HEMISPHERIC DIFFERENCES IN PROCESSING PICTORIAL MATERIAL

by

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ABSTRACT

Clinical studies have reported qualitative differences in the drawing performances of left versus right hemisphere damaged patients (constructional apraxia) which are presumed to reflect differential contributions of the two cerebral hemispheres. These studies have not employed standard materials and objective scoring criteria. The present experiment looked for these differences in the drawings of normal subjects following tachistoscopic presentations of geometric patterns to the left and right visual field using objective scoring methods. Twenty right handed males and twenty right handed females with normal or near normal visual acuity were required to draw each pattern after each exposure. Drawings were scored for detail, spatial orientation, spatial integration, and perspective. A significant right visual field (left hemisphere) advantage was found for processing detail. By contrast, a left visual field (right hemisphere) advantage was found for processing information regarding perspective, spatial orientation, and spatial location. These results support the clinical inference that both hemispheres are involved in processing pictorial information but the left is more involved with the identity of constituent elements while the right is more

involved with overall configuration. The standard stimuli and scoring methods developed for this experiment may be useful in future clinical studies.

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To the loving memory of my father.

INTRODUCTION

The primary interest of this study was to determine whether the qualitative differences observed in drawing pictorial material by brain-damaged patients could also be found using normal subjects. The experimental prediction was essentially that the qualitative differences observed between the drawings of patients with either left or right hemisphere brain damage should also be found between the left visual field and right visual field drawings of normal subjects. In other words, if the types of errors made by patients with damaged right hemispheres reflect the activity of the intact left hemisphere, then the same type of errors should be made when normal subjects try to draw material shown to their left hemisphere (right visual field).

Tasks such as drawing, copying and constructing can be impaired (constructional apraxia) following both right and left hemisphere lesions (Benton, 1962). Several studies have reported, however, that there are characteristic differences in the quality of performance on constructional tasks between right and left hemisphere cases. (Arrigoni and DeRenzi(1964), McFie and Zangwill(1960),Piercy, Hecaen and Ajuriaguerra(1960), Gainotti and Tiacci (1970), Piercy and Smyth(1962), Etlinger, Warrington and Zangwill (1950), Derenzi and Faglioni (1967).) For example, Mcfie and Zangwill(1960) described the drawings of right sided cases as scattered, fragmented and faulty in orientation and spatial relations. By contrast, drawings of the left sided cases were characterized by lack of detail, being a coherent but simplified version of the model. It was also observed that right sided cases drew energetically, while the left sided cases drew slowly and with difficulty. Table I drawn from Warrington(1969) summarizes the differences seen between the left and right sided cases.

The prevailing theoretical interpretation given to these observed differences in quality of constructional apraxia has been the inference that the left hemisphere damage results in a specific "executive" or "planning deficit", while right hemisphere damage results in a specific "visuo-spatial" deficit (Warrington, 1969). By implication, the intact left hemisphere is seen as specialized for a planning contribution and the right hemisphere is seen as specialized for visuo-spatial processing. Hecaen and Assal (1970) provide support for this interpretation.

Many other studies using both brain damaged and normal subjects have also found evidence for hemispheric differences in visuo-spatial tasks. But these studies have adopted a somewhat different theoretical interpretation, which can be defined as follows:

> "According to the analytic-holistic hypothesis, the left hemisphere specializes in analyzing complex stimulus configurations into discrete features, whereas the right hemisphere takes into account the holistic properties of stimulus configurations and constructs a meaningful Gestalt." (Moscovitch, 1979, pg. 414)

These two types of interpretations may be closely related as analysis may be a type of planning or executive control while holistic processing refers to the sorts of processing included in visuo-spatial ability.

The qualitative differences reported above are also evident in a study by Hecaen and Ajuriaquerra (1962) who found that the right hemisphere damaged patients with severe prosopagnosia (inability to recognize faces) were able to distinguish one person from another by the help of salient features; such as a hat or glasses, rather than by the general configuration of the face. If the feature aiding the recognition was removed then recognition was impossible. This result suggests that right hemisphere processing utilizes

TABLE I

Lesion side and quality of drawing

Right hemisphere	Left hemisphere
Scattered and fragmented	Coherent
Loss of spatial relations	Simplified preservation of spatial relations
Faulty orientation	Correct orientation
Addition of lines to try to make drawing correct	Slow and laborious drawing
	Gross lack of detail

general configuration while the left hemisphere looks for characteristic parts or details.

Kaplan (1976), supported the above mentioned detail versus configurational hypothesis by finding significant differences between right and the left brain damaged patients in the way they performed the Object Assembly subtest of the WAIS. The right hemisphere damaged patient's performance was characterized by focusing on the internal details of the puzzle; whereas the left brain damaged patients seemed to be focusing on configurational cues.

Veroff (1978) predicted that two modes of processing would be reflected in a picture arrangement task. The results of the study supported the predicted hypotheses. It was found that the patients with left hemisphere lesions made more errors in processing pictures which were designed to employ "left hemisphere" (categorical) processing. Patients with right hemisphere lesions made more errors on those pictures designed to employ "right hemisphere" (configurational) processing.

Results comparable to those reviewed above were also reported in studies with split- brain patients. In a study by Levy-Agresti and Sperry (1968) commisurotomized patients were asked to match three dimensional forms with their unfolded shapes drawn as expanded patterns, after exploring these forms with either the left or the right hand. It was found that the left hand (right hemisphere) was much superior to the right. Further, it was observed that each hand used a different strategy in exploring. the strategy of the left hand was marked as concerned with comparison of detail and the right concerned with the overall configuration of the form.

A similar pattern of exploring strategies was described by Zaidel and Sperry (1973) for their split-brain patients. In this study Raven's Colored Progressive Matrices with a missing piece were presented. The patients were asked to pick the correct piece tactually among an array of choices. It was found that each hand used a different strategy in exploring. The right hand (left hemisphere) performance was marked as slow and concerned with details whereas the left hand performance was more rapid and holistic.

The ability of the right and left hemispheres to comprehend part-whole relations was examined by Nebes in a series of experiments conducted on split-brain patients. In the first experiment(Nebes,1971) patients were asked to match a given arc to the corresponding complete circle included among an array of different circles. A left hand advantage was found for the task. This advantage was attributed to holistic processors within the right hemisphere.

In the second experiment (Nebes, 1972) patients were shown geometric shapes that had been cut into pieces and the pieces moved apart from each other although maintaining the original orientation. The task required matching this geometric shape to a complete form which was hidden from sight and explored tactually. As in the first experiment, it was found that patient's performance was better with the left hand thus pointing to a right hemisphere superiority in forming a complete stimulus from its pieces.

Tachistoscopic presentations of dot arrays organized to appear running either vertically or horizontally were made in a third experiment(Nebes 1973). Patients were required to signal the orientation of the dots. A superior accuracy was reported for the left visual field.

Based on the results of the three experiments, Nebes(1978) concluded that:

"All three experiments demonstrate that when required to perform a spatial transformation on sensory input (i.e., to generate a concept of the complete stimulus configuration from partial or fragmentary data) the minor hemisphere is far superior to the major."(pp 120)

Left hand(right hemisphere) superiority for matching geometric figures in Euclidean, affine, projective and topological space to visually presented forms was demonstrated by Franco and Sperry (1977). However, the interesting finding of this study was the performance of the left hemisphere. There was a marked difference within the left hemisphere as a function of different kinds of geometry. The left hemisphere performance was better when there were defining constraints, as in the Euclidean sets. Low performance was recorded for projective and especially for topological sets, where there were very few defining contraints. On finding a low performance for topological and projective sets, the authors concluded that; ' due to the holistic nature of the task, the loosely structured sets were totally suited for right hemisphere processing. On the other hand, left hemisphere performance was related to factors like: the ease or difficulty of verbalization, the extent to which analytic processing is applicable and the number of defining constraints'.

Conclusions of this sort were also suggested in studies with normal subjects. In a study by Bever (1976) subjects were asked to match nonsense figures seen tachistoscopically to figures in two different arrays of choice. In one array the difference between the array and the target figures were configurational. In the other one the difference was in the details. It was found that right hemisphere performance was superior when one had to rely on configurational information in making a choice. Left hemisphere superiority was marked, when one had to rely on detail information for the correct response.

The role of three variables (storage duration, same or different judgments and complexity) was examined in a face discrimination task. (Bradshaw and Patterson,1975). It was reported that the left hemisphere was superior in difficult discriminations while the right hemisphere was superior for simple discriminations. These results were attributed to the role of the left hemisphere as an analytic processor and the right hemisphere's role as a gestalt processor.

The processing differences between the two hemispheres were investigated by Bradshaw, Gates, and Patterson (1976). In this series of experiments the subjects were asked to match unintegrated elements. In the first two experiments matchings were based on the internal comparisons of the elements, in the third experiment the task was matching a test array to a previously stored array. It was found that a right hemisphere superiority appeared where the matching was based on an appreciation of the overall gestalt (experiment one). A left hemisphere advantage appeared where an analysis of the configuration into its components was required for matching (experiments two and three).

In another study, (Umilta, Bagnara and Simion,1978) tachistoscopic bilateral presentations of simple and complex geometric figures were made to right handed normal subjects. Subjects were asked to make same or different responses. A right visual field advantage was recorded for simple geometric figures and nonsense patterns. By contrast, a left visual field advantage was found for complex geometric figures. These results led the authors to the conclusion that the hemispheres differ in specialization. The left hemisphere is superior at handling tasks that can be performed by focusing on details, as in the case for simple geometric figures. The right hemisphere is better at tasks which require the analysis of the configurational aspects of the stimulus, as is the case for complex geometric figures.

Further evidence for the holistic/analytic dichotomy, was demonstrated by Bradshaw and Sherlock,(1980) in a series of experiments. In each experiment, stimuli which consisted of face like and meaningful non-face like(bugs) material were varied according to the analytic or the holistic mode. Subjects were asked to make same or different responses to the target and non-target stimuli. A left visual field superiority was found when a holistic strategy was required. A right visual field advantage was observed when the task required an analytic strategy.

Although these studies may seem somewhat dissimilar the results of all studies can be accounted for in basically similar terms. The various characteristic deficits found in patients with unilateral brain lesions, the patterns of performance of split-brain patients using the left or right hand, and the differences found between left and right visual field presentations to normal subjects all reflect a fundamental difference between the two cerebral hemispheres in modes of processing constructional or visuo-spatial information.

The above selective review shows that differences in processing strategies are evident in different tasks, as qualitative differences in performance. These characteristic differences were first reported in the drawing performance of the brain-damaged patients(e.g.,McFie and Zangwill,1960; Warrington,1969). Comparable results were later reported in studies with split-brain subjects in experiments utilizing a different task and a sensory modality (Levy-Agresti and Sperry, 1968; Zaidel,1973.). Similar conclusions followed from work with normal subjects using still different tasks. These results led many investigators to suggest a new way of conceptualizing hemispheric differences. Instead of a breakdown based on the nature of the stimuli processed by each hemisphere (e.g., verbal vs. visuo-spatial), a dichotomy based on processing modes (e.g., detail vs. configuration) seemed to emerge. However, there are several drawbacks to these studies. First of all, in studies with brain-damaged patients it is often hard to match the right and left hemisphere damaged groups for size and locus of injury, as well as for such factors as age, sex and premorbid intellegence; which sometimes causes inconsistent results (Semenza et al..,1978). In generalizing the results to normals, it is not possible to determine if the defective performance originates in the damaged hemisphere doing its best in face of injury, or in the undamaged hemisphere. The same argument holds true for studies using split-brain patients. The brain of a split-brain patient may function quite differently than those of normals. As a result, the findings obtained with split-brain patients have not always been replicable in normals. Because of these problems it is hard to draw firm conclusions about the intact brain from the studies with brain-damaged or split-brain patients. Conclusions about normal functioning require the confirmation with normal subjects.

Although studies with normal subjects (Bever,1976; Bradshaw and Patterson 1975; Bradshaw, Gates and Patterson;i976.) reviewed in previous pages, point to the existence of two different modes of processing; to our knowledge, no study with normals has been done up till now demonstrating the same qualitative differences as has been claimed for the drawings of the brain-damaged patients. The purpose of the present study was to re-affirm the findings of Mcfie and Zangwill(1960) in normals.

Based on the characteristic differences reported, the stimuli in this study were designed varying along four dimensions namely: spatial orientation, spatial integration, perspective <1> and detail. A left visual field advantage was predicted for the spatial integration, spatial location and perspective dimensions. A right visual field advantage was expected for the detail dimension.

It must be emphasized that the qualitative differences observed in the drawings of left versus right hemisphere lesion cases have been made clinically, that is without standardized tests, without objective scoring procedures, and without benefit of statistics. The only study to attempt an objective scoring method (Warrington,James and Kinsbourne,1966) failed to demonstrate significant differences for most of their predictions. Therefore, if this experiment succeeds in providing standard stimuli and scoring procedures and in showing statistical significance, it could be seen as more reliable evidence than the original clinical impressions. Furthermore, the stimuli and scoring method could be used subsequently in more controlled clinical studies.

Prof. Donald Harvey has pointed out that what is here termed 'perspective' would better be termed 'three dimensional representation'.

METHOD

Subjects

Twenty male and twenty female university students ranging in age from 17 to 35, served as subjects on a volunteer basis. All reported that they had normal visual acuity and were strongly right handed, as assessed by their responses to a handedness inventory. (see Appendix C)

Stimuli

The stimuli consisted of 42 cards (10cmX15cm). The first ten stimuli served as practice, thus there were 32 scored stimuli. Each contained a two digit number in the center and a figure either on the left or on the right side of the number. Each figure appeared once on the right and once on the left side. Figures were drawn beginning 2.5 degrees from the number. Figures were made of geometric shapes designed in a pattern. Patterns were drawn varying across four dimensions. The following dimensions were used as quidelines in forming the patterns.

Detail dimension: Each pattern contained three randomly selected geometric shapes.

Spatial location dimension: In each pattern shapes were located relative to one another. Every pattern contained a main shape and two auxillary shapes located relative to the main shape and to each other. Figure 1 demonstrates the main shape and the possible locations numbered from one to nine in which the auxillary shapes can be located.

Spatial integration dimension: Shapes were integrated to each other in three possible arrangements: touching, overlapping or far apart.(see figure 2)

Perspective dimension: In each pattern one of the shapes appeared 'three dimensional'(i.e.,with a perspective). Perspective could be viewed either from the top or the bottom and each shape with a perspective could face either left, right or both sides (see figure 3). An example of a pattern partitioned into its dimensions is illustrated in figure 4. For the complete set of stimuli see Appendix E.

Apparatus

A standard Gerbrands 3-Channel tachistoscope was used for stimulus presentation.

Procedure

Each subject was tested individually in a quiet room. Before the experiment subjects were asked if they had any problems with their vision. Only subjects who reported to have normal or equal eye acuity were used. Instructions (see Appendix A) were read to the subject after the handedness inventory (see appendix C) was filled out.

Subjects then were asked to place themselves facing the tachistoscope, exposure field being at the eye level. Instructions were given to observe the illuminated pre-exposure field. The pre-exposure field consisted of two dots with a fixation point centered between them, coinciding with the center of the exposure field. Subjects were asked to focus on this central point.

After ensuring that the subject was fixating on the central point in the pre-exposure field, a verbal "ready" signal was given and the stimulus was presented for 200msec duration. Immediately after stimulus presentation the subject was required to write down the number seen in the focus space and in addition to the number to draw the figure. Subjects were allowed to take their time before the following exposure. The importance of always reporting the number was stressed by the experimenter. They were urged to get the number correct. Any failure in writing down the fixation number was called to their attention. The stimuli were presented randomly to the left and right visual fields, with each stimulus appearing once in both fields. The order of presentation was the same for every subject.

Scoring system

Each drawing was evaluated on four dimensions: detail,spatial location, spatial integration, and perspective. Each figure was evaluated for the number of correct responses within each dimension. The maximum score for each stimulus (drawing) was therefore twelve points(three points for each dimension).

The following quidelines were used to determine the correct number of responses within a dimension. An example of a drawing partitioned in to its acceptable responses within each dimension,is given in figure 5.

Detail: A point was given for each correctly drawn shape in the figure; location was not considered. For example if a triangle had been shown then if the subject drew a triangle, one point was scored.

The next three dimensions were scored without considering which shapes were drawn, only location etc... was considered.

Spatial location: For each correctly located pattern a point was earned. For example, if the shape in figure 5 was presented, and a shape was drawn to the right of the main shape, a point was scored A second point was earned for having drawn a shape on the upper left hand corner of the main shape. A third point was given if a shape was drawn to the lower right hand corner of this shape.

Spatial integration: For each correctly drawn integration pattern a point was given. For example in figure 5, in order to earn a point the subject had to draw two shapes overlapping. A second point was given for having drawn two shapes touching each other. A third point was given for having drawn two shapes far apart.

Perspective: A point was given for attempting to draw a perspective. Two more points were given to correct view and direction of the perspective.

Drawings identified without correct report of the fixation number were not scored , since the subject may have been looking directly at the figure rather than the fixation space. The first ten cards in the presentation order were not scored since they were the practice cards. The final score for each dimension was determined by taking the average of the scores for all the scored responses. (figures with the correct report of the fixation number) Subjects who scored below 1.00 on the detail dimension were eliminated from the study; on the basis that they could not do the task adequately and the data would therefore be meaningless one female and a male subject were eliminated on this basis. Appendix D represents a sample of actual responses taken from different subjects.

To control for the'experimenter bias' the performance of each subject was scored by a second judge. The interjudge reliability of the scoring technique was found to be high. The highest correlation was found for the LVF Perspective dimension (0.95) and the lowest correlation was determined for LVF Spatial location dimension (0.73).

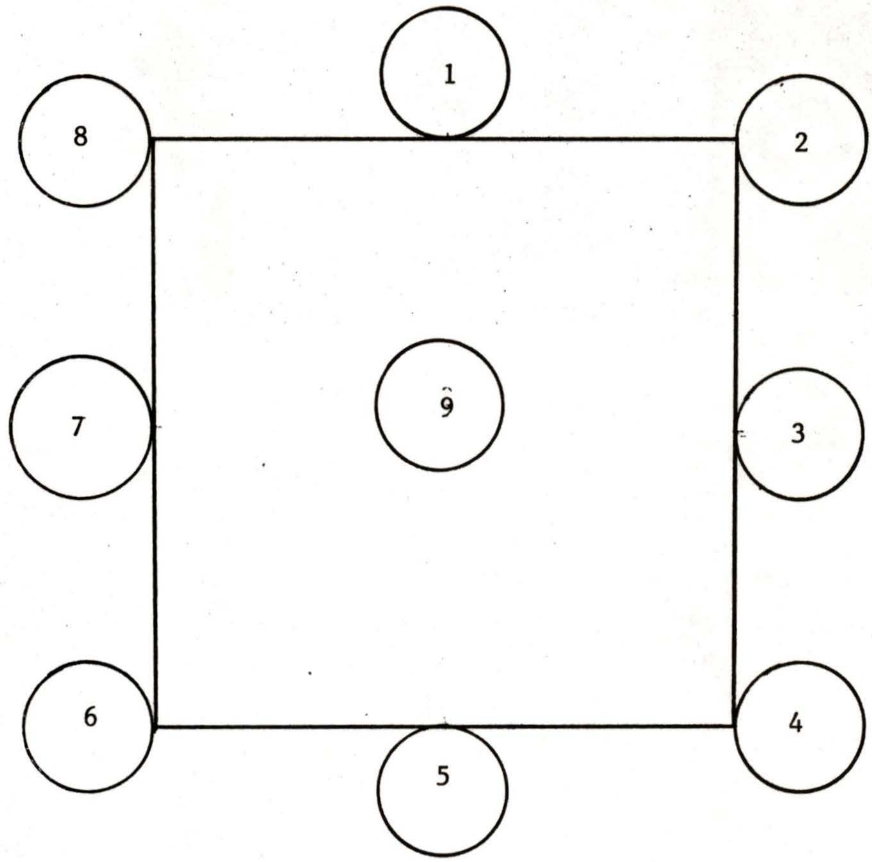


Figure 1 · Possible location patterns

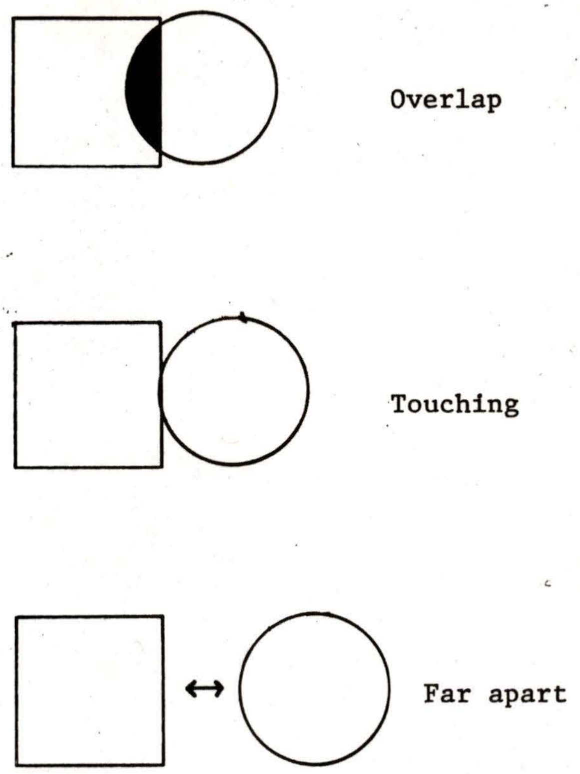


Figure 2; Possible spatial integration patterns.

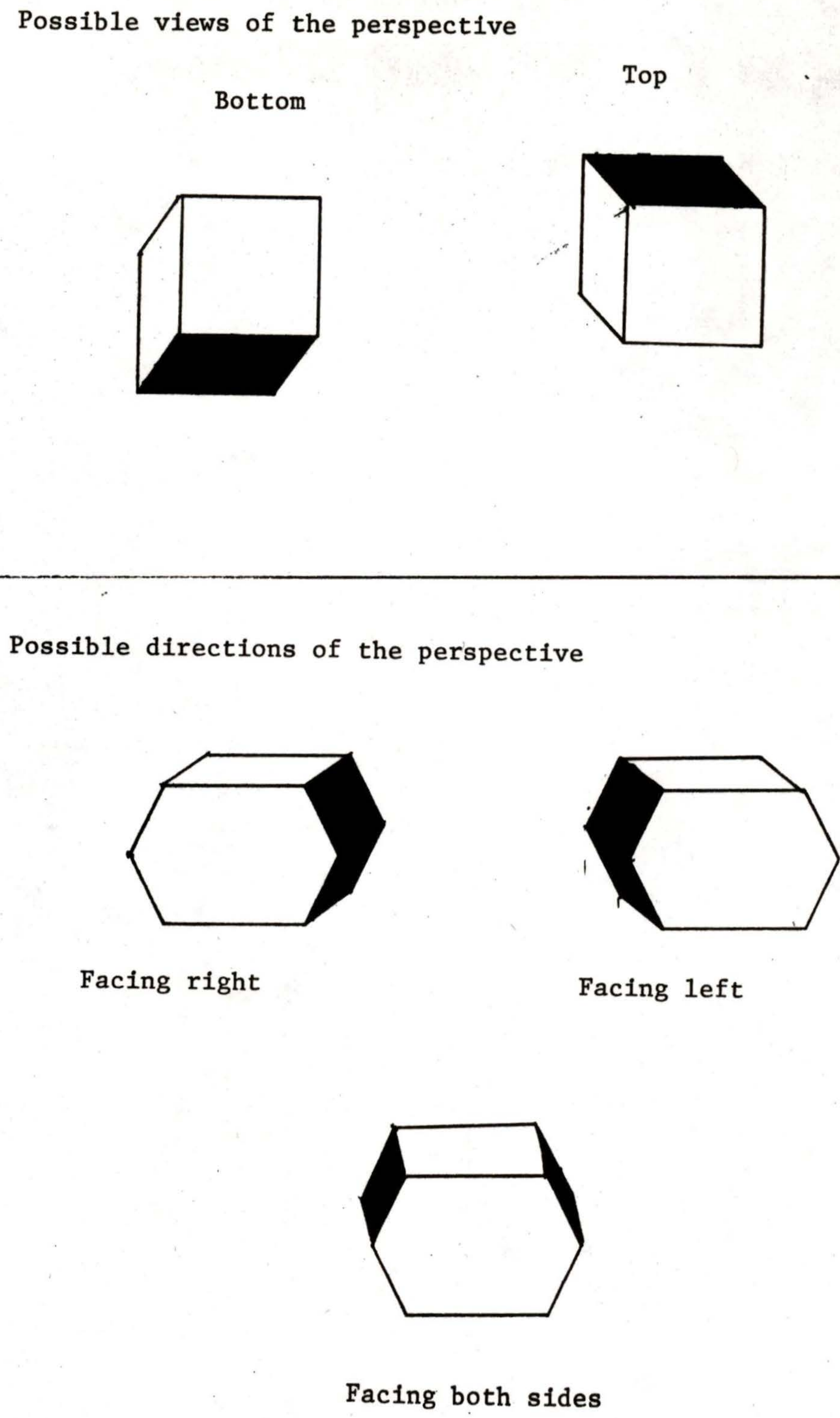


Figure 3: Possible perspective patterns.

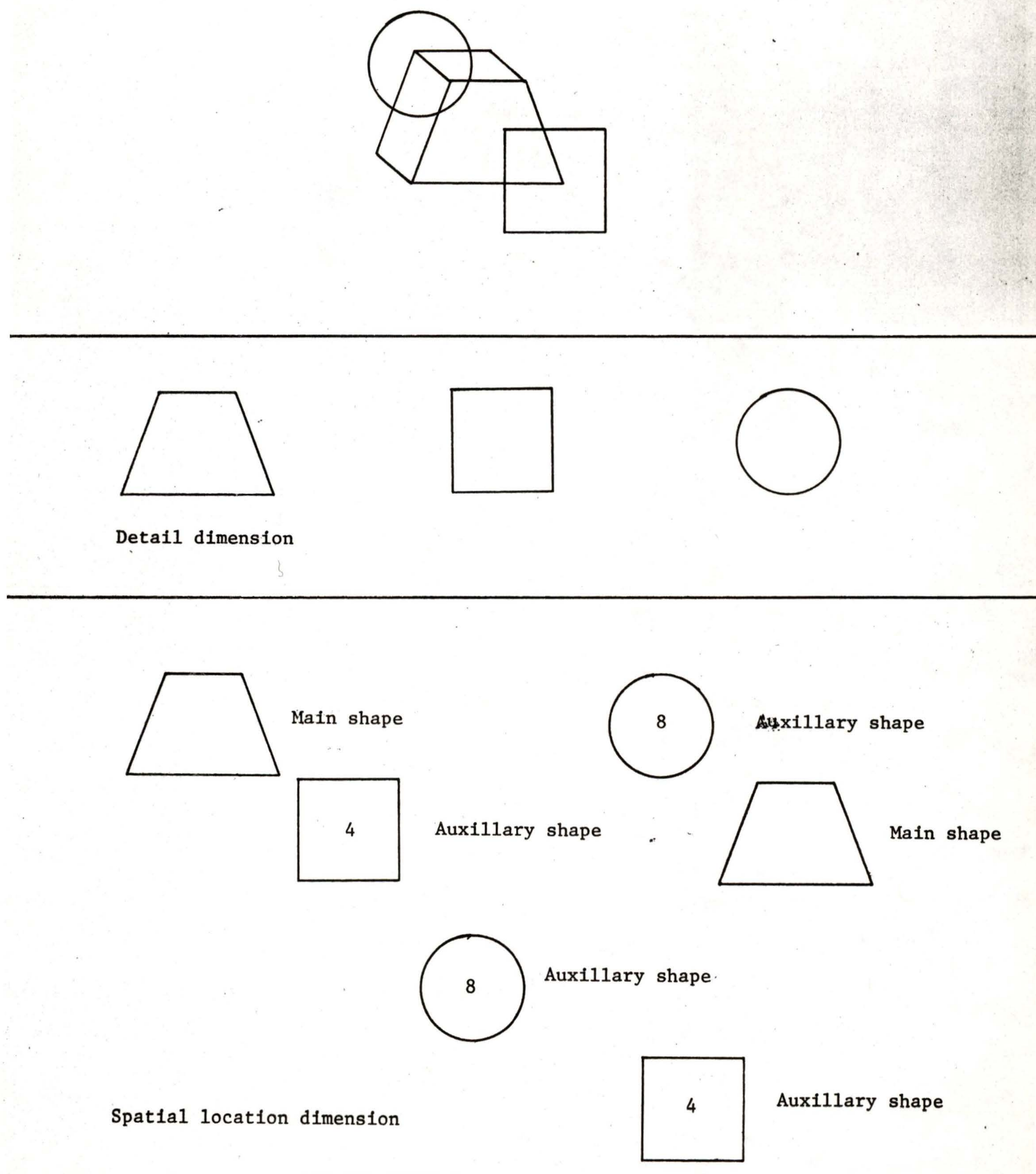
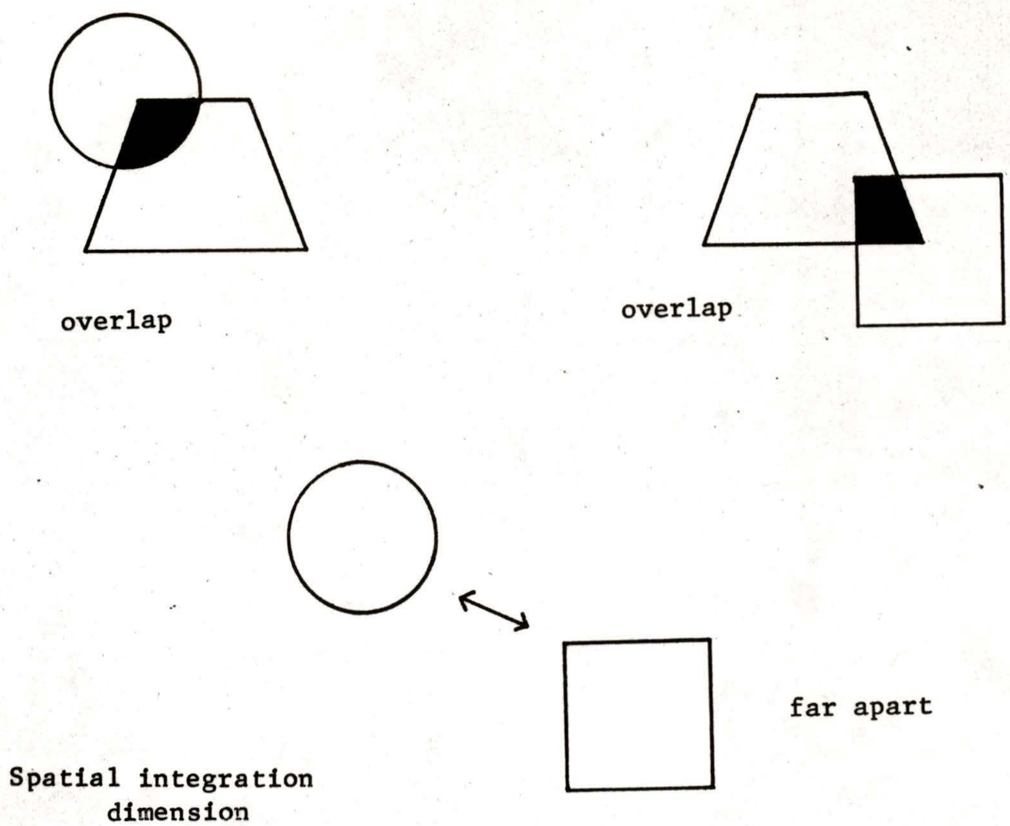


Figure 4: Example of a pattern partitioned in to its dimensions.



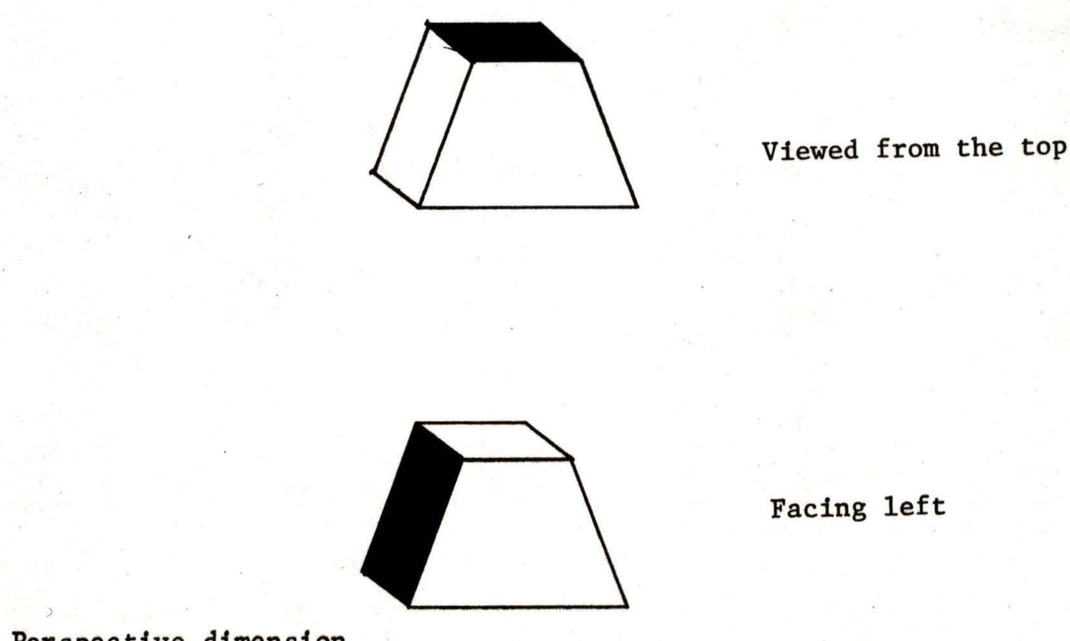


Figure 4, continued

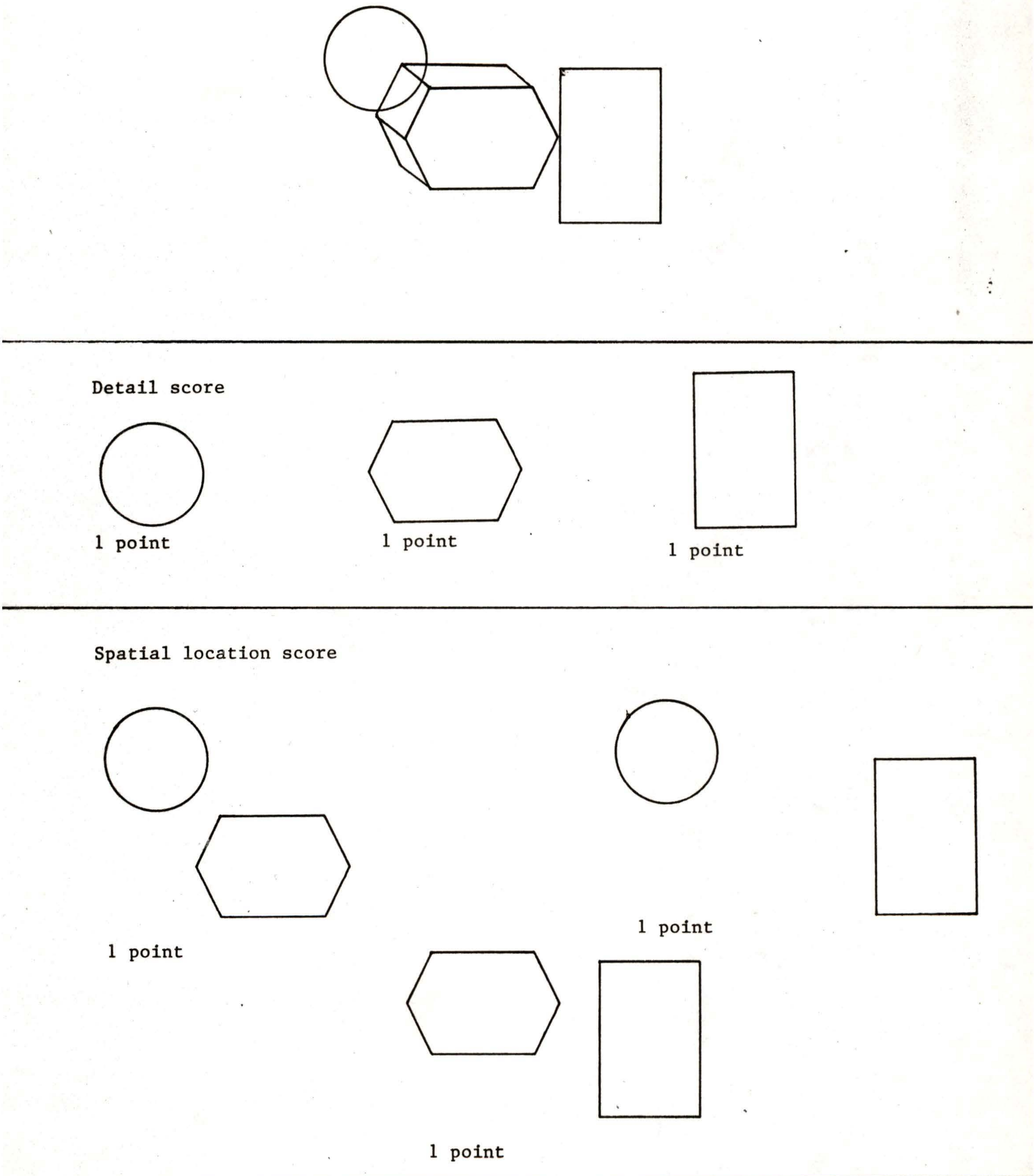
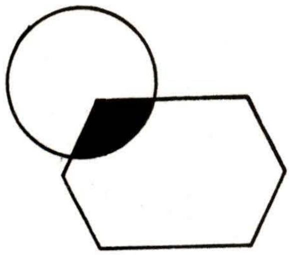
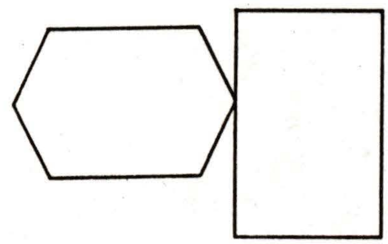


Figure 5: A pattern partitioned in to its acceptable responses within four dimensions.

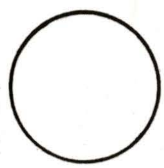
Spatial integration score

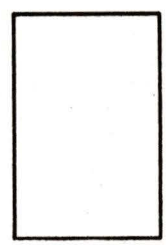


1 point



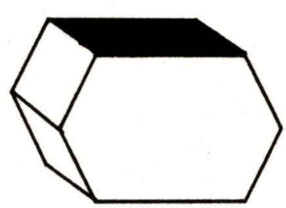
1 point



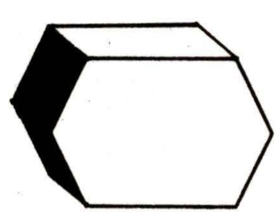


1 point

Perspective score



1 point



1 point

Figure 5, continued .

RESULTS

The design used in this study is summarized in table II. The independent variables were sex (male and female) and visual field (left and right) the dependent measure was four levels of the dimension variable The visual field and dimension variables were repeated measures on the same subject. There were twenty subjects per cell.

The data (Appendix B) were analysed in two parts. The first analysis tested whether there were any significant effects or interactions. A 2X2X4 analysis of variance was computed on the data. The summarized data are presented in table III.

Since the design was a repeated measures design; the results of the analysis were adjusted by the Geiser-Greenhouse correction formula. The summarized adjusted results are presented in table IV . The results indicated a significant visual field ($F(1,38)= 16.4, p=0.0013$), dimension($F(1,38)= 184.7$, $p<0.0001$), and visual field by dimensions effects($F(3,37)= 22.71, p<0.0001$).

An examination of the figures six seven and eight will also demonstrate the significant effects mentioned above.

Since the major impetus for doing the study lay in more specific comparisons, further analysis using planned comparisons (Kirk, 1972) was performed on the data.

Following Kirk, means of interest (see table IV) were compared by means of an F ratio at the 0.01 level.

Significant left visual field effects were found for the spatial location ($F(1,40)= 45.5$) spatial integration($F(1,40)$ 23.8) and perspective($F(1,40)=8.4$) dimensions. Significant right visual field effect was found for the detail dimension ($F(1,40)=16.25$). These differences can also be seen in figure 9. When the dimensions were compared with each other within each visual field;for the left visual field there was a significant difference between the detail and spatial location dimensions ($F(1,40)=22.34$). No difference was found between the detail and spatial integration dimensions. Within the right visual field the detail dimension was significantly different from spatial location($F(1,40)=37.76$) and spatial integration ($F(1,40)= 80.67$) dimensions.

Overall, the results indicated that pictorial material was processed differently in the two hemispheres. The left hemisphere was better in handling the components of the configuration; whereas the right hemisphere was better at processing configuration.

Table II:

Statistical design for the study

	Left visual field				Right visual field			
	D1	D2	D3	D4	D1	D2	D3	D4
Female	20	20	20	20	20	20	20	20
Male	20	20	20	20	20	20	20	20

D1:Detail dimension

D2:Spatial Location Dimension

D3: Spatial Integration dimension

D4: Perspective dimension

Table III:Means and standard deviations for the data

Condition	N	Mean	Standard deviation
Female,LVF,D1	20	1.7575	.3245
D2	20	2.0238	.3509
D3	20	1.7915	.4357
D4	.	.6265	.6023
Female,RVF,D1	.	1.9605	.2994
D2	.	1.7598	.4056
D3	.	1.5675	.4180
D4	.	.4680	.4667
Male, LVF,D1	.	1.6960	.3451
D2	.	1.8350	.4839
D3	.	1.6665	.4686
D4	.	.5795	.5702
Male, RVF,D1	.	1.8450	.3104
D2	.	1.5280	.4121
D3	.	1.4777	.4582
D4	.	.4921	.5197

Table IV: ANOVA main effects(Geiser-Greenhouse) adjusted values.

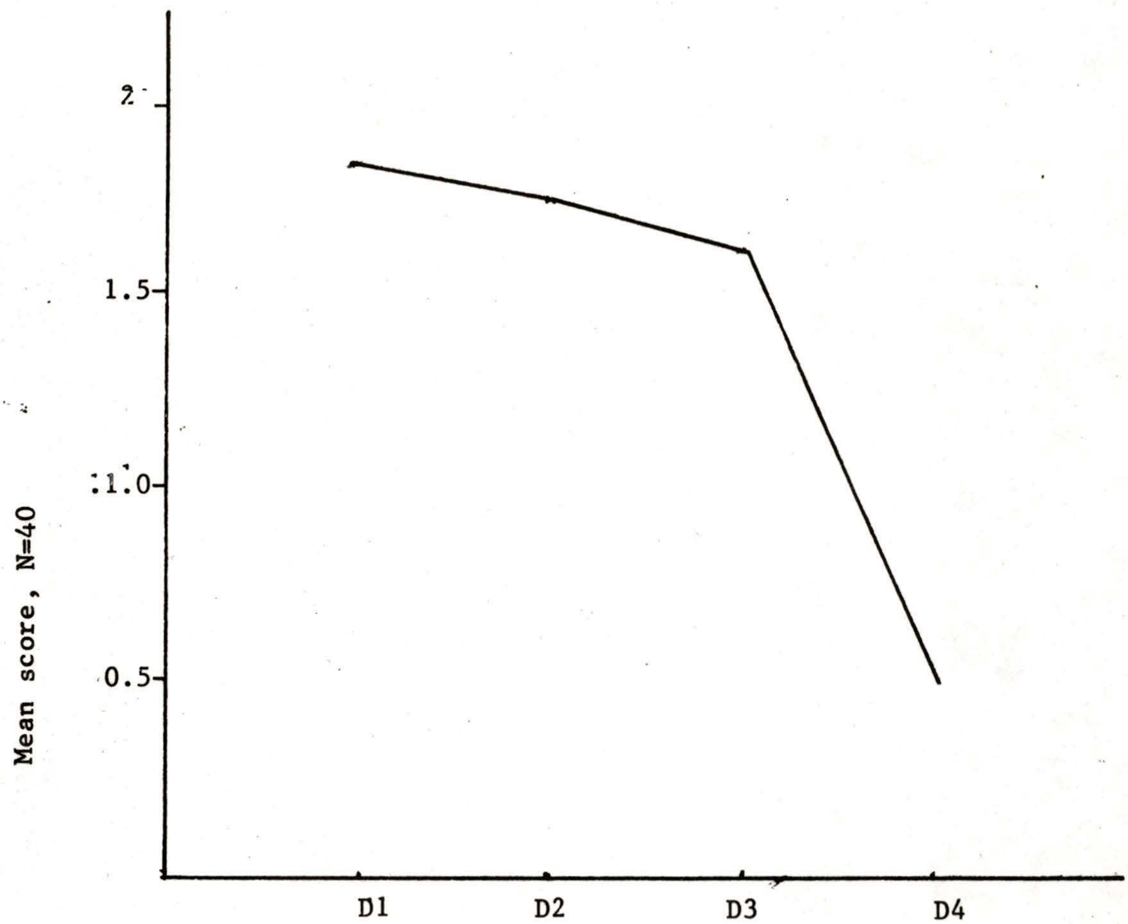
Source	DF	F	
VF	1	16.4472	**
SexXVF	1	.0019	
Dimension	1	184.6601	***
SexXDimension	1	.8429	
VFXDimension	1	22.7234	***
SexXVFXDimension	1	.5140	

** p=0.0013

***p<0.0001

Table V: Means for visual field by dimension effect

	Left visual field	Right visual field
Detail	1.73	1.90
Spatial location	1.93	1.64
Spatial Integration	1.73	1.52
Perspective	.60	.48



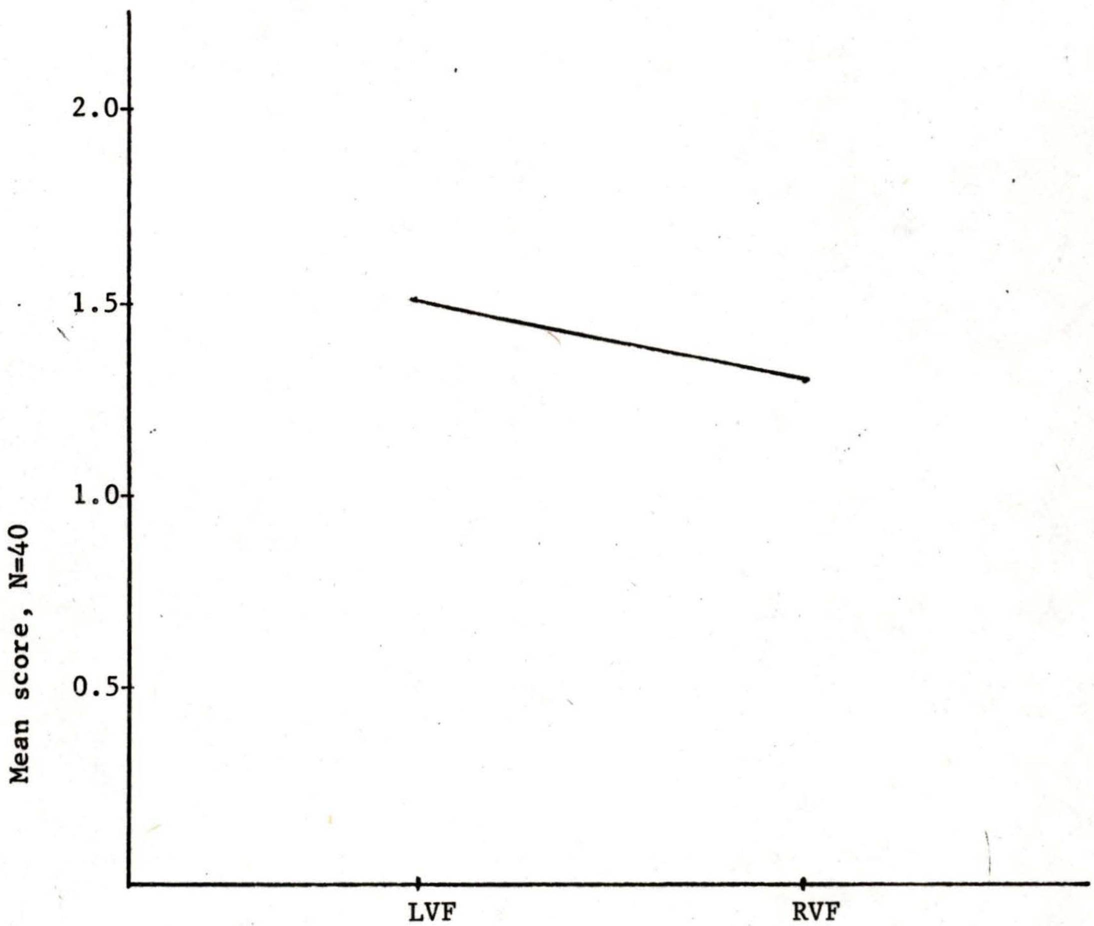
D1:Detail

D2:Spatial location

D3:Spatial integration

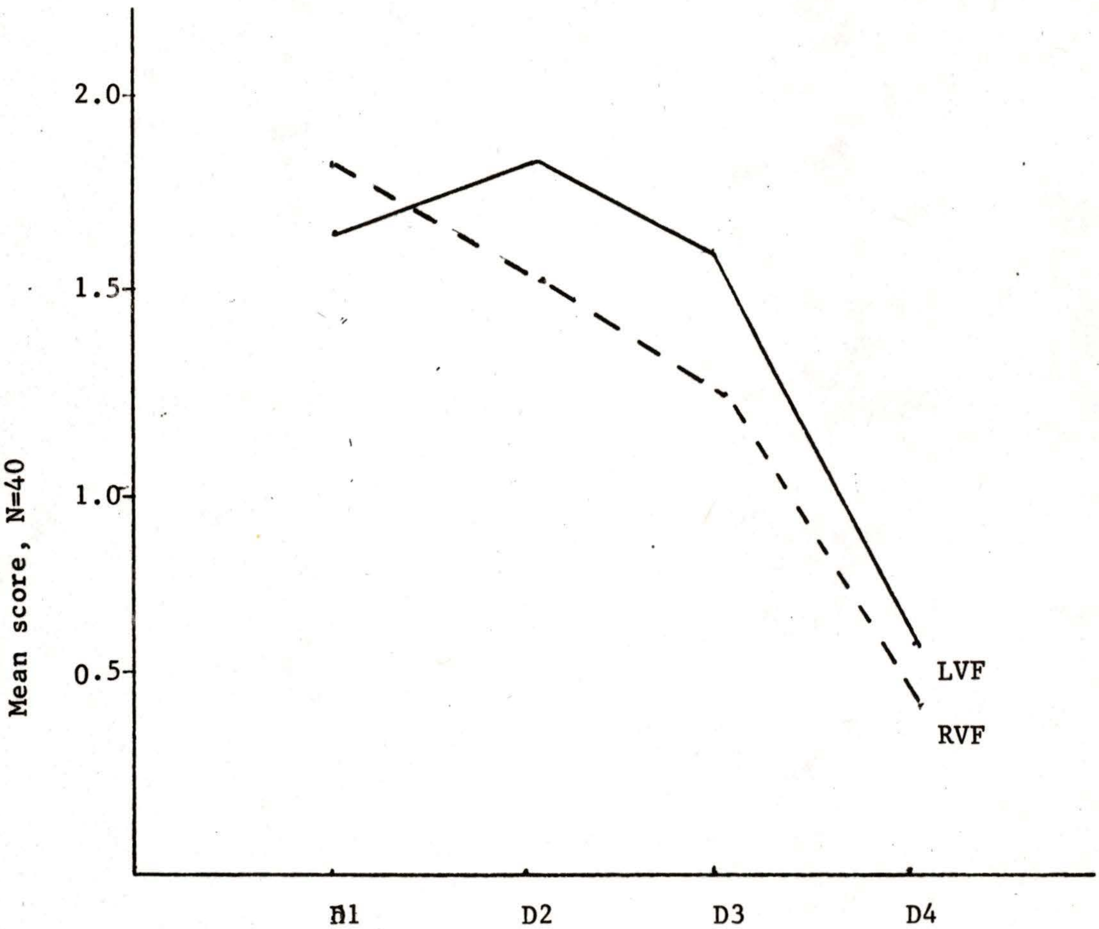
D4:Perspective

figure 6; Mean differences in dimensions averaged across visual fields and two sexes



LVF:Left visual field
RVF:Right visual field

Figure 7: Mean differences in visual fields averaged across dimensions and two sexes.



D1:Detail

D2:Spatial location

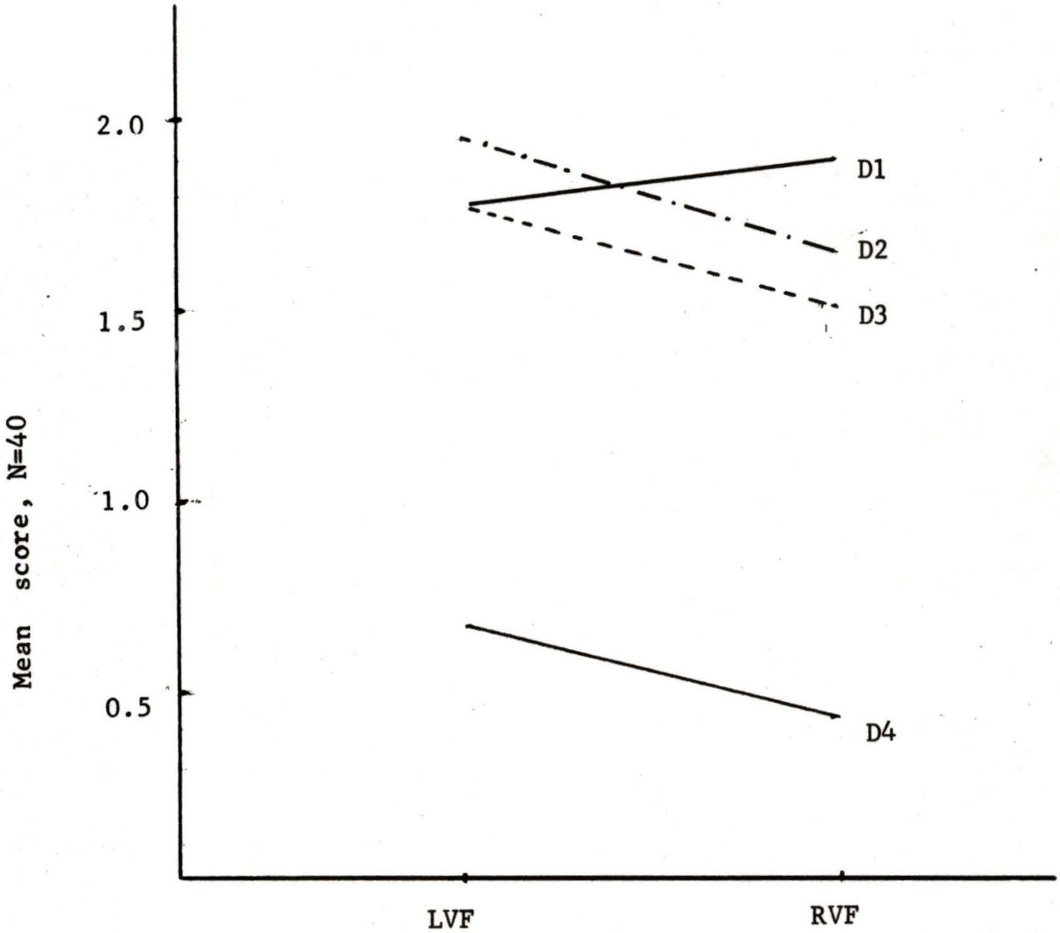
D3:Spatial integration

D4:Perspective

LVF: Left visual field

RVF: Right visual field

Figure 8: Main influence of dimensions on visual fields pooled across two sexes.



D1: detail

D2: spatial location

D3: spatial integration

D4: perspective

LVF: left visual field

RVF: right visual field

Figure 9: Mean differences in dimensions compared between visual fields.

DISCUSSION

The present results constitute particularly striking evidence that, there is a difference between the two cerebral hemispheres of normal subjects in processing pictorial material; at least for the type of pictorial material presented. When the same drawings were scored in different ways; a left visual field advantage was found for the perspective, spatial integration and spatial location dimensions, while a right field superiority was found for the detail dimension.

These results dramatically re-affirm the findings reported by Paterson and Zangwill (1944); McFie, Piercy and Zangwill (1960); Hecaen and Ajuriaquerra (1960); Piercy, and Smith (1962); Arrigoni and DeRenzi (1964); Gainotti and Tiacci (1970). The same qualitative differences in the drawing performance of brain damaged patients reported by these authors were demonstrated in normals. That is, stimulus presentations to the normal LVF (right hemisphere) led to reproductions which were relatively poor in detail but good in spatial arrangement. This is the same pattern reported for left brain damaged patients whose drawings may reflect the remaining abilities of their intact right hemisphere, in contrast, stimulus presentations to the normal RVF(left hemisphere) led to drawings qualitatively similar to those reported for patients with an intact left hemisphere. That is, drawings good in detail but poor in spatial organization. The results of this study are consistent with the view that both hemispheres are capable of processing pictorial information. But each hemisphere does so in its own style.

Veroff (1978), Semenza, et al (1978), Bradshaw and Sherlock(1980), among others have inferred the existence of two different strategies of information processing. While the left hemisphere employs an analytic strategy, the right hemisphere is characterized by a holistic mode of processing. As a result;

" While the left hemisphere analyzes input sequentially, abstracting out the relevant details, the right hemisphere is more concerned with the overall stimulus configuration, organizing and handling information in terms of wholes." (Nebes 1971, pg.333)

Although the differences demonstrated in this study can be attributed to the analytic versus holistic differences in the mode of processing; they can also be explained by the verbal/non-verbal dichotomy. The right visual field advantage for the detail dimension may be due to the left hemisphere superiority for encoding information verbally, like a 'square', 'triangle' etc... The left visual field advantage for the spatial orientation, spatial location, and perspective dimensions may be due to general right hemisphere superiority in mediating the processing of visuo-spatial material.

It may also very well be that, as Moscovitch (1979) suggested, the left hemisphere focuses on the features that can be coded verbally due to its poor non-verbal memory. In other words, the left hemisphere might not be as efficient as the right hemisphere in processing complex non-verbal information. A verbal coding, therefore , might be necessary for processing non-verbal information.

However, the complex nature of the stimuli presented in this study, makes verbal coding less likely. The shortness of the exposure duration as well argues against the above mentioned possibility.

The results of this study conclusively support the major hypothesis of the study which was that the qualitative differences observed in the drawing performance of the brain-damaged patients would also be observed in normals. The findings are taken as evidence that the two hemispheres are involved in processing visuo-spatial information somewhat independently and differently from each other. The left hemisphere processing tends to break the visual percept into details, whereas the tendency in the right hemisphere is to deal with the same visual stimuli as spatially related wholes. While the analytic/holistic dichotomy may seem to be the most valid explanation for the results of this study; it should be noted that these results do not imply that all the known functional asymmetries can be accounted by this dichotomy.

Further, the results of the present investigation demonstrated that the stimulus set and the scoring method used are successful instruments for discriminating between the right and the left hemisphere performance. Hopefully, the stimulus set and the scoring technique will be useful tools in further research in this area as well as in clinical observations. However, it would be useful to perform a standardization on a new group of normal subjects, as a measure of validation.

Another factor which would facilitate the adoption of the stimulus set and the scoring method would be a check on the reliability.

Future research may address itself to the question of whether a diagnostic tool can be generated from the technique used in this study.

REFERENCES

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

Benton,A. Clinical symptomatology of right and left hemisphere lesions. In Interhemispheric relations and cerebral dominance, Ed,by V.B.Mountcastle, John Hopkins press, Baltimore,1962.

Bever,T.G. Paper presented at the department of language and linguistics colloquim. Massachussetts institute of technology,1976.

Bradshaw,J.L. and Patterson,K. Differential hemispheric mediation of non-verbal visual stimuli. Journal of experimental psychology:Human perception and performance. 1975, 1, 246-252.

Bradshaw,J.L. and Sherlock. submitted to Quarterly journal of experimental psychology.

Bradshaw,J.L., Gates,A. and Patterson,K. Hemispheric differences in processing visual patterns. Quarterly journal of experimental psychology, 1976, 28, 667-681.

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

Etlinger,G., Warrington,E. and Zangwill,O.L. A further study of visual spatial agnosia. Brain, 1967, 3, 335-361.

Franco,L. and Sperry,R.W. Hemisphere lateralization for cognitive processing of geometry. Neuropsychologia, 1977, 15, 107-114.

Gainotti,G. and Tiacci,C. Patterns of drawing disability in right and left hemispheric patients. Neuropsychologia, 1970, 8, (3), 379-384.

Hecaen,H. and Assal,G. A comparison of constructive deficits following right and left henispheric lesions. Neuropsychologia, 1970, 8, (3), 289-303.

Hecaen,H. and Ajuriaquerra,R. Agnosia for faces (prosopagnosia). Archives of neurology, 1962, 7, 24-32.

Kaplan,E. The role of the non-compromised hemisphere in focal organic disease.Paper presented at the American Psychological Associatian Meeting. Washington. D.C, 1976.

Kirk,R.E. Statistical issues: A reader for the behavioral sciences. Belmont, Calif.;Wadsworth,1972.

Levy-Agresti,J., and Sperry,R.W. Differential perceptual capacities in major and minor hemispheres. Procedings of the national academy of science, U.S.A. 1968, 61: 1151.

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

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

Moscovitch,M. Information processing and the cerebral hemispheres. In M.S. Gazzaniga (Ed.), Handbook of behavioral neurobiology. Vol.2, Neuropsychology. Newyork:Plenum, 1979.

Nebes,L.D. Superiority of the minor hemisphere in commissurotomized man for the perception of part-whole relations. Cortex, 1971, 7, 333-349.

Nebes,R.D. Dominance of the minor hemisphere in commissurotomized man on a test of figural unification. Brain, 1972, 95, 633-638.

Nebes,R.D. Perception of dot patterns by the disconnected right and left hemisphere in man. Neuropsychologia, 1973, 11, 285-290.

Nebes,R.D. Direct examination of cognitive function in the right and left hemisphere. In M. Kinsbourne (Ed.), Asymmetrical function of the brain. New York: Cambridge university press, 1978, pp.99-140.

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

Piercy, M.F, Hecaen,H. and Ajuiraquerra,D. Constructional apraxia associated with unilateral cerebral lesions. Brain, 1960, 83, 225-242.

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

Semenza,C. et al. Analytic and global strategies in copying designs by unilaterally brain damaged patients. Cortex, 1978, 14, 404-410.

Umilta,C et al. Laterality effects for simple and complex geometric figures and nonsense patterns. Neuropsychologia, 1978, vol 16 (1), 43-49.

Veroff,A.E. A structural determaninant of hemispheric processing of pictorial material. Brain and language, 1978, 5, 139-148.

Warrington,E.K., James,M. and Kinsbourne,M. Drawing disability in relation to laterality of cerebral lesion. Brain, 1966, 89, 53-82.

Warrington,E.K. Constructional apraxia in: Handbook of clinical neurology, V 4(Eds) P.V Vinken. and G.M.Broyn, North Holland,1969.

Zaidel,D. and Sperry,R. Performance on the Raven progressive matrices test by subjects with cerebral commisurotomy. Cortex, 1973, 9, 34-39.

Appendix A: Instructions to the subject

The task in this experiment is quite simple. You will be presented cards with a figure and number on it. The number will appear in the centre. The figure will appear sometimes on the right side and sometimes on the left side of the figure.

After each exposure I would like you to write down the number and draw the figure. If you do not recognize or see the number or the figure please leave a blank space. It is very important to me that you fixate to the mid point. You will have plenty of time, after the stimulus exposure to look down, write down the number, draw the figure and look up. Again be sure to return to the fixation point before the next exposure. Please tell the experimenter when you are ready to start.

Appendix B

Data for all subjects

MALES

	LVF				RVF		
Det	S.Loc	S.Inte	Pers	Det	S.Loc	S.Inte	Pers
1.22	2.67	2.47	1.27	2.4	2.19	2.06	1.25
2.36	2.29	1.86	0.86	2.14	1.43	1.29	0.79
1.57	1.43	1.14	0	1.11	0.89	1.11	0
1.44	1.56	1.31	0.25	1.53	1.2	1	0.07
2.27	2.2	2.06	0.87	2.36	2.09	2.09	0.8
2.06	2.06	2.38	2.13	2.27	2.06	1.63	1.5
1.6	1.6	1.4	0.53	1.71	1.0	1.1	0.1
2.08	2.25	1.42	0.16	2.36	2.27	2.09	0.18
1.31	1.62	1.5	0.25	1.53	1.4	1.26	0.33
1.8	1.8	1.4	0.13	1.75	1.25	1.25	0
1.38	2	1.38	0.66	1.8	1.69	1.3	0.2
1.46	1.6	1.54	0	1.8	1.55	1.36	0.27
1.8	2.13	1.8	0.47	2.07	1.9	1.46	0.23
1.13	1.88	1.33	0.2	1.92	1.23	0.9	0.15
2.13	2.69	2.56	1.65	2.06	2.25	2.06	1.5
1.8	1.94	1.75	0.94	2.42	2.25	1.67	0.58
1.75	1.81	1.56	0.38	1.87	2.1	1.6	0.4
1.46	1.77	1.54	1.15	1.69	1.69	1.25	0.31
1.73	1.73	1.6	0	1.9	1.63	1.36	0
1.73	2.27	2.07	0.53	1.79	2.07	2.07	0.36

FEMALES

1.88	2.56	2.33	0.33	1.67	1.44	1.78	0.33
1.92	1.75	1.5	1.42	1.69	1.23	1	0.92
1.08	1.58	1.42	0	1.54	1.31	1.46	0
1.94	2	1.75	0	2.06	1.38	1.38	0.19
1.8	2.4	2.27	1.4	2.25	2.0	2.16	1.75
1.4	0.81	0.73	1.13	1.64	1.01	0.78	1.43
1.5	1.63	1.56	0.25	1.64	1.14	1.29	0.29
1.9	1.99	1.73	0	1.58	0.92	0.92	0.46
1.33	1.9	1.66	0.25	1.69	1.44	1.25	0.25
1.6	2.13	2.06	1	2.0	1.86	2.0	0.2
1.89	2.25	2.06	0	1.8	1.26	1.6	0
1.75	1.5	1.56	0.19	1.5	1.5	1.13	0.06
2.0	2.13	1.8	0.5	2.0	1.93	1.78	0.7
1.6	2.06	2.25	0	2.07	1.9	1.9	0
1.58	0.9	1.08	1.08	1.6	1.55	1.36	0.55
1.75	2.41	1.83	0.33	1.69	2.0	2.0	0
2.07	2.15	1.62	1.54	2.33	2.17	1.83	1.33
1.46	1.62	1.77	0.23	1.0	1.54	1.3	0
1.88	1.88	1.75	1	1.9	1.5	1.5	0.75
2.2	2.4	2.4	0.3	2.33	2.16	2.16	0.16

Appendix C: Handedness inventory

Medical Research Council Speech & Communication Unit

EDINBURGH HANDEDNESS INVENTORY

Surname____________________ Given Names__________________________

Date of Birth__________________ Sex__________

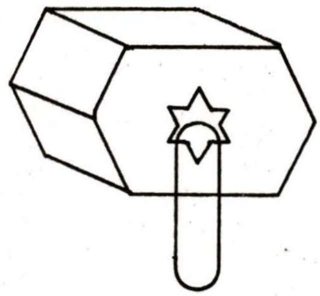
Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column.* Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put* ++. If in any case you are really indifferent *put + in both columns.*

Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

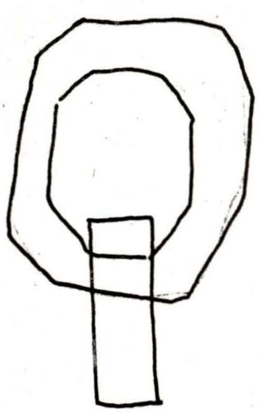
		LEFT	RIGHT
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Knife (without fork)		
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening box (lid)		
i	Which foot do you prefer to kick with?		
ii	Which eye do you use when using only one?		

Subject: Male (age=23)



Stimulus presented

Left visual field response



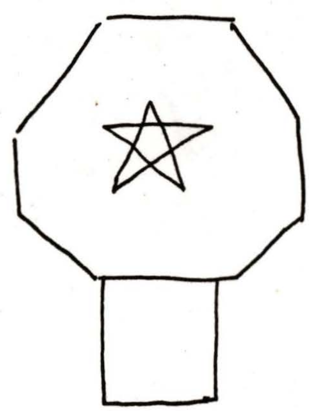
Detail............ 0

S. Location....... 3

S. Integration.... 3

Perspective....... 0

Right visual field response



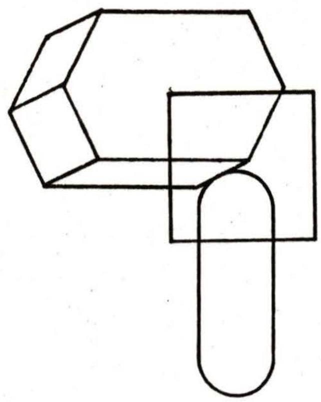
.... 2

.... 3

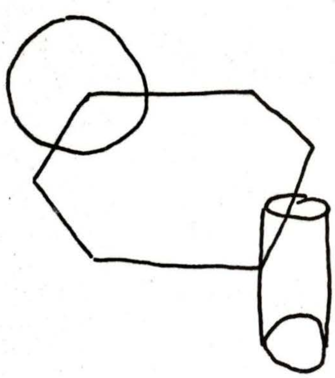
.... 1

.... 0

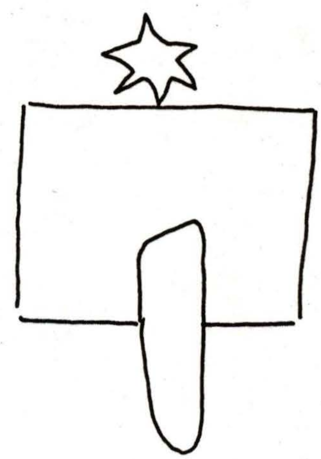
Subject; Male (age=28)



Stimulus presented



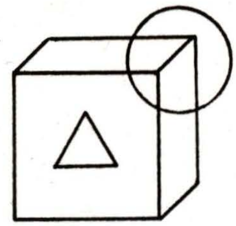
Left visual field response



Right visual field response

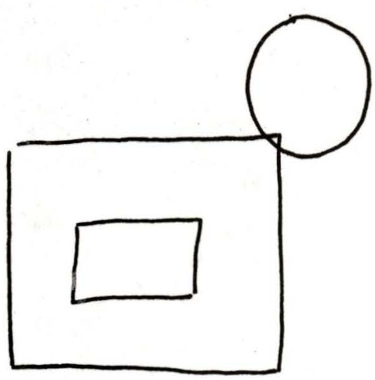
	Left visual field response	Right visual field response
Detail	1	2
Spatial location	2	1
Spatial integration	2	1
Perspective	1	0

Subject: Female (age=36)

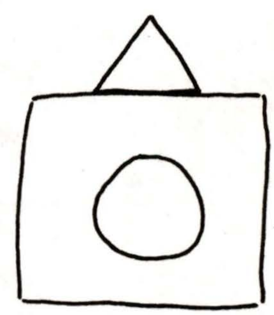


Stimulus presented

Left visual field response

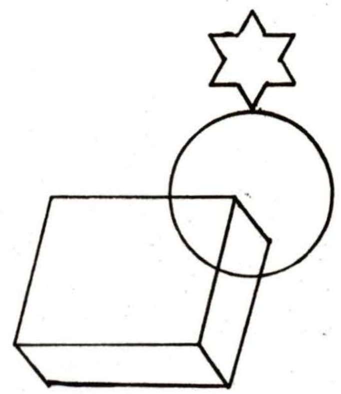


Right visual field response



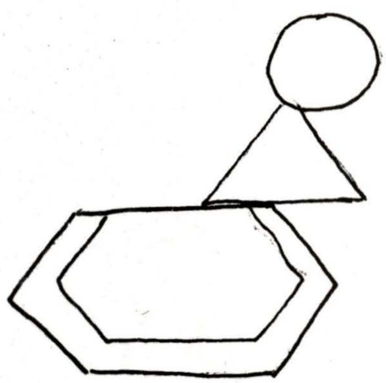
Detail	2	3
Spatial location	3	1
Spatial integration	3	2
Perspective	0	0

Subject: Female (age=27)

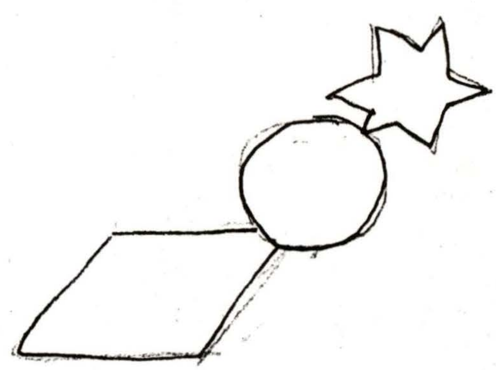


Stimulus presented

Left visual field response

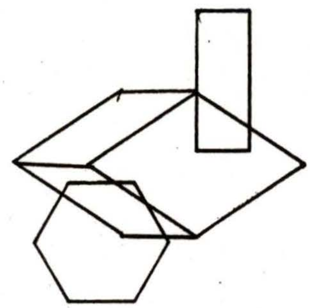


Right visual field response

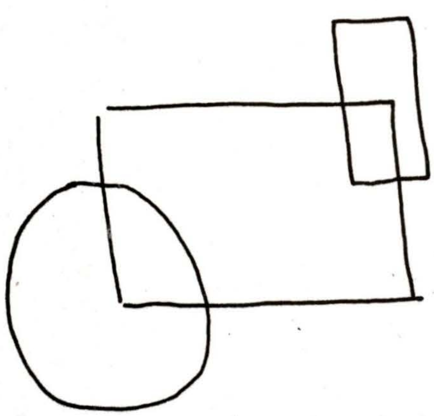
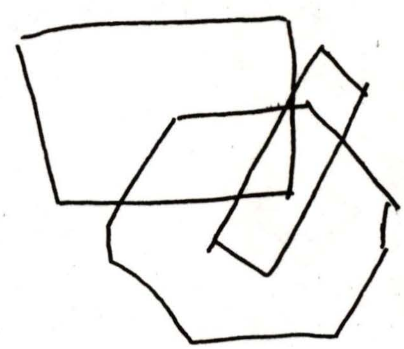


	Left visual field	Right visual field
Detail	1	3
Spatial location	3	1
Spatial integration	2	2
Perspective	2	0

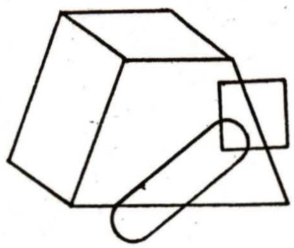
Subject: Male (age=24)



Stimulus presented

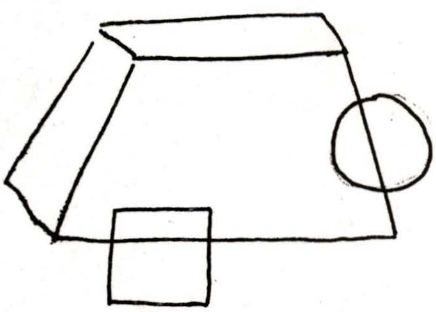
	Left visual field response	Right visual field response
		
Detail	1	2
Spatial location	3	0
Spatial integration	3	2
Perspective	0	0

Subject: Male (age=25)

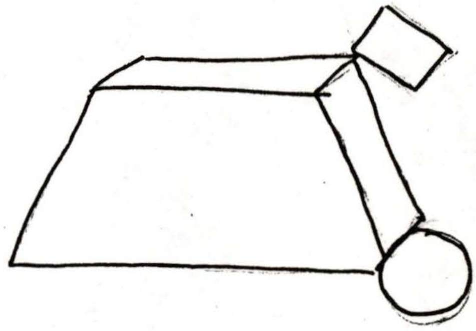


Stimulus presented

Left visual field response

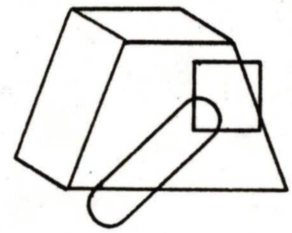


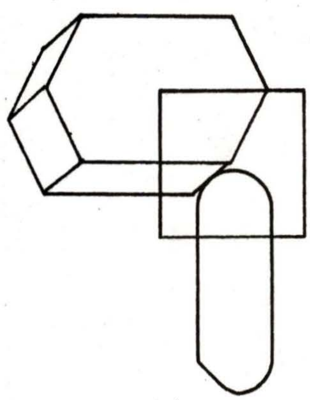
Right visual field response



	Left visual field response	Right visual field response
Detail	2	2
Spatial location	3	0
Spatial integration	2	0
Perspective	3	2

34





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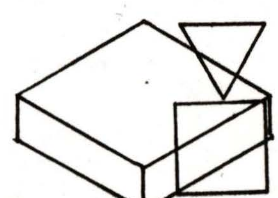

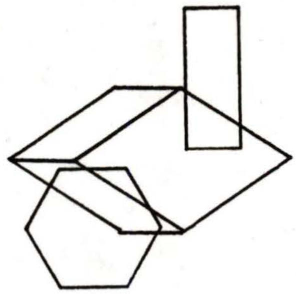

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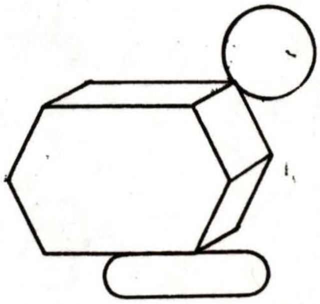

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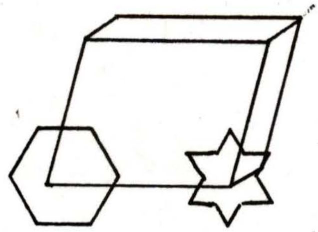

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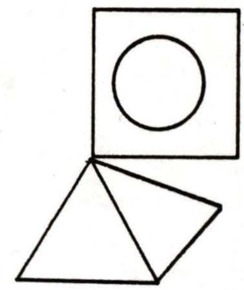

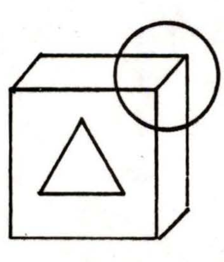

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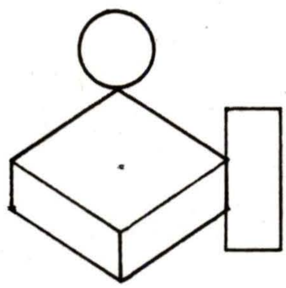

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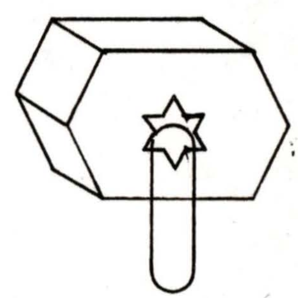

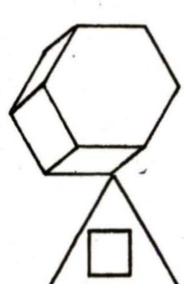

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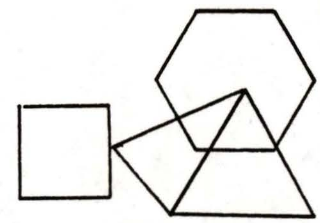

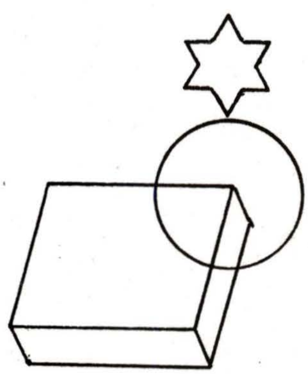

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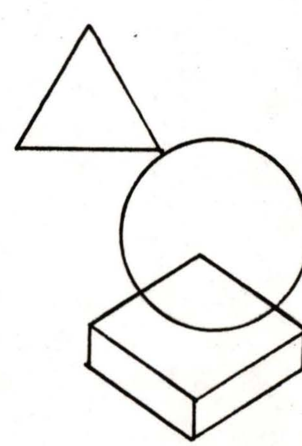

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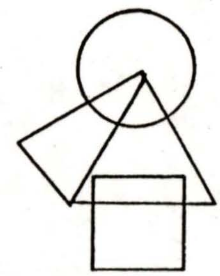

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