; however, in view of the negligible and nonsystematic differences between the three subgroup means (see Table 16), this became unnecessary. A simple one-way analysis confirmed that the three group means were statistically indistinguishable ($F_{2,45}$ = .27, p = ns). These results are summarized in Table 18.

__LBD subjects__. Analyses performed on the data obtained from the LBD sample involved a nonparametric strategy. In all cases Mann-Whitney U tests were used to evaluate whether (as hypothesized) Group 0 performed significantly better than Group 1. Performance of the two LBD subgroups on each of the WAIS Performance Scale subtests is summarized in Table 19.

1. Block Designs--This test was prioritized during the testing session and, therefore, was associated with only a single missing case. Results of a Mann-Whitney U test on these data revealed that Group 0 performed significantly better than Group 1 on Block Designs ($U_{6,21}$ = 22.5; $z_{equivalent}$ = -2.36, $p < .01$ one-tailed).

Table 18

Analysis of the Performance of the Three RBD Subgroups on Similarities (Age-Corrected Scale Scores)

Source	*SS*	*df*	*MS*	*F*
Groups	7.19	2	3.59	0.27
$Error_g$	591.49	45	13.14	

Notes. Unweighted means analysis method was employed. The analysis was performed assuming that each group contained 16.14 cases (harmonic mean).

Table 19

Performance of the Two LBD Subgroups on Three Specific Tasks

	Group 0	Group 1
Block Design:		
Mean	11.18	7.50
Median	11.80	6.50
n	21	6
Object Assembly:		
Mean	9.50	5.83
Median	9.40	4.50
n	16	6
Picture Completion:		
Mean	11.33	9.33
Median	11.00	9.70
n	18	6

Notes. The semi-interquartile range was omitted because of the small size of Group 1. Unfortunately, missing cases predominated in the unaffected group. This was due to severe time constraints on testing towards the end of the experimental remediation study (terminated LBD component prior to RBD). It must be acknowledged, however, that the possibility of a testing bias with respect to Object Assembly and Picture Completion cannot be ruled out in interpreting the respective analyses.

2. Object Assembly--This test was associated with the greatest number of missing cases. Results of a Mann-Whitney U test on these data revealed that, as hypothesized, Group 0 performed significantly better than Group 1 ($U_{6,16} = 20$, $p < .025$ one-tailed).

3. Picture Completion--The scores of the two LBD subgroups could not be reliably distinguished on this test ($U_{6,18} = 38$, p = ns).

Neurologic Characteristics of Subjects Exhibiting Pathological Asymmetries in Visuo-Spatial Attention

Neurologic characteristics of the brain-damaged subjects in the present study were presented earlier. Subjects within the two brain-damaged samples were further delineated on the basis of the presence or absence of an attentional bias. Analyses were performed in an attempt to discern which neurologic characteristics, if any, distinguished affected subjects from unaffected subjects.

Motor Function

Table 20 presents the range of motor deficits evidenced by affected and unaffected subjects in each brain-damaged sample. Subgroupings employed in the preceding analysis were retained for the study of neurologic characteristics. Inasmuch as subjects were rated along a continuum of increasing degree of motor impairment, each subject was assigned a score on a 5-point scale, reflecting their degree of motor impairment (0 = no deficit, 1 = minimal deficit, 2 = moderate deficit, 3 = marked deficit, and 4 = very marked deficit). Clinical criteria corresponding to each of these designations were described previously under *Subjects*.

Table 20

Status of Motor Function of Affected and Unaffected Brain-Damaged Subjects

Degree of Severity	Group 0	Group 1	Group 2
Upper Extremity: RBD			
Deficit--0	0	0	0
1	3	2	2
2	7	2	2
3	4	2	3
4	7	9	9
Median[a]	2.6	3.7	3.7
Upper Extremity: LBD			
Deficit--0	0	0	-
1	5	1	-
2	10	1	-
3	4	2	-
4	2	2	-
Median[a]	2.2	3.0	
Lower Extremity: RBD			
Deficit--0	1	0	0
1	3	1	1
2	12	6	3
3	3	5	6
4	2	3	5
Median[a]	2.2	2.7	3.1
Lower Extremity: LBD			
Deficit--0	0	0	-
1	8	1	-
2	9	1	-
3	3	4	-
4	2	0	-
Median[a]	1.9	2.9	

[a]These scores are based on the 5-point rating scale.

For the RBD subjects, results of Kruskal-Wallace one-way analyses of variance indicated that the three groups differed significantly in degree of motor deficit in their upper extremities ($H = 6.84$, $df = 2$, $p < .05$) and lower extremities ($H = 8.11$, $df = 2$, $p < .02$). Systematic differences between adjacent groups could not be reliably established for the upper extremity (Group 0 v. Group 1: $U_{15,21} = 117.5$, $z_{equivalent} = -1.36$, $p = .08$ one-tailed; Group 1 v. Group 2 was not performed since the two distributions are nearly identical). However, Group 1 was found to be more severely deficient in motor function of the lower extremity than Group 0 ($U_{15,21} = 105$, $z_{equivalent} = -1.81$, $p < .05$ one-tailed)[9], yet could not be reliably differentiated in this regard from Group 2 ($U_{15,15} = 88$, p = ns).

For the LBD subjects, subgroups could not be differentiated on the basis of motor deficit in either extremity (Upper: $U_{6,22} = 44.5$, $z_{equivalent} = -1.25$, p = ns; Lower: $U_{6,22} = 41.5$, $z_{equivalent} = -1.44$, p = ns). However, it is noted that with respect to both extremities, there is a trend for the affected group to be more impaired than the unaffected group.

<u>Sensory Function</u>

Table 21 presents the range of sensory deficits evidenced by affected and unaffected subjects in both brain-damaged samples. Since these data were classified into only three categories, analysis was carried out by collapsing the two levels of deficit and comparing relative frequencies of presence and absence of symptoms (χ^2 for multiple independent groups).

---

[9]Hypotheses concerning systematic differences between adjacent subgroups were clearly applicable here: Group 0 would be expected to be least impaired; Group 1 more impaired than Group 0, but less impaired than Group 2.

Table 21

Status of Sensory Function of Affected and Unaffected Brain-Damaged Subjects

	Group 0	Group 1	Group 2
Light Touch: RBD			
Norm	17	8	2
Decr	3	5	11
Abs	1	2	2
Light Touch: LBD			
Norm	17	2	-
Decr	5	4	-
Abs	0	0	-
Pain: RBD			
Norm	13	8	1
Decr	7	6	12
Abs	1	1	2
Pain: LBD			
Norm	16	3	-
Decr	6	3	-
Abs	0	0	-
Joint Position Sense: RBD			
Norm	13	7	1
Decr	4	6	5
Abs	4	2	9
Joint Position Sense: LBD			
Norm	17	3	-
Decr	4	0	-
Abs	1	3	-
Visual Fields: RBD			
Norm	16	9	3
Ext	2	3	1
HH	3	3	11
Visual Fields: LBD			
Norm	18	2	-
Ext	3	1	-
HH	1	3	-

For the RBD sample significant subgroup differences in impairment were found for all sensory measures (light touch: $\chi^2 = 16.05$, *df* = 2, *p* < .001; pain: $\chi^2 = 12.79$, *df* = 2, *p* < .01; joint position sense: $\chi^2 = 11.27$, *df* = 2, *p* < .01; visual fields: $\chi^2 = 11.35$, *df* = 2, *p* < .01). In all instances Groups 0 and 2 were clearly disparate, with Group 1 falling between the two (systematic differences between adjacent groups was not tested). Due to the limited number of subjects in Group 1 of the LBD sample, it was deemed inappropriate to consider analysis of frequency distributions. The LBD data, however, do not appear to contradict the RBD findings.

Locus of Lesion for Affected and Unaffected Subjects

In many instances patients' charts contained results of CAT scans (EMI scanner in most cases). This was usually the case for the RBDs inasmuch as such scans were obtained in conjunction with the remediation study in which many of them participated. In several cases, however, CAT scans had not been obtained for one of the following reasons: either the patient refused the scan, or the scan had been performed prior to coming to IRM. Where scans were obtained outside of IRM, patients' charts often contained only vague synopses (i.e., consistent with R-CVA; consistent with CVA in middle cerebral artery territory). Table 22 presents the CAT scan data which were retrievable. It should be recalled that patients entering IRM do so primarily for physical rehabilitation. In all cases for the present study patients had sustained some degree of hemiparesis. Therefore, it may be assumed that all subjects in the present study had involvement of internal capsule

Table 22

Locus of Lesion for Affected and Unaffected Subjects Based on CAT Scan Findings[a]

	RBD			LBD	
	Group 0	Group 1	Group 2	Group 0	Group 1
Normal	5	1	0	6	0
Frontal/Peri-3rd Ventric	4	1	0	3	0
Fron-Par/Frontal-Temporal	4	1	1	2	2
Parietal/Par-Temp (mid)	2	4	3	1	2
Post. Parietal	1	3	3	1	0
Occip/Occ-Par/Occ-Temp	0	0	3	1	1
Miss (_n_)	5	5	5	7	1

[a]Frequency counts reflect most posterior region with verified infarction.

fibers or precentral gyrus proper. As a consequence, none of the subjects in the present study can truly be classified as exclusively posteriorly (with respect to the central sulcus) damaged. This would be the case even when anterior infarction is not represented in the CAT scan. As reflected in Table 22, among RBDs there existed a tendency for greater incidence of posterior involvement among affected subjects. No clear pattern is discernible with respect to the CAT scan results for the LBDs.

Language Impairments among Affected LBD Subjects

It was anticipated that affected LBDs would be primarily comprised of those patients with aphasic symptoms usually associated with posterior lesions (i.e., Fluent or Global). As depicted in Table 23, only one of the Fluent and one of the Mixed/Global classified aphasics were found to exhibit a pathological asymmetry in visuo-spatial attention. Three of the remaining four affected LBDs were Non-Fluent classified and the last was free of aphasic symptomatology. It is noted, however, that none of these subjects exhibited inattention of a degree comparable to Group 2 RBDs. Additionally, two of the affected LBDs were reported as alexic.

Table 23

Language Impairments of Affected (Disordered Visuo-Spatial Attention) LBD Subjects

LBD	Classification	Overall FCP (%)	Average Bias (new task)
1A	Mixed/Global	20	-12.25
1B	Nonfluent	32	- 9.25
1C	Nonfluent	27 (alexic)	- 9.75
1D	Nonfluent	46	- 8.75
1E	Nonaphasic	-	- 6.75
1F	Fluent	50 (alexic)	- 4.25

CHAPTER IV

DISCUSSION

The Varying Nature of Inattention and the Problem of Detection

In proposing this research it was suggested that the study of inattention historically has been adversely influenced by problems in assessment. These problems, centering around the relative accuracy with which disordered visuo-spatial attention could be identified, were seen as arising from two primary factors:

1. Visually bound tasks vary considerably with respect to the degree to which they elicit overt evidence of disordered visuo-spatial attention (inattention);

2. Available diagnostic instruments, whether designed as such or adapted for that purpose, lack sufficient sensitivity to more subtle forms of the disturbance to be accurate barometers of its occurrence.

In anticipation of the potential influences of these factors, a task was designed for use in the present study to be uniquely sensitive to asymmetries in visuo-spatial attention. It was expected that the design characteristics of the new task would make it a particularly effective discriminator of disturbed visuo-spatial attention. The results of the present study strongly confirm this expectation. The results further confirm the task-dependent nature of inattention and the relative insensitivity of frequently used measures to more subtle manifestations of disturbed visuo-spatial attention. Among RBDs the use of the newly constructed task as a measure of inattention resulted in nearly a two-fold increase in detection rate over that of the most sensitive of the popular measures sampled. Included among these measures were two of the most frequently used: errors of omissions in copying-drawing and response-position preference on Raven's Colored Progressive Matrices. Among LBDs the newly constructed task was unique in its sensitivity to inattention.

The present results are seen as reflecting the new task's sensitivity to subtle disturbances in visuo-spatial attention among RBDs and LBDs alike. They are also seen as lending credence to the present author's speculation that the incidence of pathological asymmetries in visuo-spatial attention among the unilaterally brain damaged has been under-estimated. Despite obvious differences, however, no assertions would be warranted concerning the relative incidence or severity of attentional asymmetries in right versus left brain-damaged patients. Several authors have suggested that such assertions must be appended with the caveat that the tendency for receptive aphasics to predominate among those patients unable to comply with testing demands may result in LBD samples which are characterized by less, or at least, different structural injury than their RBD counterparts (Battersby et al., 1956; Costa et al., 1969; Zarit & Kahn, 1974).

Such was clearly the case in the present study. The present LBD sample was generated under constraints which all but precluded access to patients exhibiting moderate to severe receptive language disorders.

As a result, it comes as no surprise that CAT scans revealed that the two brain-damaged samples were not comparable with respect to either locus or extent of damage sustained. Predictably, posterior involvement was more common among the RBDs and, where evidenced in members of both groups, was more extensive in the RBD patients. This being the case, and in view of the well established relationship between damage to posterior regions and disorders in spatial attention, it would be pointless to compare the two brain-damaged groups with respect to the occurrence or severity of attentional asymmetries.

The present results highlighted yet another characteristic of inattention likely to influence its detection. In this regard the popular measures must be separated from the new task. The popular measures in their evidenced varied sensitivity to inattention lacked strong hierarchical consistency. Thus, the occurrence of inattention on an ostensibly less sensitive measure did not necessarily correspond with its occurrence on a more sensitive one. Some of the instances of disagreement were quite striking. Three RBD patients evidenced inattention on reading or copying-drawing (with incidence rates in the present RBD sample of 18% and 20%, respectively) which was not confirmed on either of the cancellation tasks or on Raven's CPM (with incidence rates ranging from 24% to 30%). This finding is, in nature, consistent with results reported by Piercy (1960) which reflected a double-dissociation between the occurrence of inattention on copying-drawing tasks and that on other spatially bound tasks (e.g., reading, locating objects by pointing). It adds an additional degree of complexity to the problems surrounding the accurate detection of disordered visuo-spatial attention. Quantitative considerations (incremental increases in detection rate) may be primary; yet it appears that qualitative considerations (task-specific instances of inattention) are warranted as well. The examples cited were the most striking instances of disagreement. The most frequent instances, however, were those involving the two cancellation tasks and Raven's CPM. In nearly all such instances of disagreement among the five popular measures, an attentional asymmetry was confirmed on the newly constructed task. This seems to indicate that the enhanced diagnostic sensitivity of the new task subsumed both the quantitative and qualitative aspects of sensitivity of the five popular measures.

The Determinants of Inattention

In the preceding discussion it was noted that the occurrence of inattention on the five popular measures was both variable and hierarchically inconsistent. This raises considerable doubt as to the degree to which the determinants of inattention might be truely definable along a continuum of task demand. Surely, as has been suggested by several authors (Colombo et al., 1976; Diller et al., 1974; Diller & Weinberg, 1977), certain types or levels of complexity of task demand exert an influence over the emergence of inattention. The present results suggest, however, that they do not do so in an entirely predictable manner.

The formulation offered by Leicester et al. (1969), while somewhat more appealing, is no more readily defensible. These authors suggest that a patient with a tendency to be inattentive will exhibit this tendency overtly when faced with cognitive demands he is unable to meet. In principle, this accounts for all instances of inattention on the basis of task difficulty. Task difficulty, however, is not defined by the task itself, but by whether the patient finds it so. On the surface this might be an acceptable principle under which to understand the lack of consistency among the popular measures. A problem arises, however, in the logical extension of this argument to where failure occurs in the absence of inattention. By the logic provided in Leicester's argument, failure on a task in the absence of overt inattention constitutes evidence that a tendency to be inattentive was absent. Clearly, this does not reconcile with the current results. Moreover, while response-position preferences on the new task did tend to become more deviant on memory trials, clinical observations suggest that the effects of task difficulty are not unidirectional.

It was noted that some patients who exhibited distinct biases on one or more trials of the new task might not exhibit a response-position preference on a trial which they were almost incapable of performing. Such patients, presenting with a clear-cut deficit in a function primary to the performance of a specific task-trial (i.e., memory deficit) might, in the absence of frank neglect, select randomly from the entire choice array. This was the case for two RBD patients during performance of the match-from-memory trial with Unfamiliar Figures. On the whole, task difficulty did tend to induce greater incidence of inattention when patients were sufficiently challenged but not overwhelmed. Where the task was perceived as overwhelming, intense effort may not have been undertaken and weakened functional components may, thereby, remain unrevealed in the overall failure.

In part, the difficulties associated with defining the determinants of inattention inhere in the type of tasks generally employed for that purpose. Inattention tends to be episodic, more likely to arise in complex situations than in simple ones. However, the necessity for use of complex tasks is problematic in that typically such tasks were not designed with provisions to measure attentional components. Moreover, the complexity of such tasks focuses on the integrated functions they were designed to reflect. That they are also sensitive to inattention is largely incidental and often attributable to a spatially expansive face construction (Jones, 1969). A study of the demand characteristics which influence the emergence of inattention, based upon patient performance on such tasks, is likely to be confounded by the more basic demands engendered by the task. Also, lacking provisions for the extraction of attentional components predisposes such tasks to be sensitive only to the grosser defects in orientation. It is by virtue of design characteristics, which linked general complexity to visuo-spatial attentional parameters, that the new task derives its strength as a measure of attentional asymmetries.

On the basis of the findings presented thus far, certain constructive observations can be made concerning the determinants of inattention on complex tasks. The findings suggest two characteristics of task demand which influence the emergence of inattention. The first is the degree of overall complexity of the task. This may be reflected in the sheer number of demands encountered, as well as in the precision with which component demands must be coordinated. This general characteristic is the source of a task's quantitative sensitivity to inattention (i.e., the degree to which it captures a greater or lesser incidence of inattention across patients). The second characteristic is related to the specific nature of the demands required. Tasks which place the greatest emphasis on one functional demand (e.g., visual-motor integration) may be more sensitive to the presence of inattention within a specific constellation of deficits (related to that functional demand) than another task which places greater emphasis on a different task demand (e.g., linear scanning). As such, these two characteristics seem to parallel the role of task complexity and stimulus parameters proposed by Diller et al. (1974) and also individual differences in task complexity as proposed by Leicester et al. (1969).

The Nature of Patient Performance on the Newly Constructed Task

Attentional Asymmetries

It was most striking to find that patients in both brain-damaged groups exhibited attentional biases with such remarkable directional consistency. Even among patients who did not evidence a statistically significant response asymmetry, there seemed to exist a systematic tendency to select responses from the side of the page ipsilateral to their respective hemispheric side of lesion. This was most evident in the response-bias distribution for the left brain-damaged patients who, it is recalled, were relatively mildly impaired. The majority of patients in this group evidenced response asymmetries which were within the statistically determined limits of those of the control sample.

However, closer examination suggests that, if a single error were to be made, it would likely be the selection of an incorrect response from the left (ipsilateral) side of the page. If several errors were made, more of them would likely be selected from the left rather than right side of the page.

The LBD sample did not differ significantly in overall performance (total number correct) from controls on the new task. It remains intriguing, however, that the magnitude of this subtle tendency to overselect responses from the left side of the page was roughly equivalent to the two-point overall difference in scores between the two groups. This raises certain questions concerning what is meant by "functioning within normal limits" following established injury to the brain. It raises the possibility that even "normal functioning" in brain-damaged patients includes elements of subtle alterations in processing mechanics. Such alterations may be of little consequence in the redundant atmosphere of everyday functioning, yet stand as potential sources of disruption under conditions requiring a high degree of processing power or efficiency.

Attentional asymmetries were found not to be solely restricted to the machanics of gross spatial exploration. Asymmetries, paralleling those for gross exploration, were also evident in patients' evaluation of individual response choices. The dual nature of attentional asymmetries evidenced in the present study seems to correspond well with Trevarthen's (1968, 1978) proposed dichotomy between ambient and focal components of spatial attention. If, as Trevarthen has proposed, visual analysis-by-synthesis involves a constant interaction between a sense of general context (ambient attention) and an elaboration of specific details (focal attention), then the effective operation of one mechanism would likely be influenced by the operation of the other. Both might further be governed by higher processes through which a percept arises. The interaction between ambient and focal attention, then, might readily account for the new task's enhanced sensitivity to attentional asymmetries over that of Raven's CPM.

The new task was designed so as to mimic the face construction of the RCPM. Furthermore, the RCPM is, at least in theory, more perceptually and cognitively demanding than the new task. The greater sensitivity of the new task to asymmetries in attention would inhere, then, in its tendency to "entrap" both ambient and focal components of attention. On the new task, ambient attention, presumed to be somewhat asymmetric, is drawn to the ipsilateral side of a page by the presence of response choices which are indistinguishable from the target in general outline. Because of the lateral placement of distortions, a similarly asymmetric focal attentive mechanism will be predisposed to miss the one source of information by which to engage ambient mechanisms for further search. On the RCPM, assuming that asymmetric ambient and focal attention does not lead to a deductive error (the missing piece must be deduced from cues in the display), and, assuming that ambient attention would be initially drawn to the ipsilateral side of the page, then the potential may still exist for adequate information to be culled via focal attention to cause a renewed search. Clearly, the RCPM contains many sources of potential confounding of attentional biases, without necessarily effecting improved performance. By confirming the presence of asymmetries in focal attention, the results of the present study provide an additional dimension by which the influence of attentional asymmetries might be understood to impair patient performance on higher visuo-cognitive tasks.

Acceptance of the ambient-focal dichotomy is not critical to the conclusion that asymmetries in fine spatial attention constitute an additional dimension by which to understand patient failure. It would be sufficient to accept this finding as reflecting the spatially dynamic nature of attentional asymmetries. Simply stated, asymmetries in attention are relative with respect to space. The field in which they are likely to be operative is defined by where, or on what, one's general attention is focused. Hence, pockets of inattention might arise within broader contexts of neglect (Apfeldorf, 1962), and attentional errors might be evidenced independent of absolute location in extrapersonal space (Albert, 1973; Kinsbourne, 1977).

Trial Demands

As already noted, comparisons between the two brain-damaged groups with respect to their relative levels of performance would be pointless. Suffice to say that a significant decrement in overall performance was found only for the RBD sample, and that with respect to both LBDs and controls. It was in their respective patterns of performance across the four trials that the three groups differed in a most interesting manner. On the basis of the performance of controls, it appears that the detail errors on the Unfamiliar Figures were somewhat easier to discriminate than those on the Familiar Figures. During memory trials, however, this seems to have been more than offset by the readily available verbal labels for the negotiation of the Familiar Figures. Hence, performance on matching trials for the controls was governed more by the relative ease of visual discriminability. During memory trials, performance was governed more by the access to verbal labels. Each of the brain-damaged samples differed from controls in a most suggestive manner. While RBD performance during matching trials was governed by the differential ease of discriminability of the two forms, their performance during memory trials did not evidence an advantage due to readily available labels. Conversely, LBDs seemingly derived benefit from the readily available labels during memory trials, but their performance during matching trials failed to reflect the differential in ease of discriminability for the two forms.

This seems to be at variance with reasonable expectation; however, certain relevant factors need to be considered in explaining this phenomenon. The LBD aphasics in the present study were relatively mildly impaired and were comprised mainly of expressive types. Some LBDs were not aphasic. Cohen, Kelter, and Woll (1980) have provided evidence that impairments in motor speech per se do not impair patients' ability to utilize labels in categorizing familiar visual stimuli. A specific disturbance in applying verbal labels would not, on an a priori basis, then, be expected to be characteristic of this LBD sample. Yet, the failure of these patients to take advantage of the easier discriminability of the Unfamiliar Figures during matching trials is perplexing. To ascribe this directly to an attentional asymmetry is difficult. To do so is to assume that the effects of such an asymmetry were blunted more effectively on matches involving

Familiar Figures. The obtained result would reflect a selective enhancement for the Familiar Figures and not a limitation on performance for the Unfamiliar Figures. Were this the case, a similar effect would be expected to be evidenced among the RBDs as well. It was not. It might be argued, instead, that this finding reflects a limitation in LBD patients' ability to meet the analytic demands of the matching paradigm. A feature of the matching trials which is not present in memory trials is the absence of any time limitations. Time available for exploration and choice selection during memory trials is limited to the length of time for which the visual trace can be maintained. Yet, Tyler (1969) has shown that motor aphasics make little use of available time for the purpose of focal exploration. Purposeful eye-movements were found only to occur during the first 10 seconds of exposure to a simple picture. The remainder of time was spent in seemingly aimless wanderings. It might be hypothesized, then, that many, if not most, of the LBDs in the present sample failed to take advantage of the easier form during matching trials because they failed to use the time available for thorough exploration. This would selectively disadvantage LBDs far less during memory trials where time limitations were present for all. As such, this defect in exploration might be considered as related to, but not synonymous with, a focal attentional asymmetry.

With respect to the RBDs, it would have been remarkable to find that they exhibited a selective deficit in the application of verbal labels to familiar stimuli. Were this the case, it would be expected that such a deficit would have an impact on other tasks for which verbal labeling might be a primary demand. Yet the RBDs showed no evidence of impairment on the WAIS Similarities subtest, even when subdivided by severity of attentional disorder. It must be concluded, then, that a specific verbally based defect cannot account for the RBDs' failure to take advantage of available verbal labels during memory conditions. It could be argued that the application of labels is of little value if the more central demands of the task were not met. The primary demand is to form and maintain a representative visual image of the target. Once formed, this image must be critically analyzed. While labels may assist in this process, they would be valueless in the absence of adequate revisualization of the target figure. It has already been shown that, where the primary demands of memory conditions require establishment of a visual trace, RBD patients are typically disadvantaged (DeRenzi, 1968). It might be hypothesized, then, that the tendency of RBD patients to "bottom out" during memory condition, despite ready access to verbal labels, is the result of a selective impairment in forming and maintaining a re-visualized image of the target figure. It is further hypothesized that such a defect arises, in part, from a subtle disturbance in ambient attentional mechanisms.

The Impact of Disordered Visuo-Spatial Attention on the Performance of Patients on Tests of Higher Visuo-Cognitive Function

It was a primary aim of the present study to determine the degree to which subtle asymmetries in visuo-spatial attention contribute to patient failure on tests of higher visuo-cognitive function. It was anticipated that, with the aid of a more definitive measure of visuo-spatial attention, a sign nt impact of disordered visuo-spatial attention would be revealed. The results of the study strongly confirm this expectation. Among right brain-damaged patients, pathological asymmetries in attention were associated with performance decrements on all visuo-cognitive tasks administered. Among left brain-damaged patients, pathological asymmetries in attention were associated with performance decrements on Raven's CPM, the WAIS Block Designs, and the WAIS Object Assembly, but not on the WAIS Picture Completion. Moreover, among LBDs, reading disorders were observed only among patients exhibiting an asymmetry in attention.

Two of the visuo-cognitive tasks were of particular interest to the present author due to their significance in the neuropsychologic community: Raven's Colored Progressive Matrices and the WAIS Block Designs. The former has been the subject of an intense debate concerning the relative role played by attentional asymmetries in patient failure. Basso et al. (1973) have argued that the performance of brain-damaged patients on the RCPM is largely governed by the relative intactness of a parietal region subserving spatial intelligence. Gianotti et al. (1977) have argued and have shown that much of the variability in patient performance on Raven's CPM can be explained by the presence or absence of unilateral spatial inattention. The results of the present study confirm those reported by Gianotti et al. (1977), that significant asymmetries in visuo-spatial attention are directly related to the failure of both left and right brain-damaged patients on Raven's CPM. Moreover, asymmetries in attention evidenced on the newly constructed task were found to be related to decreased levels of performance on the RCPM, even when such asymmetries were not evidenced on the CPM itself. This is interpreted as reflecting the influence of subtle disorders in visual-spatial attention in the genesis of disturbed visuo-cognitive functioning.

It remains to be considered to what extent factors other than attentional asymmetries contribute to patients' failure on tasks of higher visuo-cognitive functioning. In the preceding section it was hypothesized that patients in each brain-damaged group evidenced processing disturbances which were separate from their respective evidenced attentional asymmetries. LBD patients were felt to have sustained a defect in focal exploration which limited their capacity for analyzing critical details. RBDs were felt to have sustained a defect in the mechanism by which revisualization is accomplished, impairing their capacity to form and maintain a visual trace. To the extent to which each of these defects is present and independent of an attentional asymmetry, each is expected to contribute to patient performance on Raven's CPM and the WAIS Block Designs, as well. It is presumed that weaknesses are more powerful determinants of performance in brain-damaged individuals than strengths. Yet, each brain-damaged group is hypothesized to have sustained a different processing weakness (outside of an attentional asymmetry). For the LBDs their hypothesized weakness in focal exploration and critical analysis is presumed to be more reflected in their performance on matching trials than on memory trials. Conversely, for the RBDs their hypothesized weakness in the process of revisualization is presumed to be more reflected in their performance on memory trials than on matching trials. It follows, then, that for each brain-damaged group a different trial condition should be most closely related to that group's performance on the two tests of visuo-cognitive functioning.

Accounting for the presence and severity of attentional biases is, then, not expected to explain the totality of variability in patient performance. Independent of attentional biases, variability in the performance of the two brain-damaged groups on tests of visuo-cognitive functioning is expected to be differentially related to their performance on one or the other trial condition (matching or memory) of the new task. Applying the formulation discussed earlier, LBDs' performance on Raven's CPM and the WAIS Block Designs is expected to be more related to their performance on matching trials of the new task, and RBDs' performance on Raven's CPM and WAIS Block Designs is expected to be more related to their performance on memory trials of the new task. Due to basic similarity in demands, patient performance on the two trial conditions will be related. Yet, if one of the conditions truly reflects the weakness sustained by a group, that condition will subsume any relationship apparent between the other condition and performance on the two tests of visuo-cognitive function.

In order to explore this, a hierarchical partial correlational analysis was performed. Matching and memory trials were separately collapsed to yield a single matching score and a single memory score, and the signs were dropped from the attentional asymmetries. The analysis was performed as follows: zero-order correlation coefficients were computed for each trial condition with the two visuo-cognitive tests; bias scores were then partialled out; and finally, partial correlation coefficients were then obtained for each condition controlling for the effects of the other condition. As can be seen in Table 24, the results of this procedure were consistent with the hypotheses advanced. For RBDs the correlation between matching score and performance on each of the visuo-cognitive tasks is reduced to nonsignificance when the influence of attentional bias and the special characteristics embodied in the memory scores are accounted for. Among LBDs the results were less clearly defined. The expected result was obtained for Block Designs but not for Raven's CPM. It may well be that the layout of the RCPM and the demand for discerning the entire picture predispose some degree of relationship between memory conditions and the RCPM.

It would be tempting to view these additional findings as reflecting underlying differences in processing strategies for the two cerebral hemispheres. However, the considerable differences in structural injury for the two groups preclude any such musings. It is sufficient to note that performance on tests of higher visuo-cognitive functioning can be defined in terms of at least two factors: attentional asymmetries (common to both brain-damaged groups) and special impairments of detail analysis (left brain damaged) and revisualization (right brain damaged).

Table 24

Partial Correlation Coefficients for Trial Conditions with Tests of Visuo-Cognitive Functioning

	RBD[a]		LBD[b]	
	RCPM	BD	RCPM	BD
Match	.75**	.67**	.89**	.71**
Mem	.83**	.68**	.80**	.61**
Mat w Mem	.79		.77	
Mat_{Bias}	.40**	.33**	.60**	.44**
Mem_{Bias}	.63**	.47**	.55**	.32*
Mat w Mem	.45		.42	
Mat_{B} Mem	.18	.16	.50**	.36*
Mem_{B} Mat	.55**	.37**	.43**	.19

[a] $n = 51$.

[b] $n = 28$.

*$p < .05$.

**$p < .01$.

The Differential Impact of Asymmetries in Attention and Visual Field Defects on Patient Performance

Since the present study was not specifically designed to address this issue, subject selection did not systematically provide representative sampling of all possible contingencies of visual field defects (VFD) (present/absent) and attentional asymmetry (none evidenced/subtle/clear-cut). Yet there is a sufficient body of literature relating the presence of a visual field defect with impaired performance on visually bound tasks to warrant at least a preliminary investigation of this issue. Of the two brain-damaged samples, only the RBD contained patients falling into each of the six categories crossing VFD with attentional asymmetry. As reflected in Table 25, the simple distribution of patients with and without VFD varied considerably across categories of attentional asymmetry. This relationship is highly statistically significant ($\chi^2 = 11.17$, $df = 2$, $p < .01$), and provides support for the frequently reported observation that neglect of space (Group 2) is usually seen in patients who have sustained a visual field defect. However, the distribution of patients across categories also confirms the generally accepted premise that a visual field defect is neither necessary nor sufficient in the genesis of an attentional asymmetry.

Table 26 depicts RBD patient performance on Raven's CPM as a function of the six categories formed by crossing VFD and attentional asymmetry. The appropriate analysis with which to address the issue of a differential impact of the two factors on patient performance is a two-way analysis of variance. The wide disparity in subjects-per-cell and, particularly, the small number of subjects in some of the

Table 25

The Distribution of RBD Patients by Visual Field Defect and Severity of Attentional Asymmetry

	Visual Field Defect	
Degree of Severity	Present	Absent
Group 0 (none evidenced)	5	16
Group 1 (subtle asymmetry)	6	9
Group 2 (clear-cut asymmetry)	12	3

Table 26

Performance of the Three RBD Subgroups on Raven's Colored Progressive Matrices as a Function of Whether a Visual Field Defect Had Been Sustained

	VFD+[a]		VFD-[b]	
	n	RCPM Mean	*n*	RCPM Mean
Group 0 (none evidenced)	5	24.0	16	28.4
Group 1 (subtle asymmetry)	6	18.0	9	22.2
Group 2 (clear-cut asymmetry)	12	13.2	3	16.3

[a]VFD+ = present.

[b]VFD- = absent.

cells, precludes any meaningful application of such an analysis. In lieu of formal analysis, however, certain informal observations can be made:

1. The three levels of attentional asymmetry are associated with substantial differences (5 to 6 raw score points) in performance on the CPM for VFD and non-VFD patients alike.

2. A smaller, seemingly consistent difference (3 to 4 raw score points) in performance is evident between VFD and non-VFD patients at each level of attentional asymmetry.

3. There is no indication that VFD and attentional asymmetry are interactive with respect to their effect upon performance on Raven's CPM.

Although these observations require statistical verification, the division of patients by whether a field defect has been sustained does not appear to alter the basic finding that increasingly more severe levels of attentional asymmetry are associated with increasing decrements in performance on Raven's CPM. It remains a possibility, however, that a visual field defect exerts an independent negative influence on patient performance.

Appendix A

Sample Narrative for Demonstrating the Selection Process to a Patient Who Is Unable to Address the Task Demands

Present Plate A, and point to the target figure at the top.

Say: "Look at this picture. Down here there are six pictures. [Point slowly to each choice.] One of them looks exactly like the picture at the top." [Point to each choice again while saying the previous statement.]

If patient indicates the correct choice at this time, or during the exploration, give the appropriate supportive statements but suggest that, "We will examine each of the choices to make sure this is the one."

Start with #1 and proceed left to right. Describe basic similarities between #1 and target. Indicate that #2 is a triangle but is upside down and too large.

- Indicate that #3 is similar to the target on the bottom half, but is cut off at the top unlike the target which comes to a point.

- Indicate that #4 and #5 are completely different shapes; indicate that #6 is the same on the top half but has the wrong bottom part.

Insure that the patient can now produce the correct response.

Present Plate B

Use the same introduction as with Plate A.

- Indicate that #1 has the same right sides as the target but the left side is different (indicating the "serrations")

- Indicate #2 is the wrong shape

- Indicate #3 has the same left side and the same right side

- Indicate that #4 has the same left side but has little boxes on the right side

- Indicate that #5 and #6 have the wrong shape

Insure that the patient can now produce the correct response.

Reference Note

1. Weinberg, J. Personal communication. July, 1979.

References

Albert, M. A simple test of visual neglect. Neurology, 1973, 23, 658-664.

Apfeldorf, M. Perceptual and conceptual processes in a case of left-sided spatial inattention. Perceptual and Motor Skills, 1962, 14, 419-423.

Arrigoni, G., & DeRenzi, E. Constructional apraxia and hemispheric locus of lesion. Cortex, 1964, 1, 170-197.

Basso, A., DeRenzi, E., Faglioni, P., Scotti, G., & Spinnler, H. Neuropsychological evidence for the existence of cerebral areas critical to the performance of intellectual tasks. Brain, 1973, 96, 715-728.

Battersby, W.S., Bender, M.B., Pollack, M., & Kahn, R. Unilateral "spatial agnosia" ("Inattention") in patients with cerebral lesions. Brain, 1956, 79, 68-93.

Benson, D.F., & Geschwind, N. The alexias. In P. Winken and G. Bruyn (Eds.), Handbook of Clinical Neurology. Amsterdam: North Holland Pub. Co., 1969.

Bisiach, E., & Luzzatti, C. Unilateral neglect of representational space. Cortex, 1978, 14, 129-133.

Brain, R. Visual disorientation with special reference to the lesions of the right cerebral hemisphere. Brain, 1941, 64, 244-272.

Campbell, D.C., & Oxbury, J.M. Recovery from unilateral visuo-spatial neglect? Cortex, 1976, 12, 303-312.

Chedru, F., LeBlanc, M., & Llhermitte, F. Visual searching in normal and brain-damaged subjects (contribution to the study of unilateral inattention). Cortex, 1973, 9, 94-111.

Cherington, M. Visual neglect in a chess player. Journal of Nervous and Mental Disease, 1974, 159, 145-147.

Cohen, R., Kelter, S., & Woll, G. Analytical competence and language impairment in aphasia. Brain and Language, 1980, 10(2), 331-347.

Colombo, A., DeRenzi, E., & Faglioni, P. The occurrence of visual neglect in patients with unilateral cerebral disease. Cortex, 1976, 12, 327-342.

Costa, L., Vaughan, H.G., Horwitz, M., & Ritter, W. Patterns of behavioral deficit associated with visual spatial neglect. Cortex, 1969, 5, 242-263.

Critchley, M. The parietal lobes. London: E. Arnold & Co., 1953.

Denny-Brown, D., & Banker, B.Q. Amorphosynthesis from left parietal lesions. Archives of Neurology and Psychiatry, 1954, 71, 302-313.

Denny-Brown, D., Meyer, J.S., & Horenstein, S. The significance of perceptual rivalry resulting from parietal lesion. Brain, 1952, 75, 433-471.

DeRenzi, E. Nonverbal memory and hemispheric side of lesion. Neuropsychologia, 1968, 6, 181-189.

DeRenzi, E., & Faglioni, P. The relationship between visuo-spatial impairment and constructional apraxia. Cortex, 1967, 3, 327-342.

Diller, L., Ben-Yishay, Y., Gerstman, L., Goodkin, R., Gordon, W., & Weinberg, J. Studies in cognition and rehabilitation in hemiplegia. Rehabilitation Monograph #50. New York: Institute of Rehabilitation Medicine, New York University Medical Center, 1974.

Diller, L., & Weinberg, J. Hemi-inattention in rehabilitation: The evolution of a rational remediation program. In E. Weinstein and R. Friedland (Eds.), Hemi-inattention and hemispheric specialization. New York: Raven Press, 1977.

Ettlinger, G., Warrington, E., & Zangwill, O.L. A further study of visual-spatial agnosia. Brain, 1957, 80, 335-361.

Faglioni, P., Scotti, G., & Spinnler, H. The performance of brain-damaged patients in spatial localization of visual and tactual stimuli. Brain, 1971, 94, 443-454.

Gianotti, G. Les manifestations de negligence et d'inattention pour l'hemispace. Cortex, 1968, 4, 64-91.

Gianotti, G., Caltagirone, C., & Miceli, G. Poor performance of right brain-damaged patients on Raven's Colored Matrices: Derangement of general intelligence or of specific abilities? Neuropsychologia, 1977, 15, 675-680.

Gianotti, G., Messerli, P., & Tissot, R. Qualitative analysis of unilateral spatial neglect in relation to laterality of cerebral lesions. Journal of Neurology, Neurosurgery and Psychiatry, 1972, 35, 545-550.

Gianotti, G., Miceli, G., & Caltagirone, C. Constructional apraxia in left brain-damaged patients: A planning disorder? Cortex, 1977, 13, 109-118.

Gianotti, G., & Tiacci, C. Patterns of drawing disability in right and left hemispheric patients. Neuropsychologi, 1970, 8, 379-384.

Gianotti, G., & Tiacci, D. The relationship between disorders of visual perception and unilateral spatial neglect. Neuropsychologia, 1971, 9, 451-455.

Gianotti, G., & Tiacci, C. Sui rapporti fra aprassia construttiva, agnosia visuo-spaziale e negligenza spaziale unilaterale. Rivue Pathologie Nerv. Ment., 1972, 93, 103-116.

Head, H. Aphasia and kindred disorders of speech. Cambridge, Eng.: Cambridge University Press, 1926.

Hecaen, H. Clinical symptomatology in right and left hemispheric lesions. In V. Mountcastle (Ed.), Interhemispheric relations and cerebral dominance. Baltimore: Johns Hopkins University Press, 1962.

Hecaen, H., & Assal, G. A comparison of constructive deficits following right and left hemispheric lesions. Neuropsychologia, 1970, 8, 289-303.

Heilman, K., & Valenstein, E. Mechanisms underlying hemispatial neglect. Annals of Neurology, 1979, 5, 166-170.

Holmes, G. Disturbances of visual orientation. British Journal of Ophthalmology, 1918, 2, 449-516. (a)

Holmes, G. Disturbances of vision by cerebral lesions. British Journal of Ophthalmology, 1918, 2, 353-384. (b)

Holmes, G. Disturbances in visual space perception. British Medical Journal, 1919, 2, 230-233.

Holmes, G., & Horrax, G. Disturbances of spatial orientation and visual attention with loss of stereoscopic vision. Archives of Neurology and Psychiatry, 1919, 1, 385-407.

Humphrey, M.E., & Zangwill, O.L. The effects of a right-sided occipito-parietal brain injury in a left-handed man. Brain, 1952, 75, 312-324.

Jones, A.C. Influence of mode of stimulus presentation on performance in facial recognition tasks. Cortex, 1969, 5, 290-301.

Kinsbourne, M. Hemi-neglect and hemisphere rivalry. In E. Weinstein and R. Friedland (Eds.), Hemi-inattention and hemispheric specialization. New York: Raven Press, 1977.

Kinsbourne, M., & Warrington, E.K. A disorder of simultaneous form perception. Brain, 1962, 85, 461-486.

Lawson, I.R. Visual-spatial neglect in lesions of the cerebral hemisphere. Neurology, 1962, 12, 28-33.

Leicester, J., Sidman, M., Stoddard, L., & Mohr, J. Some determinants of visual neglect. Journal of Neurology, Neurosurgery and Psychiatry, 1969, 32, 580-587.

Masure, M.C., & Tzavaras, A. Perception de figures entreecroisees par des sujets atteints de lesions corticales unilaterales. Neuropsychologia, 1976, 14, 371-374.

McFie, J., & Piercy, M.F. Intellectual impairment with localized cerebral lesions. Brain, 1952, 75, 292-311.

McFie, J., Piercy, M.F., & Zangwill, O.L. Visual spatial agnosia associated with lesions of the right cerebral hemisphere. Brain, 1950, 73, 167-190.

McFie, J., & Zangwill, O.L. Visual constructive disabilities associated with lesions of the left hemisphere. Brain, 1960, 83, 243-260.

Oxbury, J.M., Campbell, D.C., & Oxbury, S.M. Unilateral spatial neglect and impairments of spatial analysis and visual perception. Brain, 1974, 97, 551-564.

Patterson, A., & Zangwill, O.L. Disorders of visual space perception associated with lesions of the right cerebral hemisphere. Brain, 1944, 67, 331-358.

Piercy, M., Hecaen, H., & DeAjuriaguerra, J. Constructional apraxia associated with unilateral cerebral lesions--left and right sided cases compared. Brain, 1960, 83, 225-242.

Piercy, M., & Smyth, V.O.G. Right hemisphere dominance for certain non-verbal intellectual skills. Brain, 1962, 85, 775-790.

Riddoch, G. Visual disorientation in homonymous half-fields. Brain, 1935, 58, 376-382.

Rosenberger, P. Some discriminative aspects of visual hemi-inattention. Neurology, 1974, 24, 17-23.

Scheller, H., & Seidemann, H. Zur frage der optischraumlichen agnosie. Monatschrift Psychiat. Neurol., 1932, 81, 97-188.

Trevarthen, C.B. Two mechanisms of vision in primates. Psychologische Forschung, 1968, 31, 299-337.

Trevarthen, C.B. Modes of perceiving and modes of acting. In H. Pick & E. Saltzman (Eds.), Modes of perceiving and processing information. Hillsdale, N.J.: Lawrence Erlbaum Assoc., 1978.

Tyler, H.R. Defective stimulus exploration in aphasic patients. Neurology, 1969, 19, 105-112.

Warrington, E.K., James, M., & Kinsbourne, M. Drawing disability in relation to laterality of lesion. Brain, 1966, 89, 53-92.

Weinberg, J., Diller, L., Gordon, W., Gerstman, L., Lieberman, A., Lakin, P., Hodges, G., & Ezrachi, O. Visual scanning training effect on reading-related tasks in acquired right brain damage. Archives of Physical Medicine and Rehabilitation, 1977, 58, 479-486.

Weinstein, E., & Friedland, R. Behavioral disorders associated with hemi-inattention. In E. Weinstein and R. Friedland (Eds.), Hemi-inattention and hemispheric specialization. New York: Raven Press, 1977.

Zarit, S., & Kahn, R. Impairment and adaptation in chronic disabilities: Spatial inattention. Journal of Nervous and Mental Disease, 1974, 159, 63-72.