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EFFECTS OF OPTICAL BLURRING, SIZE, AND PRE-EXPOSURE ON THE STRAUSS TACHISTOSCOPIC TEST

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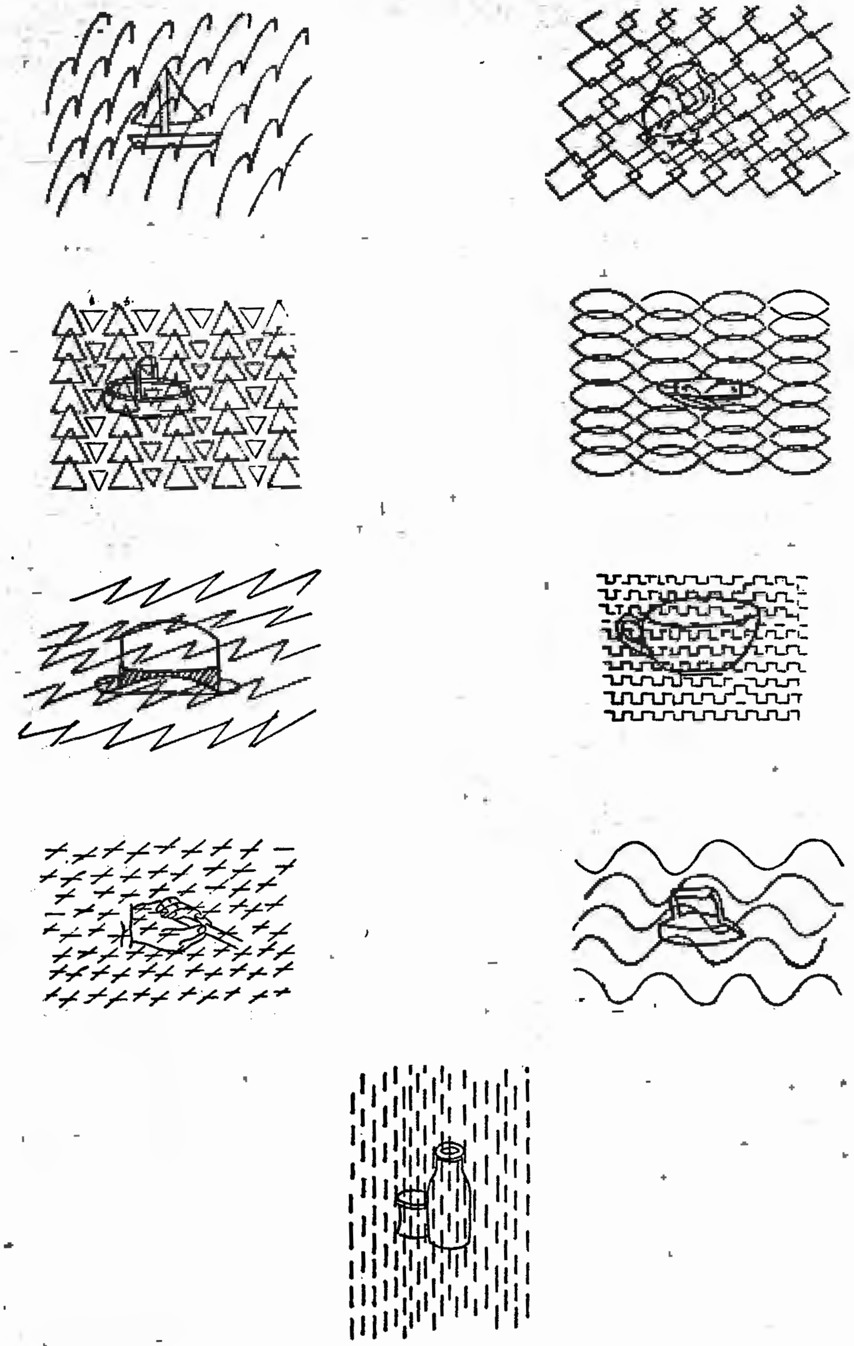


Fig. 11. Test cards of picture test, a test of pure visual perception.

INTRODUCTION

Strauss and Werner (1941) and later Strauss and Lehtinen (1947) described a series of behavioral tests to distinguish between visual-perceptual performance of normal children, brain injured children, and mentally defective children of the familial type.[8] The test was designed to study the assumption that the perceptual disturbances of brain injured children are in certain situations caused by a "forced responsiveness" to the background of figure-ground presentations.[10]

The Strauss series consists of a set of nine different drawings of various objects: a hat, a teacup, milk bottles, a knife, a chicken, a hand, a basket, a boat, and an iron. These pictures are embedded in clearly structured homogeneous backgrounds consisting of jagged and wavy lines, squares, crosses, etc. (see Figure II).

The subjects for Strauss' study consisted of three groups: 1) normal children ranging in age from 7-10; 2) mentally defective children of the familial type ranging in age from 7-11; and 3) brain injured retarded children ranging in mental age from 7-11. The slides mentioned above were tachistoscopically exposed for one-fifth of a second, and each child was asked: "What did you see?" Each slide was presented twice in succession. At the end of the series each subject observed the slides under untimed conditions. 1/5 sec

The responses of the groups were classified as: 1) correct naming of the object with no reference to the background; 2) response to the object, but only a vague description was given; 3) response to only the background; and 4) both the object and background were reported, but only an unprecise response was given.

From the information gathered the mean percentage of background responses was computed.[10]

Mean Percentage of Background Responses:

Normal	Non-brain injured	Brain injured
9%	14%	75%

During the authors' final year of course instruction some of the varied techniques and procedures employed in testing and training form perception were presented both in lecture and laboratory by Professor H. M. Haynes.[5] He has been clinically using the Strauss series as part of an exploratory battery of form tests. Class demonstration of these slides illustrated some of the problems inherent in the series itself and also the method of presentation. For example it was demonstrated that by reducing the angular subtend of the slides, the response to detection and recognition became increasingly difficult. Each slide contains two sets of figures--a central figure, or figures, and a patterned field. By presenting the slides under tachistoscopic conditions and asking, "What did you see?", we are really asking for a complex response involving two separate sets of figures. Finally, it was noted that the task becomes increasingly difficult by blurring the slides on the screen level. The effects of optical blurring of the distal stimulus on performance suggests that optical changes in the proximal stimulus mediated by changes in accommodation might also be an important clinical variable.

This study was undertaken to study the effect of size and optical blurring of the proximal stimulus upon adult subject response.

Systematic understanding of these and other variables should allow us to design a better testing series for clinical purposes.

REVIEW OF THE LITERATURE PERTAINING TO FORM PERCEPTION AND THE BRAIN INJURED CHILD

Strauss et al., in observing clinically the behavorial activities of brain injured children by way of examination, interview and classroom performance, have noted that these children tend to examine small minute details and disregard the conceptual content of the whole. They are highly distractable, experience great difficulty in writing and arithmetic problems, and erratically and incorrectly complete performance tests.[10]

The brain injured child has difficulty in constructing the whole figure from its parts, and is apt to respond to an unessential detail of the stimulus field. If the perception is made difficult, as in the case of tachistoscopic presentation where the stimulus is exposed for only a fraction of a second, it will be seen that the brain injured child responds differentially. Where several sets of figures are superimposed these children tend to respond to the patterned field rather than the central figure. The normal child, on the other hand, will report both the central and field figures.

In considering figure-ground relationship, the brain injured child cannot hold the figure if the background is also patterned. His difficulties increase as the patterning of the background becomes stronger.[7]

Strauss and other investigators felt it was important to design a test which would require solution by visual perception and motor skills.

It was known that brain injured children were usually unsuccessful in a task of copying marble forms from a pre-set pattern. A test constructed like a marble board game was expected to reveal perceptual deficiencies of the brain injured child and supply additional data in diagnosing brain-injured children. Other tests similar to the marble board tests have also illustrated the difficulties involved in visual-tactual motor skills.[7] ← for brain injured

BACKGROUND READING PERTAINING TO FORM PERCEPTION IN GENERAL

The following is a summary of some of the background reading we did to better understand form perception. It is incomplete and not intended to represent a comprehensive review of either the literature relative to brain injury or form perception in general.

Visual form perception is a topic relevant to all those who work in the area of vision. In spite of the considerable amount of work that has been done, and the excellent quality of it, perception still remains a problem area that withstands organization and does so for two main reasons: 1) the data concerning quantitative research is very much incomplete, and 2) the theories involved are either too broad or too narrow. The broad theories, while all inclusive, suffer from a lack of quantified experimental evidence to support the theories. The narrow theories are found to be reasonably well supported by experimental evidence but are so restricted in there range of view that they are generally useless in allowing in any practical problem situation.[6]

In considering the nature of a perceptual experience, one may be impressed by the coherence in space and time of that experience; and equally by its variety. There is a combination and unification of sensations arising from the different sense organs. For example, certain wavelengths of electromagnetic energy stimulate our eyes and provide us with color distribution. Our ears sense certain kinds of mechanical vibrations in the air and provides the distribution of sounds. These sensations are really only part of the story. There is the total visual experience or perception that we report which depends upon a combination and integration of sensations from the different sense organs. The sense organs change the various environmental energies into nervous impulses which in turn go to the Central Nervous System. Through the psychological process of perception the pattern of energies become known as objects, events or other aspects of the world. It may generally be stated that perceptual reconstruction of the external environment always appears to aim at preserving the continuity and stability of the objects in the field.[3]

A great number of different experimental methods as well as different types of experimental material have been used by those working in the area of perception. There is a fair amount of agreement as to the fundamental stages which may be observed in the development of full knowledge of the nature of the objects exposed. The first stage consists of a vague awareness or knowledge that there is something in the visual field. Davies (1905), exposed a series of geometric forms using a short flash of light in a dark room. He found that there is a primary consciousness of light that occurs before there is any consciousness of form. Then Helson and Fehrer (1932), followed the same procedure as Davies, but with low intensity brightness in the exposure. The results showed an awareness of the appearance of light at a much lower intensity than was necessary for the appearance of form. The first stage found by Dickinson (1926) in the tachistoscopic perception of groups of letters and of playing cards was the experience of a visual pattern having 'thereness' or flat clearness without any logical meaning. Throughout the description of the first stage, there seems to be a sound of vagueness and uncertainty. This was also determined by Bartlett (1916) in which he describes 'having a feeling of' or 'an impression of' something.[9]

The second fundamental stage in the perceiving process has been called the generic object - the awareness that the visual stimulation is connected with some kind of object with an existence in the visual field. The second stage was so named by Dickinson (1926) and Freeman (1929). The object falls into a general category of objects, or it has a similarity to some known class of object. This knowledge usually results from a partial differentiation of the total visual field, whereby certain parts stand out more clearly and assume more importance than their surroundings. Certain details may be noted which may be significant in interpreting the perceptual situation. It is at this stage that grouping or organization begins. These parts, and especially those of more important detail rise out of the field, while the remainder fades into the background. These specific parts are recognized as pertaining to some particular or specific object. Thus the third stage is called the specific object. The form characteristics of the field, or rather, of the relevant and important parts of it, are now fully recognized; the conscious reception of the pattern of visual stimulation is complete.

The last stage encountered in the perceptual process is that of identification and understanding of meaning. Here the visual pattern takes on the meaning of a form or object in the external world. In Bartlett's perceptual experiments (1916) the observer's reported an 'effort after image'. Thus the percept developed fully from the vague and distorted sensory pattern, and the observer became subjectively certain of its forms even when this was of fact very different from the stimulus form.[9]

It is noted that the first step of the perceptual process is characterized by the vague impression of 'something there,' which in turn passed on to the generic object when there is a general impression that the visual stimilus is connected with some kind of object existing in the field. From these stages one sees a differentiation of one part of the field from the rest, and that the one part that becomes the main precept is separated from what remains the background. The Gestalt psychologists have called this the "figure-ground" phenomenon. This term was suggested by Rubin (1921). The Gestalt psychologists find this phenomenon quite important in the perceptual process and indicate it as a primary factor in the organization of the perceptual field. To them, the first essential stage in perception is the emergence of one principal part of the field which is the "figure" from the remaining part which is the "ground". Thus one law of organization concerning perception is organized into parts, some of which are figure and some of which are ground.

Another law to consider is the law of closure. It is developed from observations that our perceptions tend to complete incomplete figures. If a partially completed figure is drawn, one will tend to perceive a completed figure. This results from the external and internal forces which help to obtain a clear and stable percept. What this means is, if the objective qualities of the field, called the external forces, are not such as to give rise spontaneously to "good" configurations, then there is an internal force which is within the individual to help modify the pattern of retinal stimulation in the direction of possessing configuration. Thus if three spaced dots are easily seen as a triangle, the closer the dots are placed the stronger becomes the impression of a closed figure.[9]

Continuously closed figures show more stability and persist longer than do discontinuous ones.

Both the law of figure-ground and the law of closure come from

Gestalt psychology.

Contemporary work in the area of form perception is almost entirely at the level at which it was abandoned by the Gestalt psychologists. This means that today we cannot satisfactorily explain the perception of simple form.

Historically speaking, the Gestalt position was the first theoretical position which was not only aware of the problem of explaining form perception but attempted a systematic approach to understanding it.

In the area of contemporary works, two terms are discussed - detection and recognition.

In a broad sense, detection refers to that level of performance in which a distinction between nothing and something is made. This is made in reference to the observer who says that he saw "something" and that not even a guess could be made as to what that something might be. To make the distinction between something and nothing, even at the crudest levels, is not without problems. The person reports something when nothing is there. Regardless of what the independent criterion may be, the levels at which a person says "something is there" are not constant ones.[4]

One of the most common means to define detection has been to plot the function that results when correctness of response is measured as a function of changes in increments of illumination. In such a structured graph, the point at which the subject has been correct 50% of the time in determining nothing as against something is known as the detection level.

Recognition on the other hand refers to the ability of not only being able to determine something as opposed to determining nothing, but it also refers to correctly identifying what that something is. In a very vague way it is generally agreed that this level of performance is more complex than detection. Recognition is arbitrarily defined as the 75% response point or some point greater than 75%.

The usual experimental approach has been to manipulate some particular independent variable in order to establish the relationship between area and detection and/or recognition.

Current work may be divided into three main groups. One group of theorists emphasizes the total area as the main variable that determines detection. A second group stress the edge of a particular form as being the most important variable. The third group is a combination of the first two groups in that they speak of perimeter/area ratios as being the determining factor.

In considering the area, the theorists have obtained Ricco's Law. It postulates that the area times the intensity is a constant. Or another way of expressing it is that as area increased the intensity of illumination needed by a subject to detect the area would decrease. The general agreement now is that the relationship is only linear for stimuli that subtend an angle less than 10 minutes. As the size of the angle subtend increases, the relationship becomes curvilinear so that increasing amounts of area are necessary to reduce the threshold for detection.[2]

Other workers such as Graham propose that the relationship of intensity to area is best handled when provision is made for the fact that within any given area the stimulation provided in the visual system is not constant across the area. At the center of the retinal image excitation will be the greatest and the contribution falls off as you leave the center. This is to say that shape is a factor in itself.

In considering edge, Fry points out that by manipulation of the border of a figure, detectability thresholds are definitely affected. He concludes that detectability of a figure is not a function of the width, as long as it exceeds the blur circle, but that it is a function of the length. Here he is considering rectangular objects. The threshold is also effected by the shape of the borders. He further concludes that the area per se is not a factor, but rather it is more a function of the type of boundary enclosing the area rather than the area itself.

The workers who speak of the perimeter/area ratios say that neither area nor some aspect of the edge or border is enough, but a ratio of perimeter to area. Bitterman has suggested that the form detection threshold is a function of the ratio of perimeter to area. The less the magnitude of the ratio the lower the detection threshold.[1]

PROBLEM

It was the purpose of this study, through the use of the Strauss slides and tachistoscopic flash, to 1) determine the effect of plus lenses upon discrimination of central figures and/or patterned field, and 2) determine the effect of varying the angular size upon discrimination of central figures and/or patterned field, and 3) show the effect of pre-exposure vs. non pre-exposure upon the responses of the subjects.

Different individuals respond differently to the same stimuli. Even the same individual does not remain consistent from time to time. The problem of describing how an individual responds often becomes as difficult as the problem of determining the relative stimulus variables. How important are an individual's past experiences in determining just what sort of form perception evolves out of a given set of stimuli? It is of prime importance to maintain adequate control of stimulus variables in testing and training form perception. We believe a thorough understanding of the dynamic refraction of the individual is also necessary.

EXPERIMENTAL DESIGN

Tachistoscopic testing techniques involve a myriad of variables. In the design of this study the following variables were considered: 1) illumination, 2) angular subtend of the target, 3) focus of the projector, 4) focus of the stimulus at the retinal level, 5) time of exposure, 6) border and contrast variables of the target, 7) shape of the target, and 8) subject familiarity with the target.

SUBJECTS

A group of twenty Pacific University students were randomly selected to participate in this study. Each subject wore his habitual distance prescription, and it was assumed to contain the best cylinder and anisometropia correction. A binocular cross-cylinder (#14B) was determined at twenty inches both from the plus and minus side. The average #14B$^{20''}$ was determined and used as a basis for operationally defining the accommodative response relative to the twenty-inch testing distance. By error, the habitual prescription of each subject was not recorded.

ILLUMINATION

A room illumination of 1 FC was used for each subject. The illumination of the projector, as measured at the twenty inch testing distance, remained a constant 5 FC for each subject.

ANGULAR SUBTEND OF THE TARGET

Using a pre-existing set of Strauss slides each of the nine slides were photographed at three different distances to give a full field of view, half field of view and quarter field of view. As an operational definition "field of view" refers to the central figure with the boat slide as a standard.

At a twenty inch testing distance, the central figure of the boat slide gave a visual acuity of ≈ 20/1850, the half size gave a visual acuity of ≈ 20/713, and the quarter size gave a visual acuity of ≈ 20/320. Due to an error in photographing the slides, the visual acuities are not multiples of two. For purposes of comparison it was decided that the range of visual acuities produced would be adequate.

FOCUS OF THE PROJECTOR

The slides were mounted in glass to eliminate unequal focus as the series was presented.

FOCUS OF THE STIMULUS AT THE RETINAL LEVEL

Using the average #14B$^{20"}$ as a base level to compensate for minute fluctuations in accommodation, three other lens conditions were established: #14B + 1.00, #14B + 2.00D, and #14B + 3.00D. These lense conditions were determined during pre-experimental testing based on the authors' own responses. The combination of the one-quarter size and the #14B + 3.00D was found to be the maximum limit of definition for the figure and/or patterned field. The remaining lens conditions were arbitrarily chosen as they were assumed to present less difficulty in recognition.

TIME OF EXPOSURE

The time alloted for exposure of each slide was set at 1/25 of a second. This was the time element involved in the testing procedure for each subject. The time interval between exposures was not constant for all subjects, because as the maximum limits of recognition were approached, the responses were more difficult to attain.

BORDER AND CONTRAST VARIABLES

The border and contrast characteristics were held constant for each of the various size slides within the limits of the photographic process.

SHAPE OF THE TARGET

Each slide consisted of two sets of figures--a central figure or figures and a patterned field. As an operational definition we will refer to the two figures as a central figure and patterned field in this study.

SUBJECT FAMILIARITY WITH THE TARGET

In order to give a random sample of both size and slide order 36 full size, 27 half size, and 27 quarter size slides were produced.

The twenty subjects were divided into two groups: 1) pre-exposed subjects, and 2) non pre-exposed subjects to show the effect of familiarity with the target.

GROUP CONDITIONS

The experimental group of twenty subjects was broken down into four groups consisting of five subjects each. Thus the following conditions designed were:

Condition 1: This group consisted of five subjects who were pre-exposed to the 9 full size Strauss Series slides under untimed conditions before the standard test procedure was begun at 1/25 of a second. The test sequence in this condition consisted of exposing 108 randomly arranged slides beginning with the #14B, #14B + 1.00D, #14B + 2.00D, and the #14B + 3.00D (27 in each condition).

Condition 2: This group consisted of five subjects who were not pre-exposed to the full size Strauss Series slides before the standard test procedure was begun at 1/25 of a second. The test sequence in this condition consisted of exposing 108 randomly arranged slides beginning with the #14B, #14B + 1.00D, #14B + 2.00D, and the #14B + 3.00D (27 in each condition).

Condition 3: This group consisted of five subjects who were pre-exposed to the 9 full size Strauss Series slides under untimed conditions before the standard test was begun at 1/25 of a second. The test sequence in this condition consisted of exposing 108 randomly arranged slides beginning with the #14B + 3.00D, #14B + 2.00D, #14B + 1.00D and the #14B (27 in each condition).

Condition 4: This group consisted of five subjects who were not pre-exposed to the full size Strauss Series slides before the standard test sequence was begun at 1/25 of a second. The test sequence in this condition consisted of exposing 108 randomly arranged slides beginning with the #14B + 3.00D, #14B + 2.00D, #14B + 1.00D and the #14B (27 in each condition).

INSTRUCTIONS

For purposes of instruction the above four groups were classed as two.

Group 1 consisted of the above mentioned Conditions 1 and 3, and the instructions given were as follows:

A. Under untimed conditions each subject was told:

1. "I will show you a set of slides. Look at each slide and tell me everything that you see."

2. "Notice that you have seen a central figure and a patterned field consisting of various shaped lines."

3. With the #14B + 3.00D in place the knife slide** of

**The knife slide was previously found by Haynes to be the most difficult to identify.[5]

1/4 size was presented to the subject and he was asked to:

"Look at this slide and tell me everything that you see."

If the subject could not resolve this slide the #14B + 3.OOD lens condition was eliminated.

B. Under timed conditions of 1/25 of a second with the #14B in place the subject was told:

"You will now see the same slides only in a random order and consisting of different sizes. The slides will be presented under flash conditions. After each exposure tell me everything that you see.

You may see one of four things: —

1. Light or light and something
2. A figure
3. A patterned field consisting of various shaped lines
4. Both a figure and a patterned field consisting of various shaped lines."

Group 2 consisted of the above mentioned Conditions 2 and 4 with the following instructions given:

A. With the #14B + 3.OOD in place the knife slide of 1/4 size was presented to the subject and he was asked to:

"Look at the slide and tell me everything that you see."

If the subject could not resolve this slide the #14B + 3.OOD lens condition was eliminated.

B. Under timed conditions of 1/25 of a second the subject was told that: "You will now see a series of slides similar and including this one consisting of different sizes under conditions of flash. After each exposure tell me everything that you see."

You may see one of four things:

1. Light or light and something
2. A figure
3. A patterned field consisting of various shaped lines.
4. Both a figure and a patterned field consisting of various shaped lines.

The instructions were designed to elicit from each subject a response from all the stimulus elements. It was found in preliminary explorations with the instruction "Tell me what you see," that the subjects arbitrarily described what they thought to be important. Therefore, the subjects were told all possible observations such as central figure or figures, patterned field of various shaped lines, light, etc.

RESULTS

Table I gives information as to the effect of pre-exposure to non pre-exposure with regard to the ability to correctly identify both central figure and patterned field. It also may be seen from this data the effect of size of the target in each case. Graphic presentation of this information appears in graphs #1 and #2 of this study.

TABLE I

Lens Control	Group	No. Subjects		Total No. of Responses to Both Central Figure and Pattern Field	Total No. of Responses to Central Figure and Pattern Field by Size: Full	Half	Quart.
#14B	*CI	5		50	23	19	8
	CII	5		18	14	4	0
	*CIII	5		31	20	11	0
	CIV	5		7	5	2	0
			Total:	106	62	36	8
#14B + 1.00	*CI	5		30	18	10	2
	CII	5		10	10	0	0
	*CIII	5		14	10	2	2
	CIV	5		1	1	0	0
			Total:	55	39	12	4
#14B + 2.00	*CI	5		11	11	0	0
	CII	5		3	3	0	0
	* CIII	5		0	0	0	0
	CIV	5		0	0	0	0
			Total:	14	14	0	0
#14B + 3.00	*CI	1		0	0	0	0
	CII	3		0	0	0	0
	*CIII	2		0	0	0	0
	CIV	1		0	0	0	0
			Total:	0	0	0	0

* Pre-exposed

Table II below shows the effect of the plus lenses on responses. No separation has been made between pre-exposed and non pre-exposed groups. Responses have been separated as to the total number of responses to both central figure and patterned field (Both), central figure or pattern field ($\frac{1}{2}$), or a response of something or an incorrect response (0). Graphic presentation of this information appears in graph #3.

TABLE II

Lens Control	Number of Subjects	Both	$\frac{1}{2}$	0
#14B	20	106	175	259
#14B + 1.00	20	55	114	371
#14B + 2.00	20	14	58	468
#14B + 3.00	7	0	2	187*

* Only 7 subjects viewed the slides in this series.

Table III gives information as to the role of size in responses of central figure and pattern field according to the various lens conditions. Graphic presentation of this information is found in graphs #4 and #5.

TABLE III

Lens Control	Group	No. Subjects		Total No. Responses to Central Figure			Total No. Responses to Pattern Field		
				Full	½	¼	Full	½	¼
#14B	*CI	5		0	2	1	11	16	5
	CII	5		3	0	2	21	22	5
	*CIII	5		7	2	1	13	19	3
	CIV	5		0	0	0	22	11	3
			Total:	11	4	4	67	74	16
#14B + 1.00	*CI	5		4	1	0	15	9	1
	CII	5		4	1	0	16	8	0
	*CIII	5		1	0	2	20	8	4
	CIV	5		0	0	0	11	10	0
			Total:	9	2	2	62	35	5
#14B + 2.00	*CI	5		0	0	0	11	6	1
	CII	5		1	0	0	18	1	1
	*CIII	5		1	0	0	12	1	1
	CIV	5		0	0	0	4	0	0
			Total:	2	0	0	45	8	3
#14B + 3.00	*CI	1		0	0	0	1	0	0
	CII	3		0	0	0	0	0	0
	*CIII	2		0	0	0	1	0	0
	CIV	1		0	0	0	0	0	0
			Total:	0	0	0	2	0	0

* Pre-exposed

Table IV shows the effect of the various lenses on the detection level, i.e., the responses of something vs. nothing. For graphic presentation see graph #6.

TABLE IV

Lens Control	Group	No. Subjects		Total No. Responses to Something			Total No. Responses to Nothing		
				Full	½	¼	Full	½	¼
#14B	*CI	5		1	1	6	2	2	16
	CII	5		2	3	10	0	8	19
	*CIII	5		1	7	14	1	3	22
	CIV	5		9	17	6	0	8	33
			Total:	13	28	36	3	21	90
#14B + 1.00	*CI	5		0	2	4	6	18	35
	CII	5		9	14	12	1	20	31
	*CIII	5		8	7	10	2	24	26
	CIV	5		11	9	10	18	21	28
			Total:	28	32	36	27	83	120
#14B + 2.00	*CI	5		1	3	1	19	32	41
	CII	5		9	11	9	6	30	35
	*CIII	5		7	7	5	21	35	39
	CIV	5		8	4	7	33	39	38
			Total:	25	25	22	79	136	153
#14B + 3.00	*CI	1		0	0	0	8	7	8
	CII	3		7	5	5	17	21	21
	*CIII	2		2	2	1	13	16	17
	CIV	1		0	0	0	9	9	9
			Total:	9	7	6	47	53	55

* Pre-exposed

SUMMARY OF RESULTS

We were interested in comparing the number of responses that were correct to both central figure and patterned field in a group of pre-exposed subjects vs. a group of non pre-exposed subjects. The effect of plus lenses on the number of correct identifications of central figure and patterned field was determined by grouping the responses of all subjects. In addition, the subjects were compared according to the number of responses of figure vs. patterned field, responses as a function of size of the distal stimulus, and responses of something vs. light or nothing. Finally, the number of correct responses of subjects beginning the series at the #14B level was compared to the number of correct responses of subjects starting at the #14B + 3.00D level.

The effect of pre-exposing the subjects under untimed conditions produces a higher percentage of total number of correct responses to (1)
central figure and patterned field. Approximately 70% of the total number of correct responses were found in the pre-exposed group.

As we expected, the data shows that as the stimulus definition (2)
becomes more difficult through optically blurring of the proximal stimulus, the number of correct responses drops. Twenty out of twenty subjects showed lowered correct responses as plus lenses were added over the #14B.

Data indicates that as the proximal stimulus definition is
blurred the percentage of correct responses to the central figure (3)
drops off and subjects tend to respond more to the patterned field. As the limits of optical blur are approached: 1) more responses were to light or nothing and 2) less responses to patterned field

or something.

The size of the distal stimulus was seen to play an important role in responses of the subjects. Twenty out of twenty subjects showed lower responses as the angular size was decreased. The angular size in conjunction with the plus lenses was found to be a limiting factor in all subjects. Only 35% of the subjects were able to resolve the quarter size target under conditions of #14B + 3.00D.

The chi square test was applied to the data showing the effect of starting the sequence from the #14B level vs. the #14B + 3.00D level. The authors set the level of significance acceptable in this study at the .05 level.

Comparing the pre-exposed subjects starting at the #14B level to pre-exposed subjects starting at the #14B + 3.00D level gave a chi square value of 6.36. With three degrees of freedom this places the data at the .10 significance level. Therefore, we cannot reject the null hypothesis.

Comparing the non pre-exposed subjects starting at the #14B level to the non pre-exposed subjects starting at the #14B + 3.00D level gave a chi square value of 2.47. With three degrees of freedom this places the data at the .50 significance level. Again, we cannot reject the null hypothesis.

Combining the pre-exposed and non pre-exposed subjects starting at the #14B level and comparing them to pre-exposed and non pre-exposed subjects starting at the #14B + 3.00D level gave a chi square value of 7.58. With three degrees of freedom this places the data at the .10 significance level. The null hypothesis cannot be rejected.

From the above calculations the authors conclude that for this sample there is no significant difference between correctness of response to both central figure and patterned field of 1) pre-exposed subjects starting at the #14B level or starting at the #14B + 3.00D level; 2) non pre-exposed subjects starting at the #14B level or starting at the #14B + 3.00D level; and 3) either pre-exposed or non pre-exposed subjects starting at the #14B level or starting at the #14B + 3.00D level. We believe that this may be a significant variable with a larger sample.

DISCUSSION OF RESULTS

It was the purpose of this study, through the use of the Strauss slides and tachistoscopic flash, to determine the effect of: 1) plus lenses upon discrimination of central figures and/or patterned field, 2) varying the angular size upon discrimination of central figures and/or patterned field, and 3) show the effect of pre-exposure vs. non pre-exposure upon the responses of the subjects.

Twenty subjects randomly selected were divided into two main groups: 1) ten subjects were pre-exposed under untimed conditions to each of the nine full size Strauss slides. Each of the ten subjects then viewed 27 slides (9-full, 9-half, and 9-quarter size) in each of four lens conditions (#14B, #14B + 1.00D, #14B + 2.00D, and #14B + 3.00D). Exposure time was 1/25 sec.; 2) ten subjects were not pre-exposed to the Strauss slides. They viewed the same slides mentioned above in each of the lens conditions. Exposure time was 1/25 second.

Each of the above groups was further divided so that five of the ten subjects in each group started the series at the #14B level while the other five started at the #14B + 3.00D level.

Subjects were asked to tell the authors everything that they could see (central figure or figures, patterned field, something or light. Verbal responses after each exposure were recorded.

Results indicate that as stimulus definition becomes more difficult by optically blurring and reducing the size of the distal stimulus, subjects respond less to the central figure and more to the patterned field. The effect of pre-exposing subjects to the series gives a higher percentage of correct responses. Finally, results of this sample indicate no significant difference between starting the series at the #14B level or the #14B + 3.00D level. The authors expect that in a larger sample this may be a significant variable.

The authors were able to substantiate, in part, the work of Strauss by showing that a response similar to that of brain injured children may be induced in adults by altering the angular size or optically blurring the proximal stimulus. As far as designing a better clinical series, we may suggest that the present series can be used but that the angular size of the proximal stimulus should be large enough for resolution and should be controlled from subject to subject.

Strauss makes no mention of the dynamic refractive status of the children who participated in his study. This is certainly of prime importance as we have seen in the responses under conditions of induced myopia or optical blur of the proximal stimulus.

This study has revealed the need for careful control of the stimulus variables in tachistoscopic testing and training. Above all, a thorough understanding of the dynamic refraction of the individual receiving the testing or training should be known.

SUGGESTIONS FOR FUTURE STUDIES

The results of this study and the observations made by the authors as the study was conducted give rise to a number of recommendations. A study using the Strauss slides in which each subject maintained fixation at a central point on the projection screen could be designed. This was not done in our study. The purpose of such a study would be to determine if fixation effects response of central figure or patterned field. As pointed out by Haynes, this adds another variable to the testing sequence.[5] It is questioned if such a study would be valuable for clinical purposes, since in tachistoscopic work we are often interested in the subject's ability to return fixation to the same point or region in the field.

A more precise level of detection and recognition as proported in the background literature could be determined. A study designed in which one size slide would be presented through a series of lens conditions might be valuable in determining the average detection level. Also, a study involving only one lens condition and several sized targets could be used to determine a detection level for size.

Since the present study affects the stimulus definition by altering the stimulus to accommodation, in future studies an average #14B should be taken at the end of the series with each subject. This would determine if the accommodative level had changed as an effect of time and test sequence.

The shape of each central figure in each target was not consistent throughout the series. In some cases the authors noted curved, circular lines made up the central figure. Other central figures were composed of curved, angular lines. Another study could be designed to study the effect of degrading the proximal stimulus of the central figure by using a homogeneous white or figured field. Finally, as a result of Strauss and others, as well as our own work, this type of test needs to be studied to show the responses as a function of age by both cross-section and longitudinal studies.

SUMMARY

Twenty subjects were systematically studied using three variables related to the Strauss Series Tachistoscopic Test. We found that angular size, optical blurring of the proximal stimulus and pre-exposure were important variables. In general, central figure responses decreased as angular size was decreased. Also optical blurring produced a similar decrement in responses to both central figure and patterned field. Pre-exposure to the series was found to give more correct responses of central figure and patterned field. Finally, our sample showed no significant difference in beginning the series under conditions of blur or conditions of clarity.

APPENDIX A

PRESENTATION OF GRAPHS

GRAPH NUMBER 1

Graph number 1 illustrates the effect of pre-exposing the subjects to the nine Strauss slides. Only those responses that were correct to both the central figure and the patterned field appear on this graph.

Pre-exposed group: (CI and CIII)[1]. Each of the ten subjects was exposed under untimed conditions to each of the full size Strauss slides. Each subject was presented the slides again under conditions of flash (1/25 second). Each subject viewed 27 slides in each lens condition (9-full, 9-half, and 9-quarter size slides randomly arranged). With ten subjects viewing 27 slides each, a total of 270 correct responses was possible.[2]

Non pre-exposed group: (CII and CIV)[3]. Each of the ten subjects was presented 27 slides in each lens condition as above. Slides were presented under conditions of flash (1/25 second). With ten subjects each viewing 27 slides a total of 270 correct responses was possible under each lens condition.

1. CI = #14B, #14B + 1.00, #14B + 2.00, #14B + 3.00.
   CIII = #14B + 3.00, #14B + 2.00, #14B + 1.00, #14B.
2. 270 applies to: #14B, #14B + 1.00, #14B + 2.00.
   189 applies to #14B + 3.00. Since only 7 subjects out of 20 viewed slides under #14B + 3.00, it was decided to use only those subjects who could sesolve the $\frac{1}{4}$ size knife slide under untimed conditions.

3. CII = #14B, #14B + 1.00, #14B + 2.00, #14B + 3.00.

CIV = #14B + 3.00, #14B + 2.00, #14B + 1.00, #14B.

PRE-EXPOSED VS. NON-EXPOSED

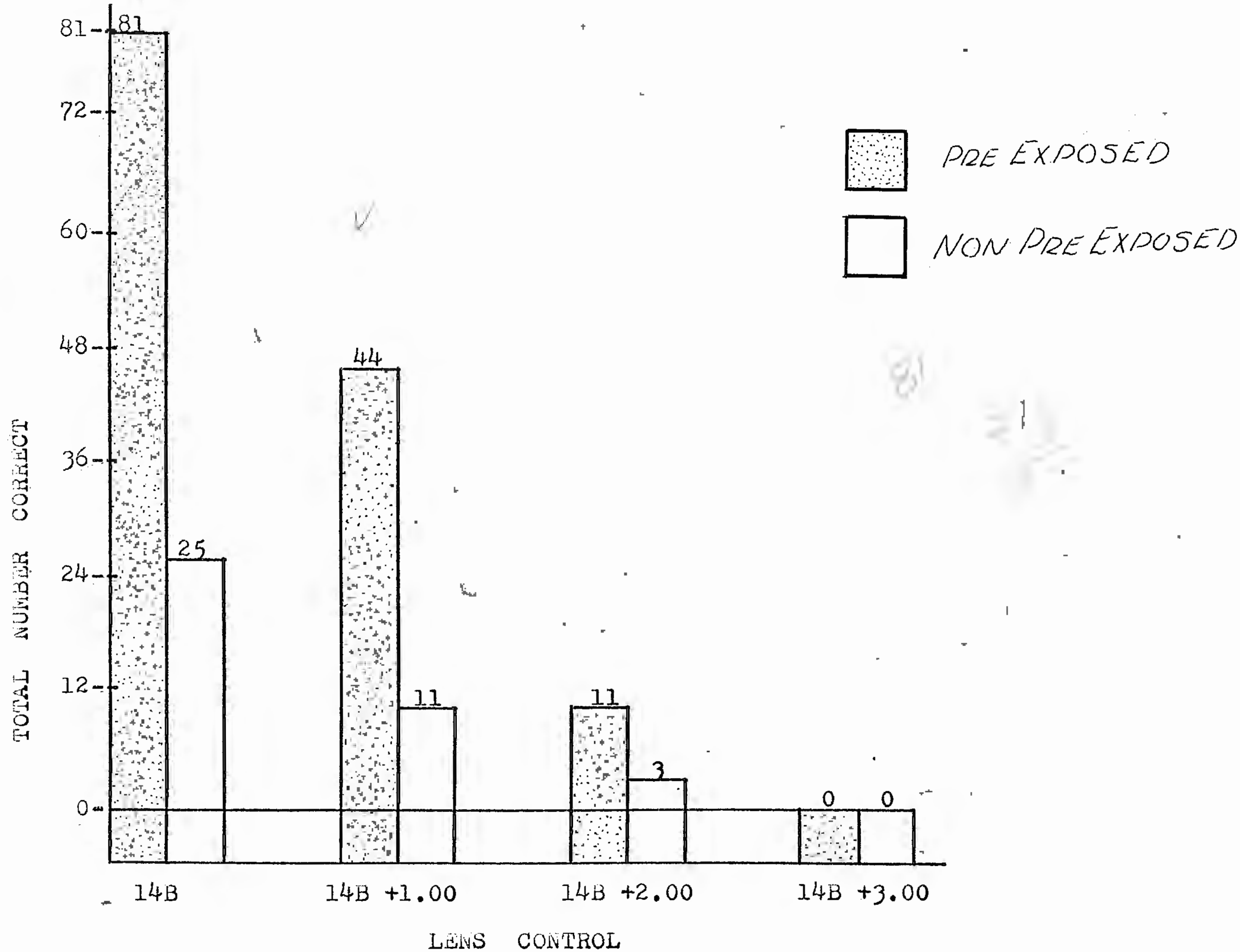
ACCORDING TO LENS CONDITION

Percent correct to both figure and patterned field out of 270 possible:

Group	#14B	#14B + 1.00	#14B + 2.00	#14B + 3.00
Pre	30.0%	16.3%	4.1%	0
Non	9.3%	4.1%	1.1%	0

GRAPH 1

TOTAL NUMBER CORRECT RESPONSES
PRE-EXPOSED VS. NON-PRE-EXPOSED
ACCORDING TO LENS
CONTROL



GRAPH NUMBER 2

Graph number 2 is a further breakdown of Graph number 1. The authors separated the total number correct responses by slide size. Again "correct" means both central figure and pattern field were identified correctly.

Acuity was based on viewing the sailboat at 20 inches.

1 = Full = 20/1850

½ = Half = 20/713

¼ = Quarter = 20/320

With 10 subjects in each group exposed to 9-Full, 9-Half, and 9-Quarter size slides, a total of 90 correct responses were possible for each slide.

PRE-EXPOSED VS. NON-EXPOSED

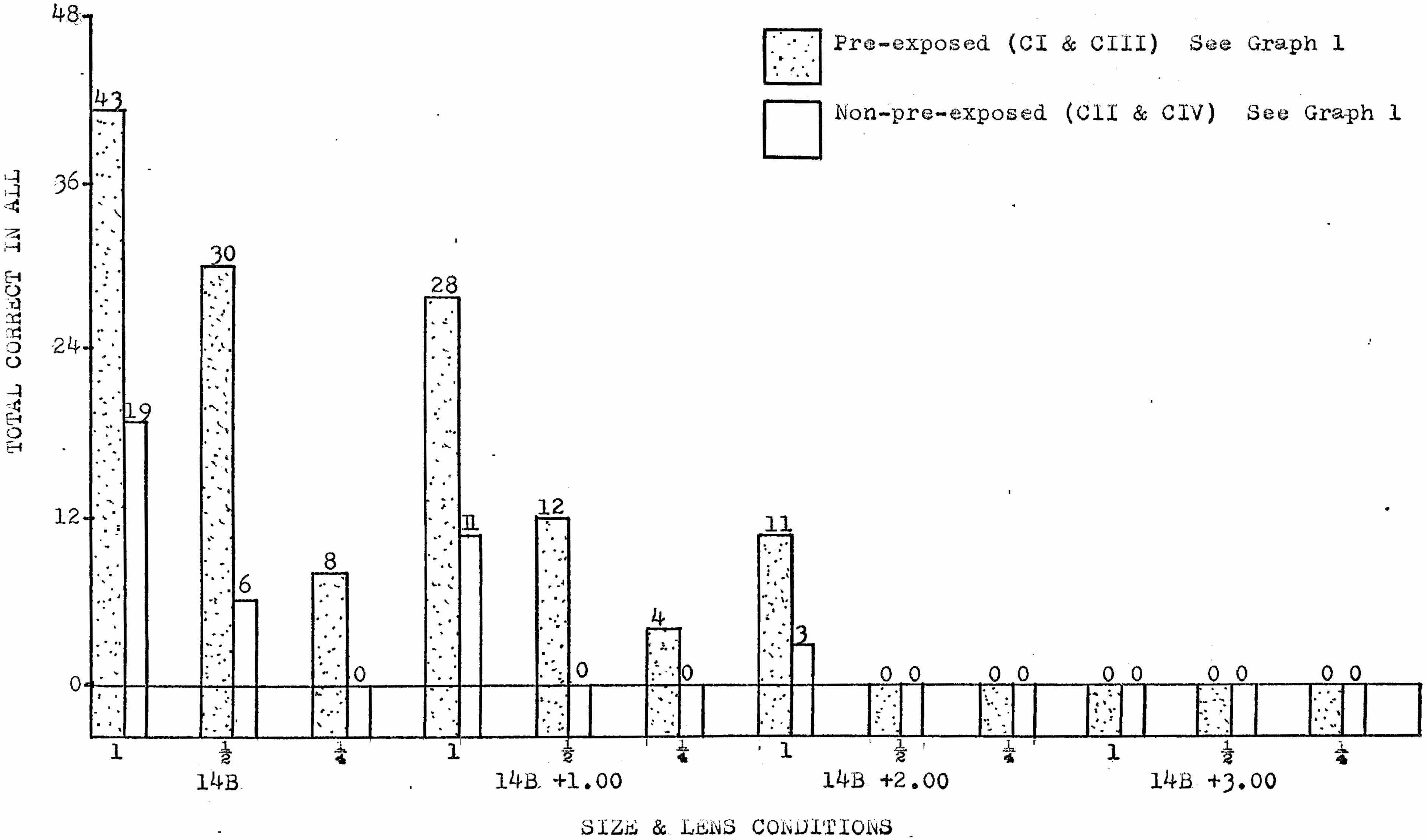
ACCORDING TO SIZE AND LENS CONDITION

Percent correct to both figure and patterned field out of 90 possible:

	#14B			#14B + 1.00			#14B + 2.00		
Group	Full	Half	Quarter	Full	Half	Quarter	Full	Half	Quarter
Pre	47.8%	33.3%	8.9%	31.1%	13.3%	4.4%	12.2%	0	0
Non	21.1%	6.7%	0.0%	12.2%	0.0%	0.0%	3.3%	0	0

GRAPH 2

TOTAL NUMBER CORRECT RESPONSES
PRE-EXPOSED VS. NON-PRE-EXPOSED
ACCORDING TO SIZE & LENS CONDITIONS



GRAPH NUMBER 3

This graph combines both pre-exposed subjects and non pre-exposed subjects. With 20 subjects[1] each viewing 27 slides, 540 responses were recorded for each lens condition. Responses were categorized as stated.[2]

1. Only 7 subjects viewed the slides in lens condition #14B + 3.00. With 7 subjects each viewing 27 slides a possible 189 responses were recorded.

2. Both = Central figure and pattern field seen.

   $\frac{1}{2}$ = Central figure or pattern field seen.

   0 = Neither central figure nor pattern field nor incorrect response reported.

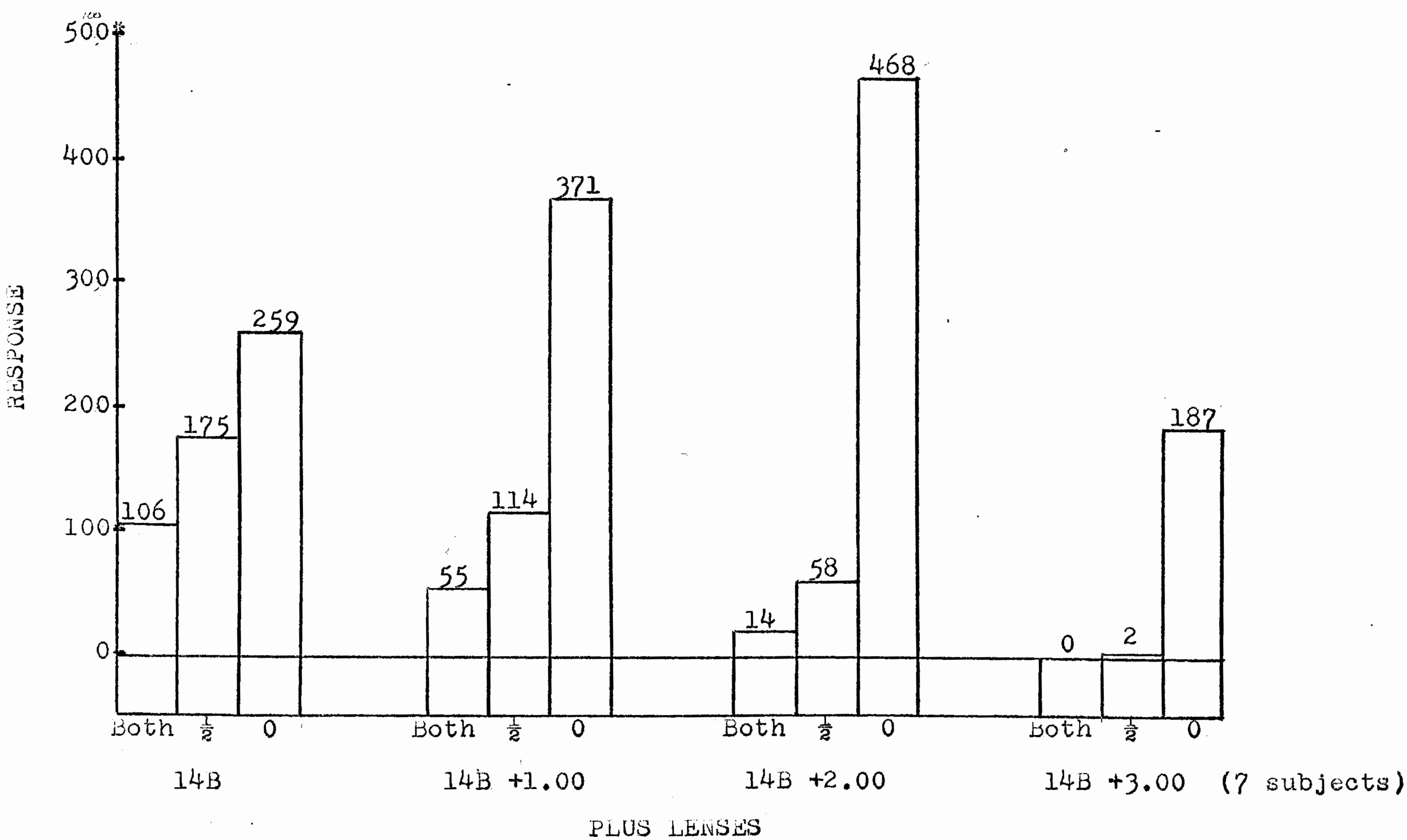
   All sizes were considered.

RESPONSE VS. PLUS LENSES

Percent response to Both, Figure or patterned field, or Light out of 540 possible: (Note: In #14B + 3.00 there were only 189 possible)

Response	#14B	#14B + 1.00	#14B + 2.00	#14B + 3.00
Both	19.3%	10.2%	2.6%	0.0%
Figure or Patterned Field	32.4%	21.1%	10.7%	1.1%
Light or Incorrect	47.96%	68.7%	86.7%	98.9%

GRAPH 3 RESPONSE VS. PLUS LENSES



GRAPH NUMBER 4

This graph represents a further breakdown of Graph number 3. Here we have separated the $\frac{1}{2}$ response of Graph number 3 to show more clearly the effect of plus lens to the response of central figure and pattern field.

FIGURE VS. PATTERNED FIELD

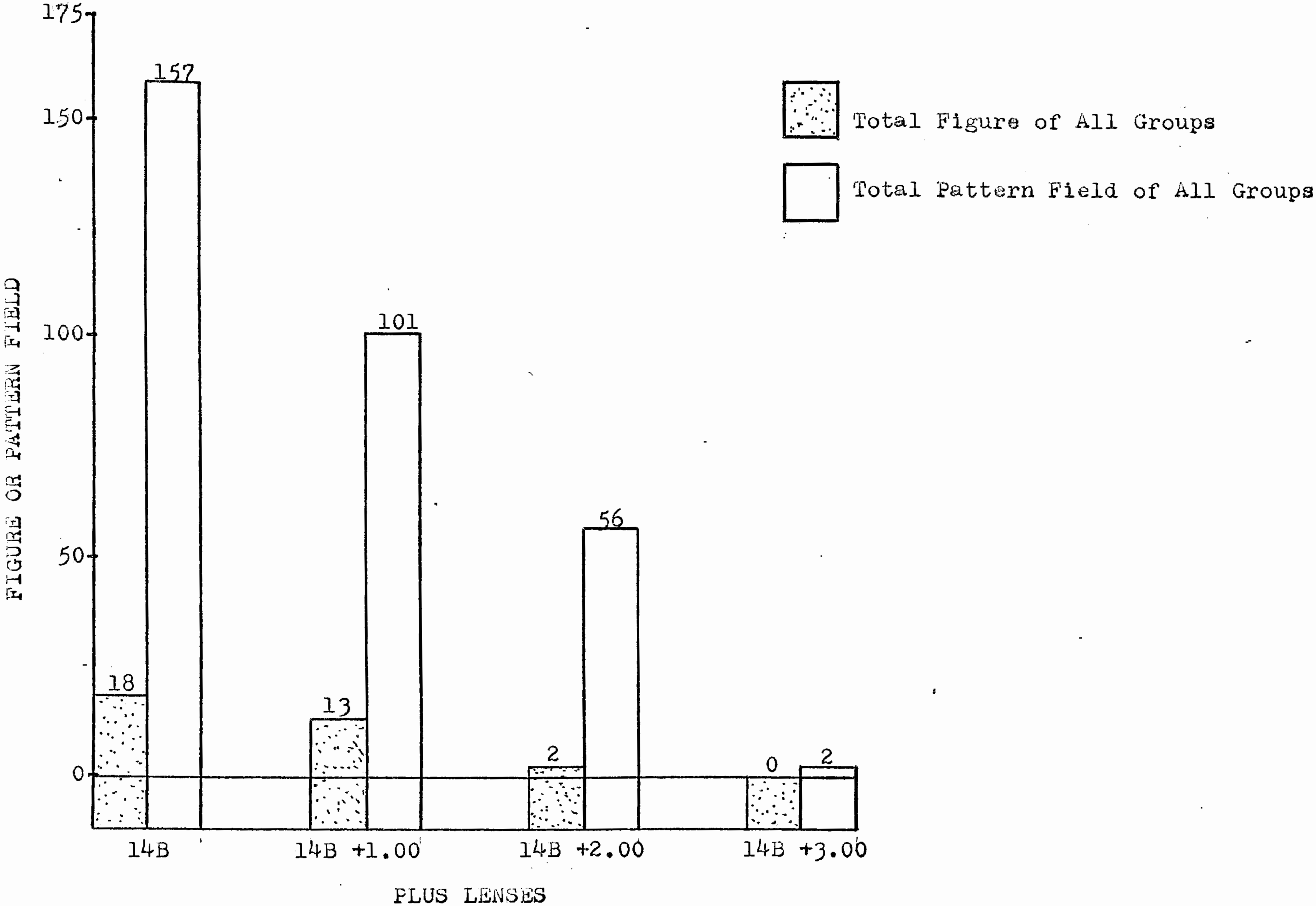
ACCORDING TO LENS CONDITION

Percent figure or patterned field based on total number responses to figure or patterned field in each lens condition:

Response	#14B	#14B + 1.00	#14B + 2.00	#14B + 3.00
Percent Figure	10.3%	11.4%	3.4%	0.0%
Percent Patterned Field	89.7%	88.6%	96.6%	100.0%
Total No. Responses	175	114	58	2

GRAPH 4

FIGURE VS. PATTERN FIELD
(ACCORDING TO LENS)

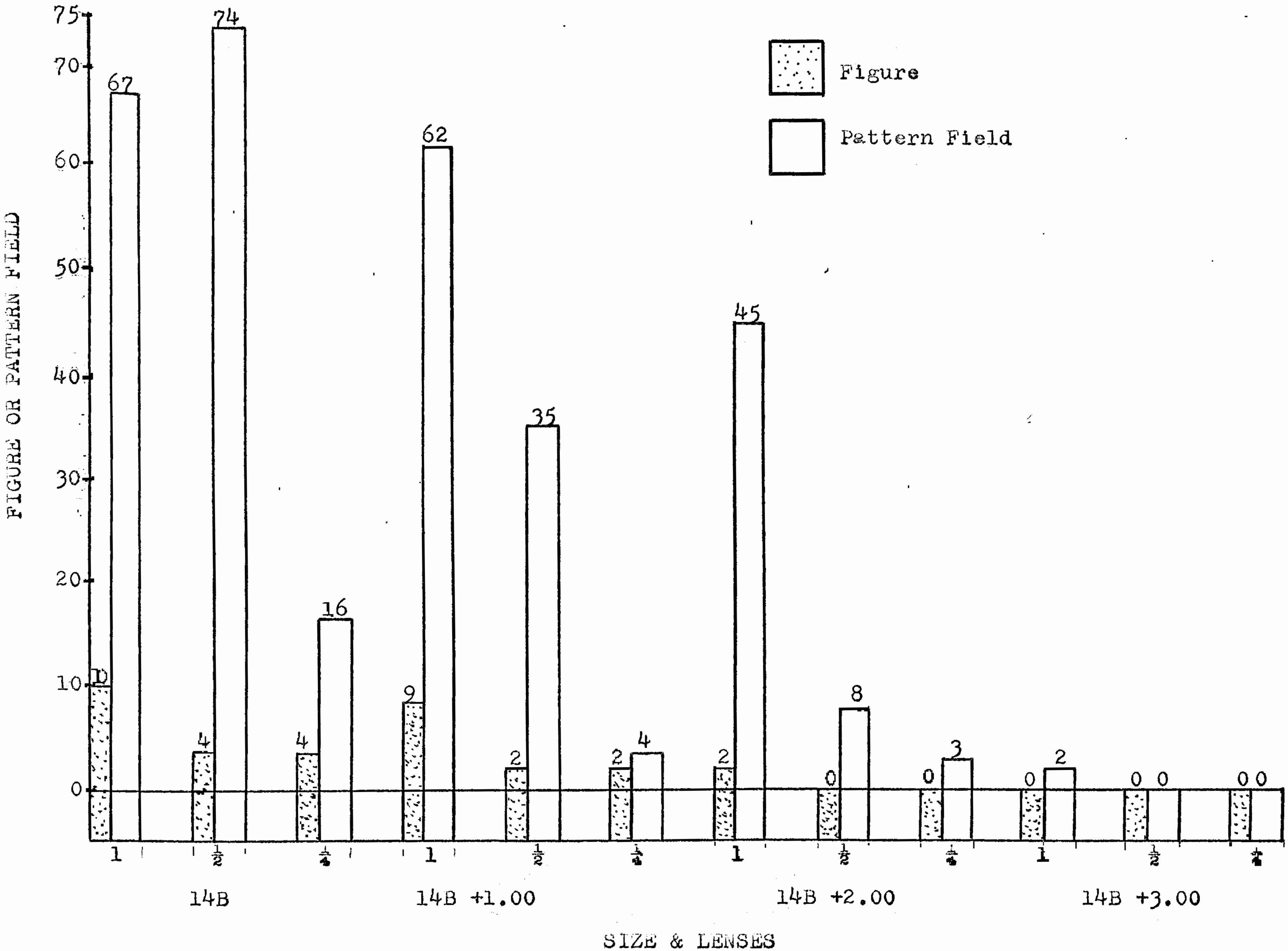


GRAPH NUMBER 5

This graph is a further breakdown of graph number 4. Here we see which size appears to play the dominant role in the response of figure or patterned field.

GRAPH 5

FIGURE VS. PATTERN FIELD
(ACCORDING TO SIZE AND LENS)



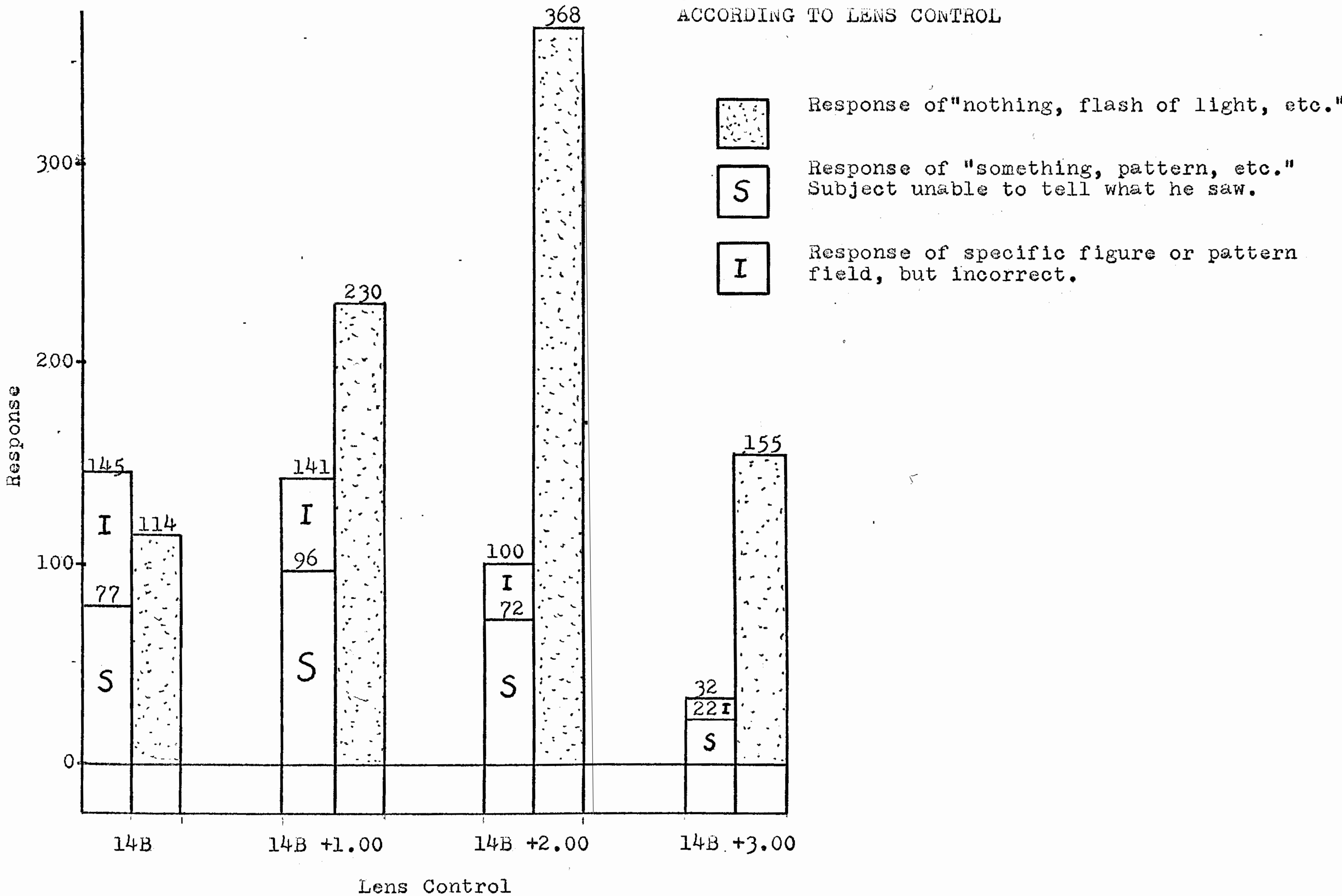
GRAPH NUMBER 6

This graph represents a further breakdown of Graph number 3 Here we have tried to show the effect of plus lenses on the detection level. By detection level we mean the level at which a person may distinguish between a vague something and nothing or light.

Included in this graph are those responses which were neither correct as to figure or ground.

GRAPH 6

RESPONSE OF SOMETHING VS. NOTHING ACCORDING TO LENS CONTROL



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