PERFORMANCE AND PSYCHOLOGICAL TESTING OF BIFOCALS AND PROGRESSIVE LENSES

by

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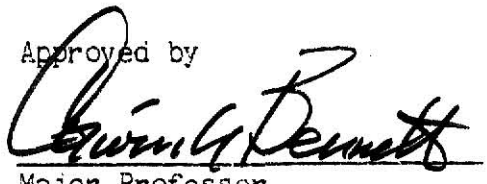

Major Professor

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INTRODUCTION

Bifocals and Their Problems

As people grow older important body tissues and organs start to shrivel and shrink. The muscles wither and lose their resiliency. However, there is an exception to this -- the crystalline lens of the eye. From the moment of birth to death it continues to grow and expand. It ages not by shrinking but by growing hard and inelastic. Early in life the crystalline lens is quite elastic and can change its curvature quickly, thus automatically adjusting the focus of the eye. With age there is a loss of accommodation; this problem is more acute after the age of forty (it may be earlier in warmer climates). Therefore in the early forties, usually, people begin wearing bifocals with a special high power (reading) lens area for close distance seeing, set into the area for medium and far distance seeing.

Many bifocal wearers complain about problems due to the discrete change between the two sections of the bifocals. Sometimes it is difficult for the wearer to accustom himself to moving from one segment to the other of different strength. The size and shape of objects appears somewhat changed and the "jump" in between is confusing. The sidewalk seems to come up to meet him, and walking down stairs is a hazard at first.

Progressive Lenses and Their Advantages

To take care of the discrete change several companies have developed "progressive lenses". A progressive lens is one in which the reading portion of the lens gradually changes to the far distance seeing area. A true progressive addition lens has not only distance and near power, but

also an infinity of powers for varying intermediate distances.

Conventional progresssive lenses were launched in 1973. They were not a panacea for all bifocal problems, and neither are the second generation progressive lenses. The disadvantage of the conventional progressive lens is that good peripheral vision through the lower part of the lens is posible only in the vicinity of the central area. On the other hand, Varilux 2 (a brand name of Multi-Optics Corporation) which belongs to the second generation of progressive lenses provides the same advantages as conventional lenses; comfortable vision at all distances along the vertical meridian. Figures 1 and 2 are from the sales literature of Varilux 2 and show the regularity of power. In Figure 1 there are aberrations in the lateral areas unlike the Varilux 2 shown in Figure 2 which has no aberrations.

Figures 3, 4, and 5 show the horizontal and vertical lines of bifocals, conventional progressive lenses and Varilux 2 respectively. In the bifocal lenses the vertical meridian is not distorted but there is a sudden change of power below the dividing line. Horizontal lines are broken below the dividing line. The result is that peripheral vision through the lower part of the lens is seriously disturbed.

In conventional progressive lenses (Figure 4) the vertical meridian is not distorted. The other vertical lines are more distorted with their distance from this meridian. The horizontal lines are more distorted with their distance from the middle of the lens. The result is that good peripheral vision through the lower portion of the lens is possible only in the vicinity of the central area.

In Varilux 2 (Figure 5) the vertical meridian is not distorted. The other vertical lines are little distorted in the central part of the lens and less distorted at increasing distances from this meridian. The hoizontal lines are very little distorted. All this leads to good peripheral vision all over the lens.

Criteria for comparison.

It was desired to carry out a research program to compare bifocals and Varilux 2 lenses.

There are three types of effects which might take place as a basis for comparison of the types of lenses (as well as any other treatment of people): subjective effects, which the person might directly feel; task performance effects which could be measured directly; stress effects which might be manifested in various ways.

Subjective measures. At least two indicators of one's feelings could be shown by scales and questionnaires and treatment choices. With scales and questionnaires the subject would make a response(s) to the effect that he felt a certain way, such as happy, aggressive, etc. This then might reflect on the lens or other treatment. With the treatment choice, he might directly select one lens or the other.

Subjective measures have the merit of simplicity but are dubious because these measures are vulnerable to influences by irrelevant factors like the subject's own appearance. Furthermore, reactivity of the subject may confound the results. The subject may be inclined to base his response on pleasing or displeasing the researcher.

From the above it is obvious that it is important to be aware of the limitations of subjective measures, and a certain amount of discretion

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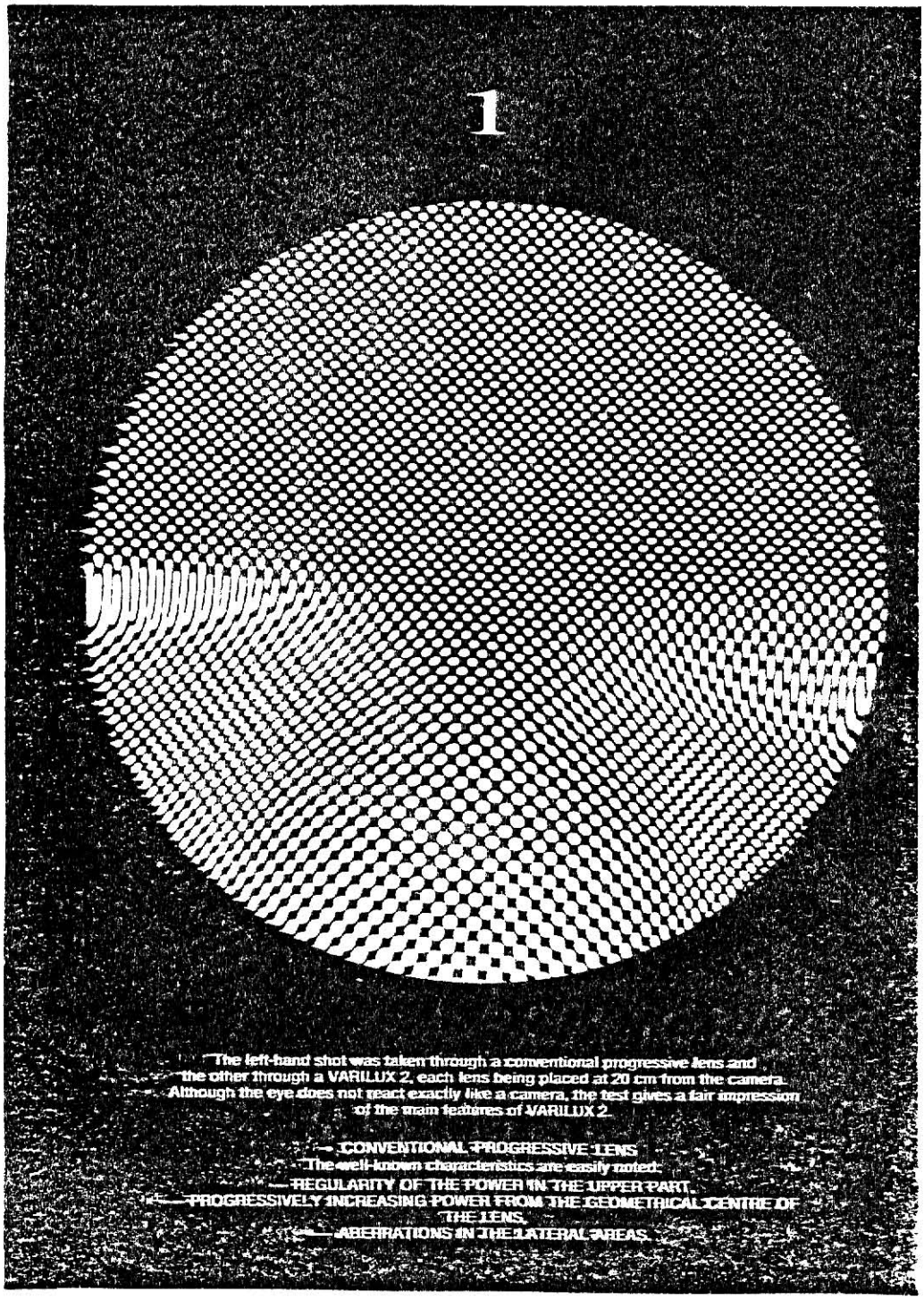

Figure 1: Conventional progressive lenses

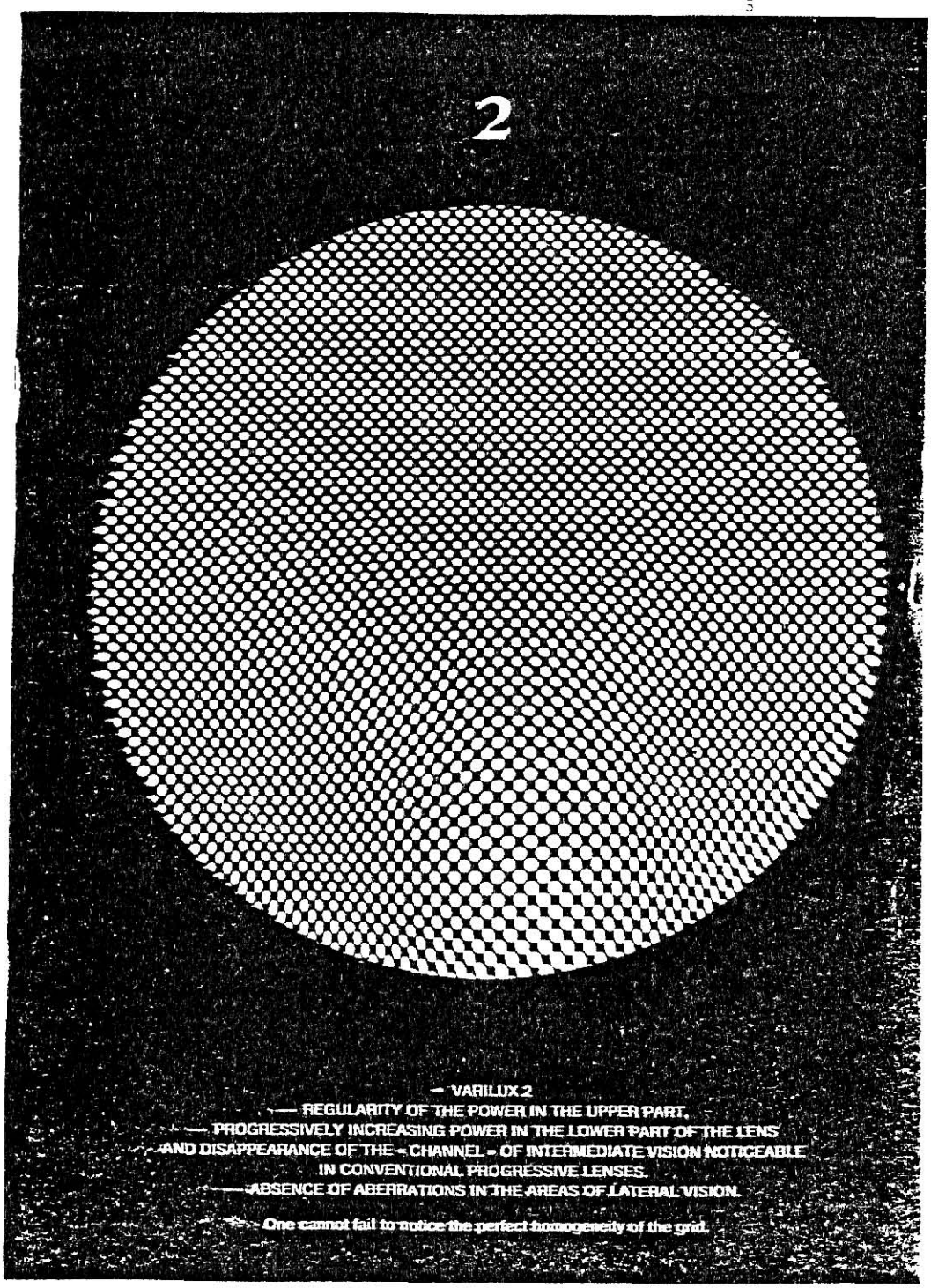

Figure 2: Varilux-2

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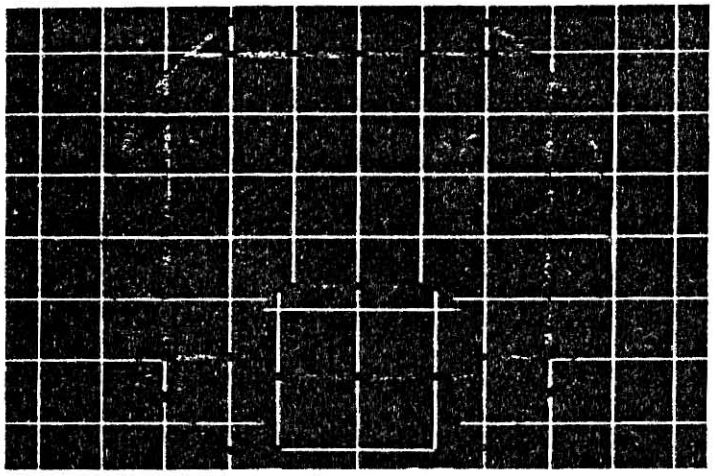
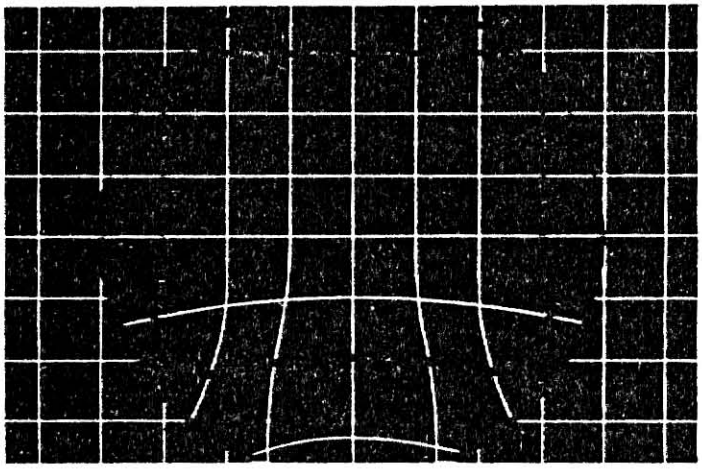
VISION OF STATIONARY OBJECTS



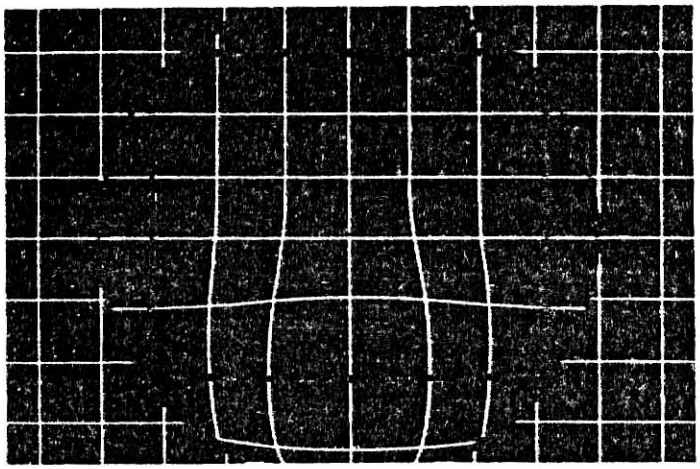
Bifocal lenses

Figure 3



Conventional progressive lenses

Figure 4



VARILUX 2

Figure 5

should be used with these. All this leads to the conclusion that the results obtained from subjective measures should be validated by other measures, instead of using them as the sole criterion.

Performance measures. Performance measures directly compare the lens types. They have the advantage that if subjects are motivated to do well, then performance advantages can be accepted as believable, and of importance if people perform important tasks.

Performance measure that take into account some degree of visual functioning would, of course, have special interest in the comparison of lens types. However, the performance of non visual tasks can play a role in evaluation as noted below.

Stress and stress measures. If one lens results in poorer visual functioning than another then over the course of time it might produce more stress for the wearer. However, because everyone is exposed to so many stress-producing and stress-reducing influences in living, some of them major, it would generally be difficult to observe this one effect.

It would be easiest to demonstrate the superiority of one lens over the other under conditions where people are more "marginal" (have less "spare capacity" to get along). Under severe stress there would be obvious and direct indicators of difficulty. But research ethics precludes exposing research subjects to severe stress and restricts one to mild stress.

If mild, temporary stress could be produced experimentally in association with the wearing of one or another of two types of lens, that stress added to whatever lens produced stress there is should add together and show up on measures of stress. If one lens was worse than the other

this should show up.

Stress could be induced in the laboratory by task difficulty, noise, crowding, etc. In this study task difficulty was used to induce stress. These tasks were also those that were used as performance measures. Hence performance measures provided direct comparison of the lenses and were also used to induce stress.

The subjects were asked to perform these tasks at a pace of "15" on the Borg's RPE (Relative Perceived Exertion) scale shown in Figure 6. The numerical value of 15 corresponds to "hard" on this scale. It was assumed that at a task difficulty level of "hard" mild stress would be induced. The RPE scale was developed for physical tasks but was used here for convenience.

Two types of stress measures are used - physiological and psychological - as discussed below. Further, any measures of performance (as discussed above) might also display the effects of combined stress.

Physiological measures. These have the greatest credibility both because of the reductionist bias of many which favors biological over psychological explanations and because of the feeling that it would be less easy for the subject to influence these than to alter his behavior (as in the polygraph or lie detector test).

Some of the physiological measures used are circulatory measures, elecrodermal measures, respiratory measures, muscle activity, ocular activity, and voice quality. Some of the circulatory measures are blood pressure, finger pulse amplitude, heart rate, and oxygen saturation of blood. Some of the electrodermal measures are: skin conductance and

resistance, and skin potential and recovery of skin. The respiratory measures are: respiration amplitude, respiration cycle time, and inspiration expiration ratio. Some ocular measures used are eye blink, eye movement, and pupillary change.

However, physiological measures were not used in this study.

Psychological measures. Considerable literature has grown up using various psychological measures obtained after stress as indicative of the degree of stress (Cohen, 1980). Here the "adaptive cost hypothesis" applies. The hypothesis suggests that humans may adapt to stressful conditions but eventually one's adaptive reserves are drained and this is manifested as poor performance in subsequent tasks. According to Dubos, "Although man is highly adaptable and can therefore achieve adjustments to extremely undesirable conditions, such adjustments have indirect effects that are deleterious". Others (Basowitz, Persky, Korchin and Grinkler, 1955, Milgram, 1970) have expressed similar opinions. It has been suggested that there will be "costs" even if the adaption to the principal task is incomplete or unsuccessful.

Review of psychological stress. The early work done on the after effects of stress concentrated on stressor effects of physical health and psychological health.

Awareness and exploration of the area of post stressor effect is not recent; it can be traced back to as early as 1955. However, it was only recently that studies on post stressor effects on behavior have been reported (Glass, and Singer, 1972). Since the publication of their book there have been over 30 published studies on post stimulation effects of stressors on performance and social behavior.

Glass and Singer (1972) reported five studies that examined post stimulation effects after exposure to unpredictable, uncontrolled noise (pp. 47, 50, 52, 55, 80). The subjects were exposed for 25 minutes to 108-110 db(A) random-intermittent bursts of a broadband conglomerate noise made up of a number of fairly typical urban sounds. During noise exposure the subject worked on simple cognitive tasks. Immediately after the noise exposure period one or more of three measures were administered to the subject: the Feather (1961) tolerance for frustation task (studies reported in Glass and Singer, 1972, p. 80).

The Feather measure requires a subject to work on two soluble and two insoluble geometric puzzles.

The subject can only work on one puzzle at a time and can't return to a puzzle after moving on to the next. The puzzles are presented so that the first and third are soluble and second and fourth are insoluble. Stress shows up as failures to persist.

The Proof reading task involves correcting misspellings, grammatical mistakes, incorrect punctuation, transpositions and typographical errors. There is a time limit (although nothing is said about the time) and the score on this test is the percentage of errors not found of the total number of errors. Stress shows up as performance deficit.

The Stroop color task is based on the Stroop phenomenon which occurs when words are printed in incongrous colors, e.g., the word blue printed in red. Confusion between the "color of the print" and the "word itself" increases with stress. Stress shows up as poor performance on this task.

Post-stimulation deficits in performance occurred in all five studies

and on all three tasks. The effects were totally reliable except for a lack of effect on the proof reading task in one study (p.80).

Altruism has also been used as an indicator of stress. Altruism has been defined as behavior which is voluntary, beneficial to others and undertaken with no personal gain. In an experiment designed to measure the effect of stimulus overload on altruism, 60 female subjects were randomly assigned three stimulus conditions of 20 subjects each: (1) overload, (2) overload with perceived control, and (3) no overload. Subjects performed simultaneous proof reading and number attention tasks while at the same time listening to distracting or non-distracting background sound, and one group believed they could have the sound turned off if they desired. Following a task performance all subjects were requested for a favor from a confederate. Results show that altruism increased significantly across the three conditions. Thus mild stress produced deficits in altruism.

Pilot Study

A pilot study was done for this study. The title of the pilot study was "To govern stress and hence post stress by pacing". The objective of the pilot study was to verify if post stress could be governed by manipulating a subject on the RPE scale. One of the other objectives of the pilot study was to check the sensitivity of the RPE Scale as a means of pacing or adjusting a subject's task difficulty was tried out.

Subjects were divided into two independent groups. One group did the performance tasks at an RPE level of "12" while the other group did them at "14". Subsequent to the performance tasks the subjects were asked to

do the post stress tasks. The performance and the post stress tasks used in the pilot study were the same as the ones used in this study. The hypothesis was that more stress would be induced at "14" than at "12". The results showed a difference in one of the post stress tasks. The Feather task indicated the tolerance for frustration in a subject. It was found that subjects were more persistent at "12" than at "14".

After the pilot study it was felt that running subjects at "14" was not inducing adequate stress. Hence in the main study the subjects were asked to perform at "15".

Summary.

As suggested above the degree of stress induced could be found by performance measures or by psychogical measures. In this study both performance measures and psychological measures were used.

If progressive lenses produced less stress than bifocals this should show up in the post stress and thus demonstrate their superiority.

PROBLEM

The purpose of this study was to compare bifocals and Varilux 2 progressive lenses. In order to credibly assess the lenses three types of measures were used. They were: subjective measures, performance measures, and psychological stress measures.

The first hypothesis was that the proportion of bifocal and progressive lens wearers before the study will be the same as that at the end of the study.

The second hypothesis was that performance on tasks which require visual functioning is better with Varilux 2 than bifocals.

The third hypothesis was that Varilux 2 reduces the degree of stress in the wearer more than bifocals.

METHOD

Procedure

Overview. Forty subjects selected a single frame to be used for the two types of lenses and at random (half each) wore Varilux 2 or bifocals initially for one month, were tested, and then wore the other lens and were tested again. Prior to wearing either lens the subjects had a session where they were asked to do just the performance tasks. In the second and third sessions both performance tasks and stress tests were performed.

Performance testing. At the beginning of the research and at the end of each month of lens usage, each participant was given a battery of "performance tasks". The tasks were: (1) Visual pegboard assembly, (2) Blindfolded pegboard assembly, (3) Penny Inspection Task, (all on a conveyor belt), and (4) VDU task.

Mild stress was induced by task difficulty. This was based on the Borg Relation Perceived Exertion (RPE) scale. The RPE scale is designed for use with physical tasks such as lifting. In those cases, multiplying the numeric scale value by ten gives the heart rate of the worker. While this is not true for non physical tasks as used here, the RPE scale (Figure 6) is a convenient device.

The difficulty of each task was varied by varying the speed of the conveyor in the first three tasks and by varying the time of display in the VDU task.

In the first session the conveyor speed was adjusted upward from a slow rate until the subject reported on the Borg RPE scale that this task was at this pace "hard". A particular task had to be usually repeated

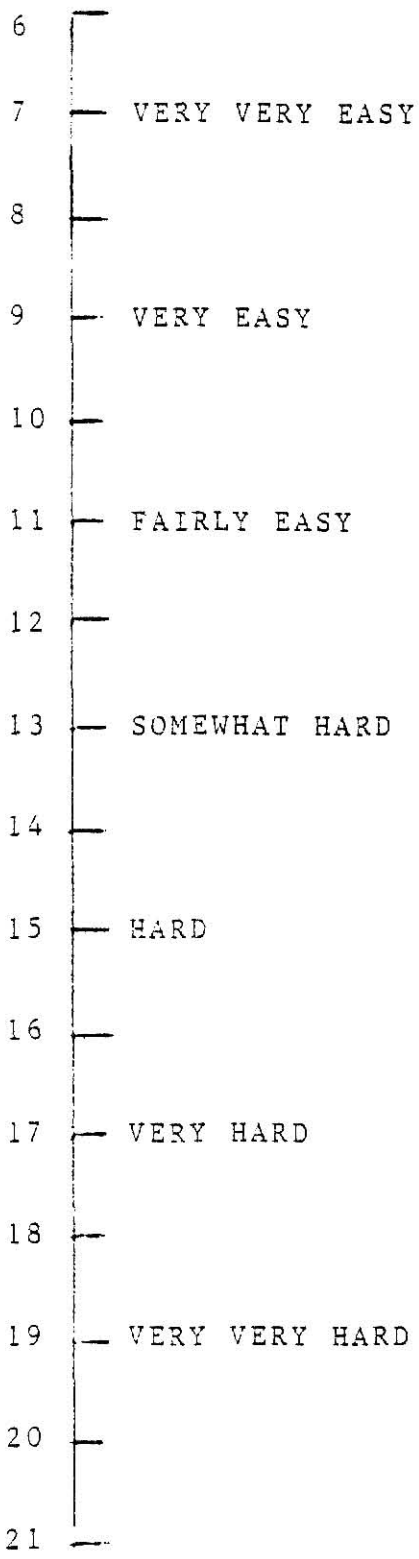


Figure 6: BORG'S PERCEIVED EXERTION SCALE

several times before the subject said that the level of difficulty was "hard". "Hard" on the RPE scale corresponds to a numeric value of 15. The speed of the conveyor was recorded when the subject said "hard"; in the VDU task the time of display was recorded.

For example if a subject said "15" at a conveyor speed of 20 ft/min in the first session, he performed the same task in the second and third session at 20 ft/min. After performing the task he was asked for a new RPE rating. Theoretically the new pace would be a 15 but at times it was different.

Stress testings. In the second and third sessions after the performance tasks (which were intended to induce mild stress), post stress tasks were given. The degree of stress induced was found by the following post stress tasks:

(1) Feather frustration for tolerance test

(2) Stroop color test

(3) Proof reading test

At the beginning of the second and third session a "Short Form of the Mood ACL" (Figure 7) was given. This was done to find if there was any effect on the expressed mood of a person due to wearing a particular type of lens.

Each of the words on this form described feelings or mood. The subject was asked to go through the list rapidly and indicate how that word applied to him. For example, was he very relaxed or slightly relaxed or unsure or definitely not relaxed.

This list took into account 11 factors or types of feelings. They were:

(1) Agression	(4) Elation	(7) Social Affection	(10) Egotism
(2) Anxiety	(5) Concentration	(8) Sadness	(11) Vigor
(3) Surgency	(6) Fatigue	(9) Skepticism	

A Short Form of the Mood ACL

Each of the following words describes feelings or mood. Please use the list to describe your feelings at the moment you read each word. If the word definitely describes how you feel at the moment you read it, circle the double check (vv) to the right of the word. For example if the word is relaxed and you are definitely feeling relaxed at the moment, circle the vv as follows:

relaxed (vv) v ? no. (This means you definitely feel relaxed at the moment.)

If the word only slightly applied to your feeling at the moment, circle the single check v as follows:

relaxed vv (v) ? no. (This means you slightly feel relaxed at the moment.)

If the word is not clear to you or you cannot decide whether or not it applies to your feelings at the moment, circle the question mark as follows:

relaxed vv v (?) no. (This means you cannot decide whether you are relaxed or not.)

If you definitely decide the word does not apply to your feeling at the moment, circle the no as follows:

relaxed vv v ? (no). (This means you are definitely not relaxed at the moment.)

Work rapidly. Your first reaction is best. Work down the first column, then go to the next. Please mark all words. This should take only a few minutes. Please begin.

angry	vv	v	?	no	kindly	vv	v	?	no
clutched	vv	v	?	no	sad	vv	v	?	no
carefree	vv	v	?	no	skeptical	vv	v	?	no
elated	vv	v	?	no	egotistic	vv	v	?	no
concentrating	vv	v	?	no	energetic	vv	v	?	no
drowsy	vv	v	?	no	rebellious	vv	v	?	no
affectionate	vv	v	?	no	jittery	vv	v	?	no
regretful	vv	v	?	no	witty	vv	v	?	no
dubious	vv	v	?	no	pleased	vv	v	?	no
boastful	vv	v	?	no	intent	vv	v	?	no
active	vv	v	?	no	tired	vv	v	?	no
defiant	vv	v	?	no	warmhearted	vv	v	?	no

Figure 7. A Short Form of the Mood ACL.

fearful	vv	v	?	no	sorry	vv	v	?	no
playful	vv	v	?	no	supicious	vv	v	?	no
overjoyed	vv	v	?	no	self-centered	vv	v	?	no
engaged in thought	vv	v	?	no	vigorous	vv	v	?	no
sluggish	vv	v	?	no					

Figure 7 (continued). A Short Form of the Mood ACL.

Each factor appeared on the list thrice. For example, aggression appeared as (a) angry, (b) active, (c) rebellious. The factors were listed in a cyclic order. That is words 1, 13, and 23 corresponded to factor 1. Words 2 (clutched), 14 (fearful), and 24 (jittery) corresponded to factor 2 (Anxiety) and so on.

Four, three, two, or one points were assigned to vv, v, ? and no respectively. Each factor score was determined by combining scores across the three words constituting each factor.

General Instructions. As soon as a subject came in he was given the general instructions. The instructions are shown in Figure 8.

Visual pegboard assembly. The experimenter kept placing pegs on the conveyor at one end and the subject picked them up at the other end, and placed them in the holes of the pegboard. The relative positions of the subject, experimenter, conveyor and pegboard are shown in Figure 9. A photograph of the set-up is shown in Figure 10.

The conveyor was driven by an AC motor and its speed was varied by a transformer. The experimenter recorded the voltage readings for different conveyor speeds. Later on the set-up was calibrated to find the conveyor speeds in ft/min corresponding to different voltages, and are given in Appendix 1.

The subject was asked to use one hand to pick up the pegs and to use the other to keep the pegboard steady. The task was done while standing and the subject could pick up pegs from only a marked off "picking up area" (Figure 9).

There were 30 holes in the pegboard and 30 pegs were provided to the subject. If the subject missed a peg, the peg would fall off the

GENERAL INSTRUCTIONS

The research you are participating in today is a project which evaulates bifocals and progressive lenses.

You will do some performance tasks and also some post-tasks. The performance tasks are the following:

1. Pegboard assembly
2. Pegboard assembly (blindfolded)
3. Visual Inspection
4. Visual display unit task.

The three post-tasks are:

1. Feather task
2. Stroop color task
3. Proof reading task

In this first session we will only be doing the performance tasks. I will adjust the speed of the equipment from time to time. If the speed is greater it will be more difficult to do the task. In fact at some speeds you may not be able to keep up. Work as fast as you can to keep up.

Each time I will ask you to judge how difficult the task was at that speed on the attached scale.

If you have any questions at any stage feel free to ask. You are free to leave the experiment at any stage, however, I would appreciate your participation until the end. Please participate until the end to get your lens money back.

Figure 8. General Instructions

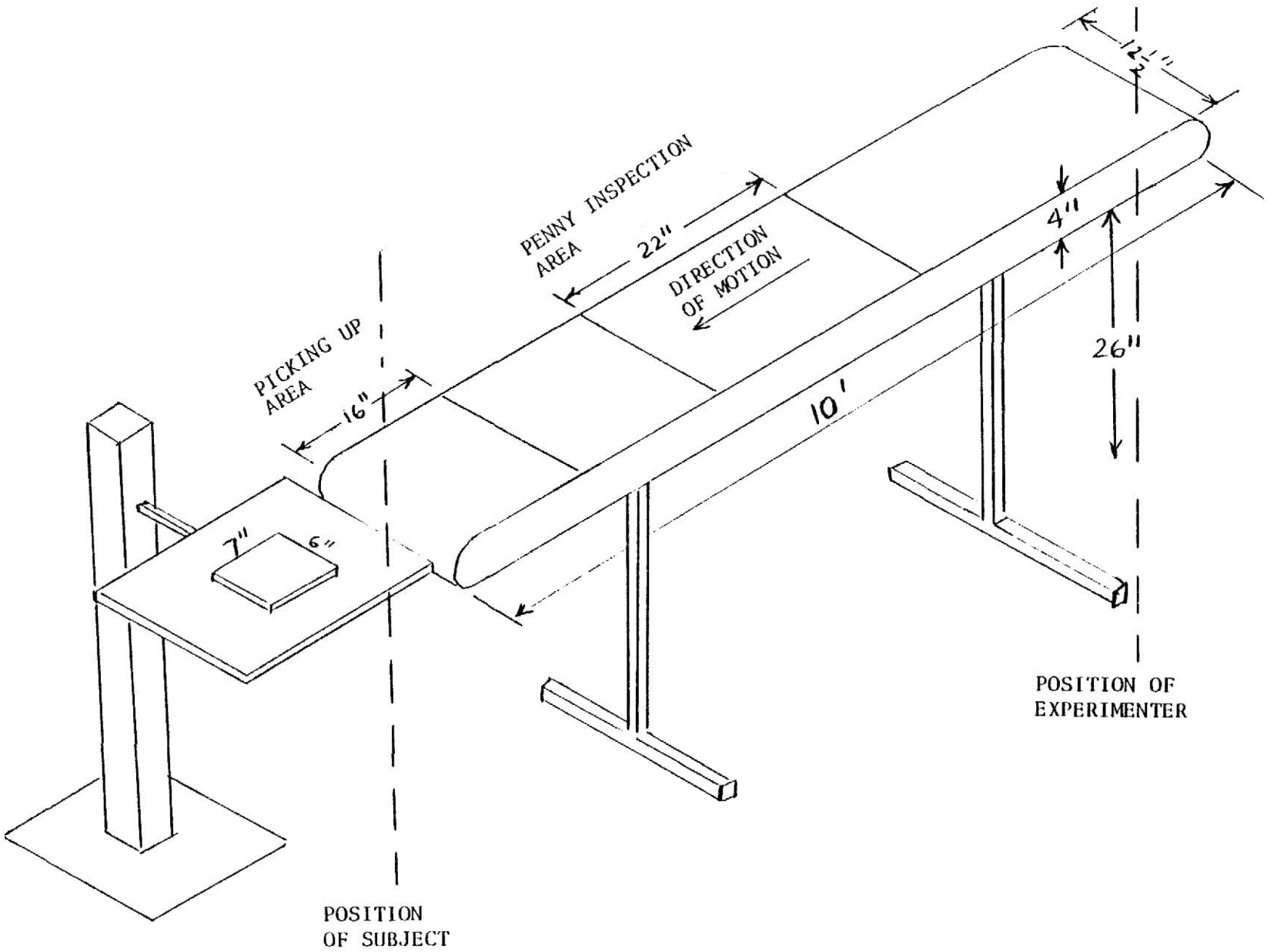


Figure 9. Experimental setup for pegboard tasks.

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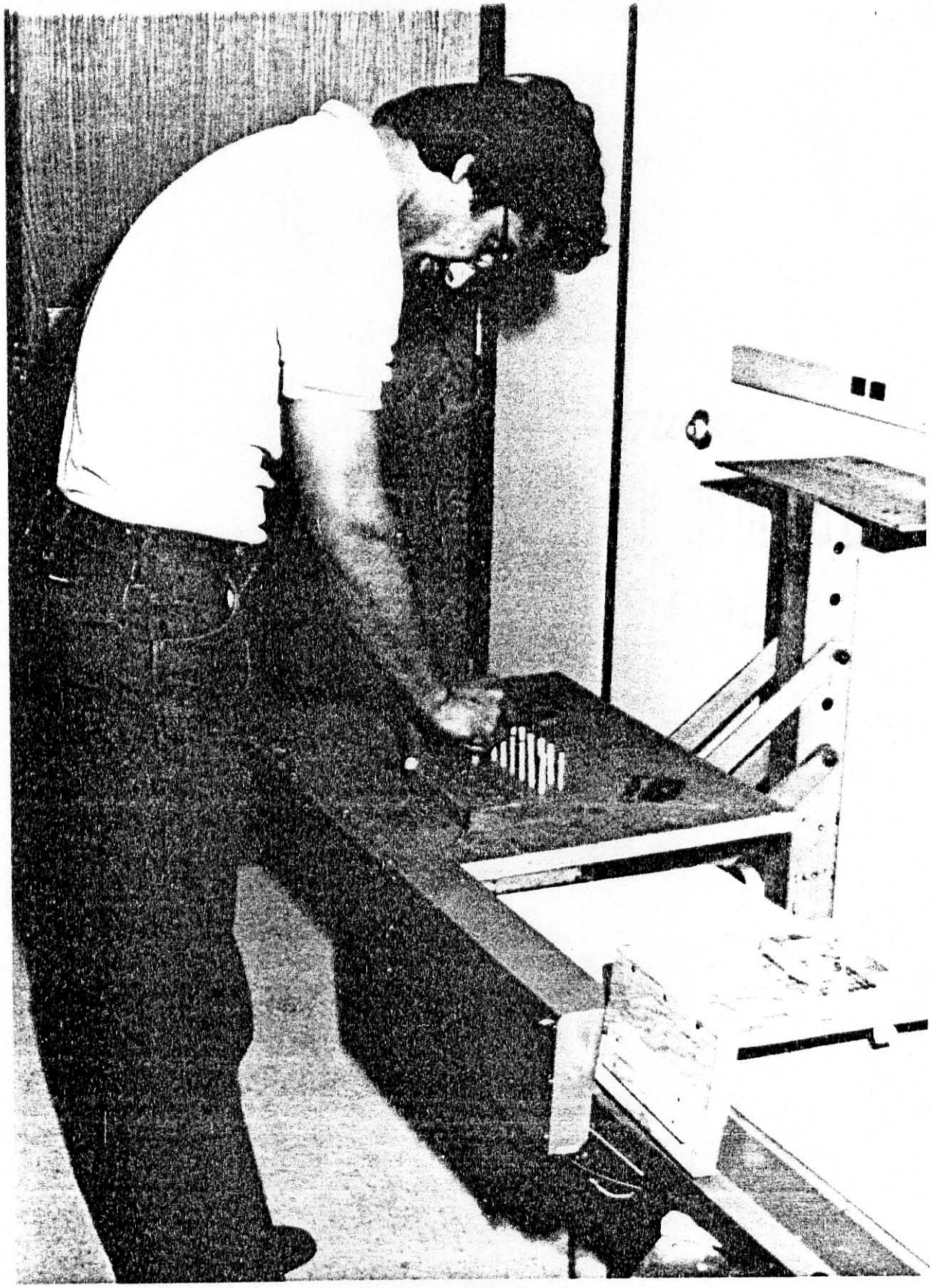


Figure 10: Set up for visual pegboard assembly.

conveyor. The score on the task was found by counting the number of empty holes in the pegboard and pegs placed upside down.

Instructions for this task are shown in Figure 11. Conveyor speeds corresponding to "hard" on this task ranged from 30 ft/min to 56 ft/min.

Blindfolded pegboard assembly. This task was like the previous one except that the subject was blindfolded.

The subject was asked to use one hand for picking up the pegs and could use the other for keeping the pegboard steady. He was told to locate the conveyor and the pegboard before he put on the blindfold. He was advised to proceed systematically in filling the holes. There were times when the subjects failed to do so and had trouble locating empty holes towards the end of the task.

The conveyor speeds for this task were slower than for the visual pegboard asssembly. "Hard" on this task ranged from 4 ft/min to 45 ft/min of conveyor speed.

The score on this task was the number of pegs missed and the number of pegs placed upside down. It ranged for 0 to 2 pegs.

Instructions for this task are given in Figure 12. Figure 13 shows a subject performing this task.

Penny inspection task. The task was to identify defective pennies. Forty pennies were stuck on a board (15" x 9") and there were 20 such boards. Some of these pennies had been marred at the edges by a chisel. Totally there were 60 defectives. Defectives on a board ranged from zero to six.

The boards were placed on a moving conveyor. As the boards came into

a defined area called the "penny inspection area" (Figure 9) the subject was asked to mark the defectives with the pen given to him. The subject was seated near the penny inspection area on an adjustable chair. Refer to Figure 14 for experimental set-up.

PEGBOARD ASSEMBLY (VISUAL)

This task is a pegboard assembly. The pegs will be provided to you on the conveyor. This task will be done at several speeds of the conveyor.

Please use only one hand for picking up the pegs and placing them in the holes. The other hand may only be used to keep the pegboard steady. Place the pegs in pointed end first. We expect you to do the task while standing. This is the area for picking up the pegs; do not pick up the pegs from anywhere else. Work systematically. First fill the hole in the far left-hand corner. Work across from left to right. Then fill the next row.

I will score your work by counting the number of empty holes or pegs placed upside down. There are no extra pegs so try to keep up with the conveyor.

Please rate the difficulty of the task at each speed of the conveyor on the scale given.

Figure 11. Instructions for visual pegboard assembly.

The pennies were covered by clear, acetate paper. Hence any marks were actually made on the acetate paper rather than directly on the pennies. Any board could be used again and again by just wiping off the marks.

After completion of the task the experimenter counted the check marks on the defective pennies.

The instructions to the subjects are shown in Figure 15.

The conveyor speeds on this task ranged from 18 ft/min to 45 ft/min. The percentage of pennies not identified ranged from 5.00 to 8.6 percent.

VDU task. This task was an inspection task on the VDU and was an attempt to simulate conditions in which computer terminals are used.

The subject was given a sheet with 15 diagrams on it. These diagrams were the "correct diagrams" (Figure 16). Corresponding to each diagram in Figure 16 there was a set of six diagrams on the screen. All the diagrams in a particular set were similar but not identical to a particular diagram in Figure 16. These sets of diagrams were displayed one at a time. As soon as a set was displayed the subject had to refer to Figure 16 and identify the incorrect diagram/diagrams. After identifying the diagram/diagrams the subject had to put check mark/marks on the answer sheet as explained in the instructions (Figure 17).

PEGBOARD ASSEMBLY (BLINDFOLDED)

This task is a pegboard assembly. You will be blindfolded while you do the task. The pegs will be provided to you on the conveyor. This task will be done at several speeds of the conveyor.

Please use only one hand for picking up the pegs and placing them in the holes. The other hand, may only be used to keep the pegboard steady. We expect you to do the task while standing. This is the area for picking up the pegs; do not pick up the pegs from anywhere else. Before putting on the blindfold locate the pegboard and the conveyor with your hands. Otherwise work as you did before on the task.

Figure 12. Instructions for blindfolded pegboard assembly

Figure 13: Subject performing blindfolded pegboard assembly.

Figure 14: Experimental set up for penny inspection.

PENNY INSPECTION

This is a visual task. You will be presented with a number of pennies on the conveor. You will do the task while sitting. Your task is to put a check mark on the defective pennies. You can put the check marks only when the pennies are in the "pennies inspection area".

Please use the pen given by the experimenter. The task will be repeated at different speeds of the conveyor. There may be a few defective pennies on each board. For this purpose consider only pennies whose edges are marred as defective. Ignore color or markings on the coins.

I will score your work by counting the number of defective pennies which you missed, so try to keep up and mark all the bad ones.

Please rate the difficulty of the task at each speed on the scale given.

Figure 15. Instructions for the penny inspection task.

The number of defectives in a set ranged from zero to six. Totally there were 23 defectives out of 90 diagrams in each session.

This task was done on a Tektronix 4054 microcomputer with a 19" display. The time of display was varied by a "call wait" subroutine from the Tektronix software. "Call wait, 10" meant that a set would be displayed for 10 seconds, disappear, the next set would be displayed for 10 seconds and disappear and so on until the fifteenth.

The correct diagrams used in sessions 1, 2, and 3 are given in Figure 16, 18, and 20 respectively. The instructions are given in Figure 16.

The subject was asked to hold the sheet with the correct diagrams in his hand and keep the answer sheet at his side and on the table as shown in Figure 21 (Photograph showing subject doing VDU task).

The time of display corresponding to "hard" on this task ranged from 5 to 20 seconds. The percentage of incorrect diagrams not identified ranged from 4.3 to 100 percent.

Post Stress Tasks

Feather task. This task consisted of four line diagrams printed on 5 x 6 inch cards arranged in four piles. This task was adapted from the one used by Feather (1961). Each pile contained only one kind of puzzle. The task was to trace over all the lines of a diagram without tracing any line twice and without lifting the marker from the figure. The subject was informed that he could take as many trials as he wanted at a given item. However, there was a time limit on a given trial and the experimenter would inform him when his time was up. He was also told that such a notification did not mean that he had to move to the next pile. This decision was entirely his. It simply meant that he must decide whether to

take another card from the same pile or move on to the next item.

If the subject wanted another trial he discarded his unsuccessful card and took another copy of the same diagram.

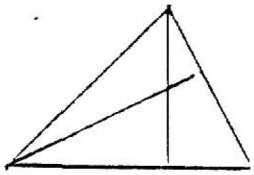


Fig. 1

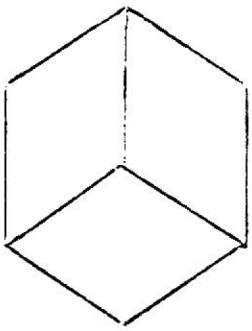


Fig. 2

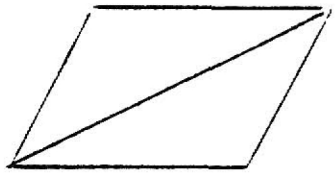


Fig. 3

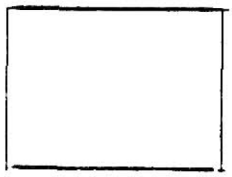


Fig. 4

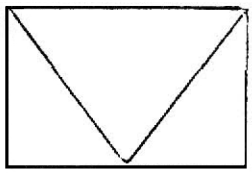


Fig. 5

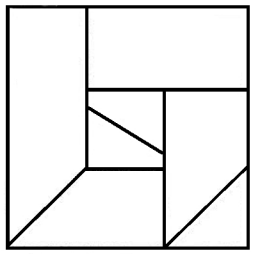


Fig. 6

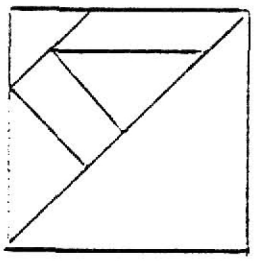


Fig. 7

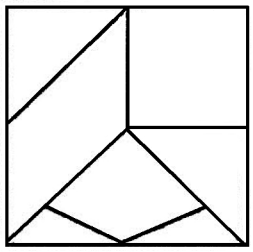


Fig. 8

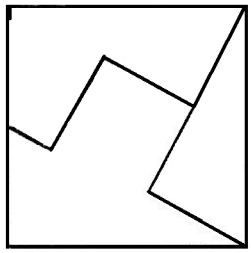


Fig. 9

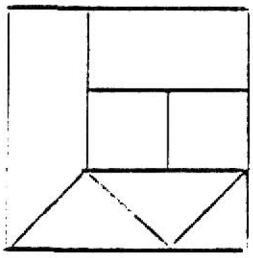


Fig. 10

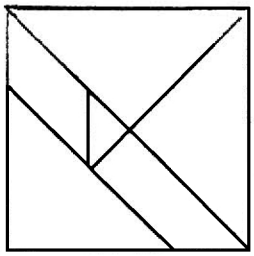


Fig. 11

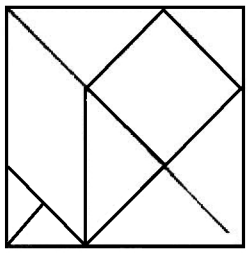


Fig. 12

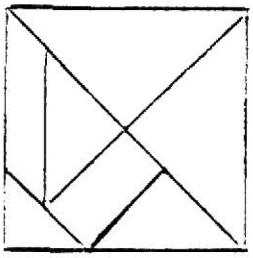


Fig. 13

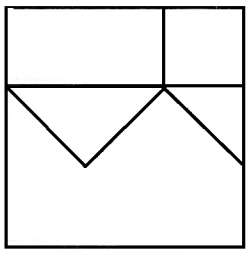


Fig. 14

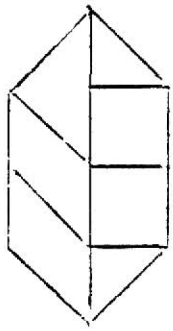


Fig. 15

Fig. 16

Diagrams used in the first session of the VDU task

VISUAL DISPLAY UNIT TASK

This is a visual display unit task. Basically this task is to identify diagrams that are not identical to the ones on page 2. The diagrams on page 2 are the "correct" diagrams. Corresponding to each diagram on page 2 there is a set of 6 diagrams. All the diagrams in a particular set are similar, but not identical to a particular diagram on page 2. For example, set 1 is similar to Fig. 1.

These sets of diagrams will be displayed to you one at a time. As soon as a set is displayed refer to page 2 and identify the "correct" diagram/diagrams. For set 1 refer to Fig. 1, for set 2 refer to Fig. 2 and so on.

The boxes on page 3 represent the relative positions of the diagrams in a set. If the top row extreme right diagram on the display is incorrect, put a check mark on the top row extreme right box.

I will adjust the time for which a set is displayed. The task will be repeated at several speeds. Please rate the difficulty of the task each time.

When you are ready to begin type 'RUN' and press 'RETURN'.

Figure 17. Instructions for the VDU task.

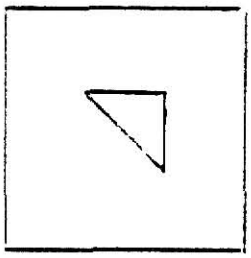


Fig. 1

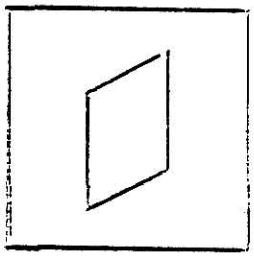


Fig. 2

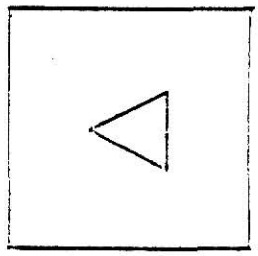


Fig. 3

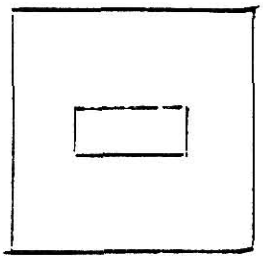


Fig. 4

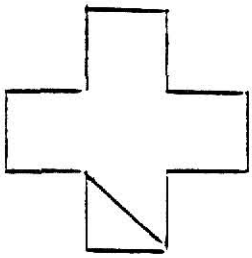


Fig. 5

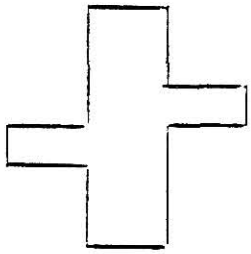


Fig. 6

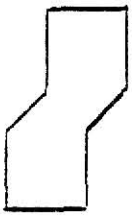


Fig. 7

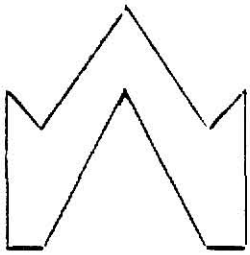


Fig. 8

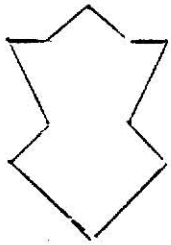


Fig. 9

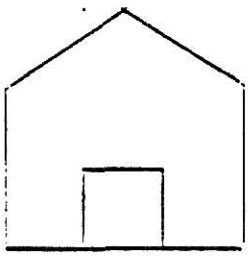


Fig. 10

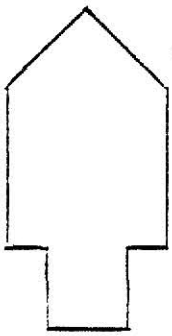


Fig. 11

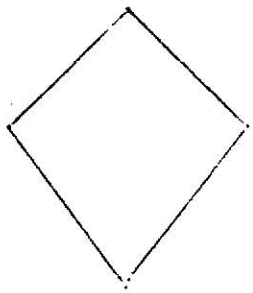


Fig. 12

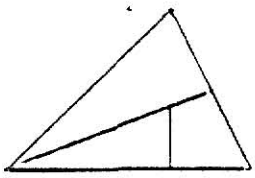


Fig. 13

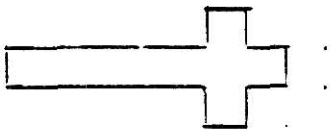


Fig. 14

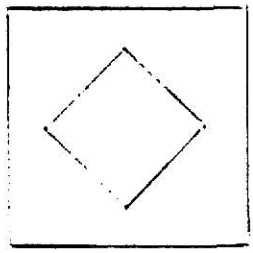


Fig. 15

Figure 18

Diagrams used in the second session of the VDU task

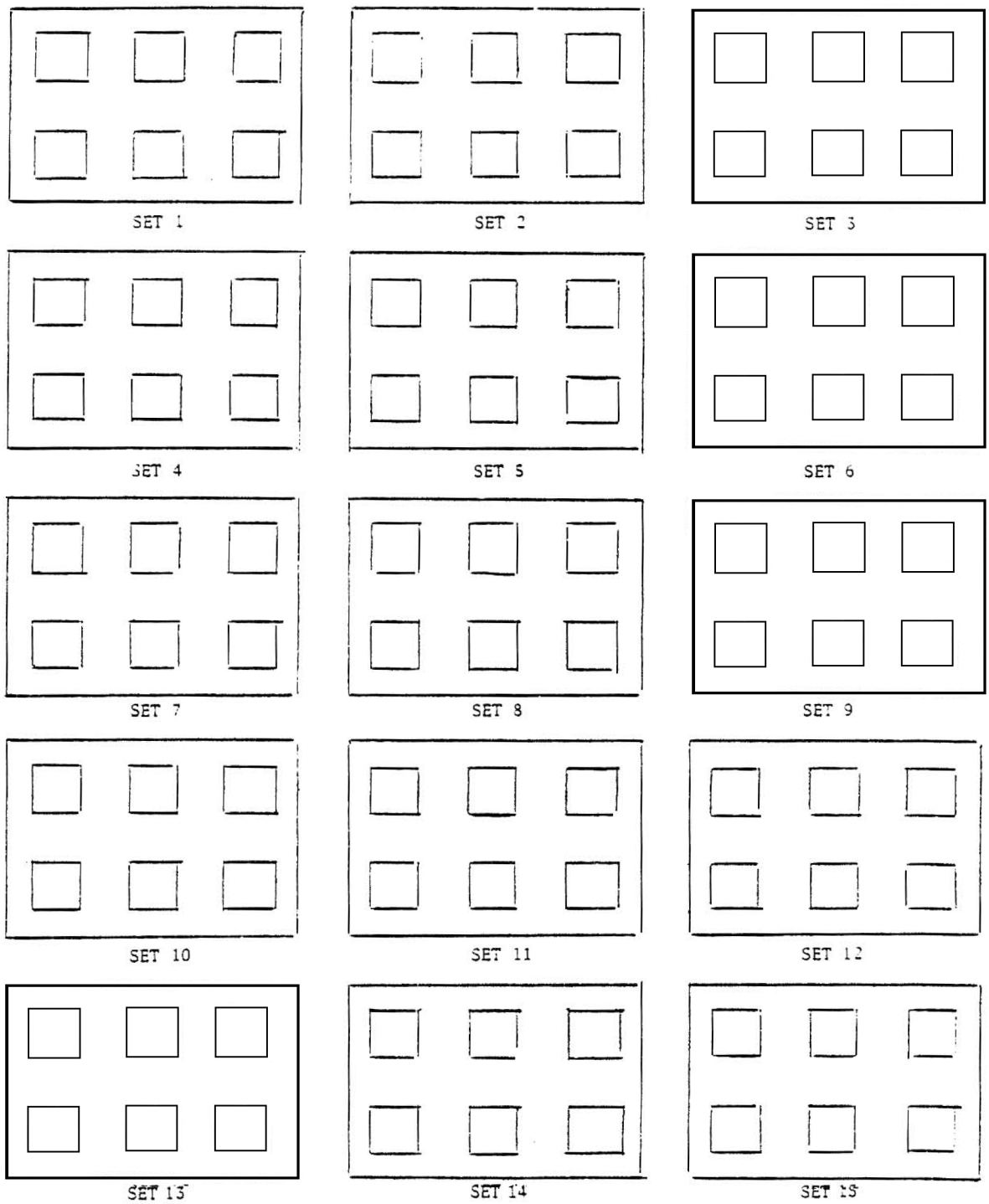


Figure 19: Answer Sheet

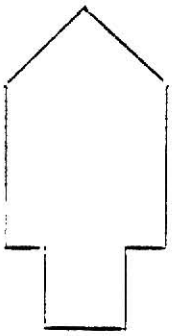


Fig. 1

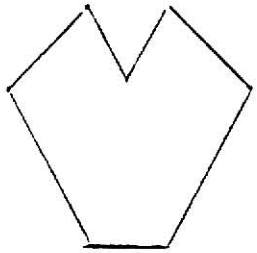


Fig. 2

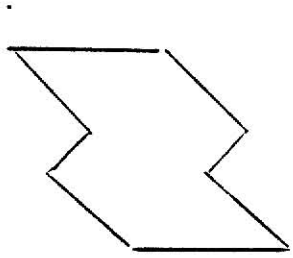


Fig. 3

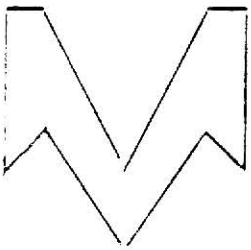


Fig. 4

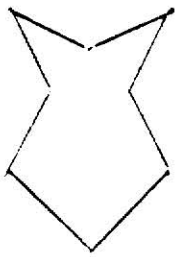


Fig. 5

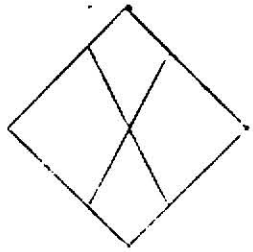


Fig. 6

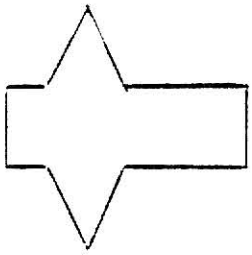


Fig. 7

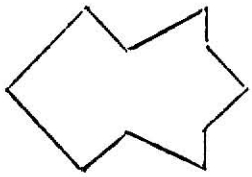


Fig. 8

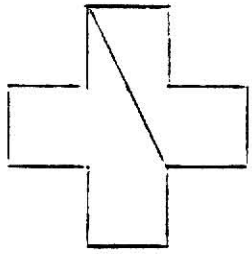


Fig. 9

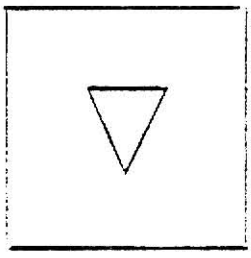


Fig. 10

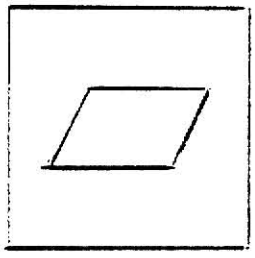


Fig. 11

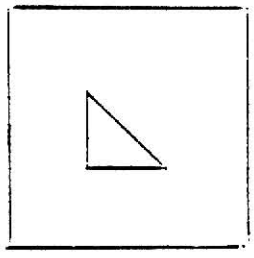


Fig. 12

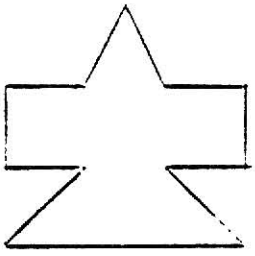


Fig. 13

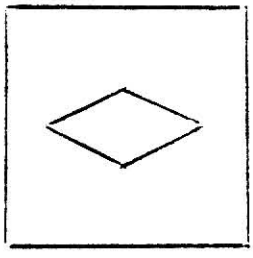


Fig. 14

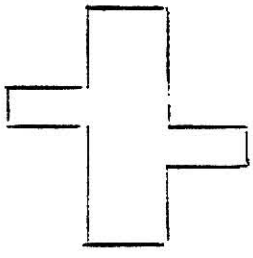


Fig. 15

Figure 20

Diagrams used in the third session of the VDU task

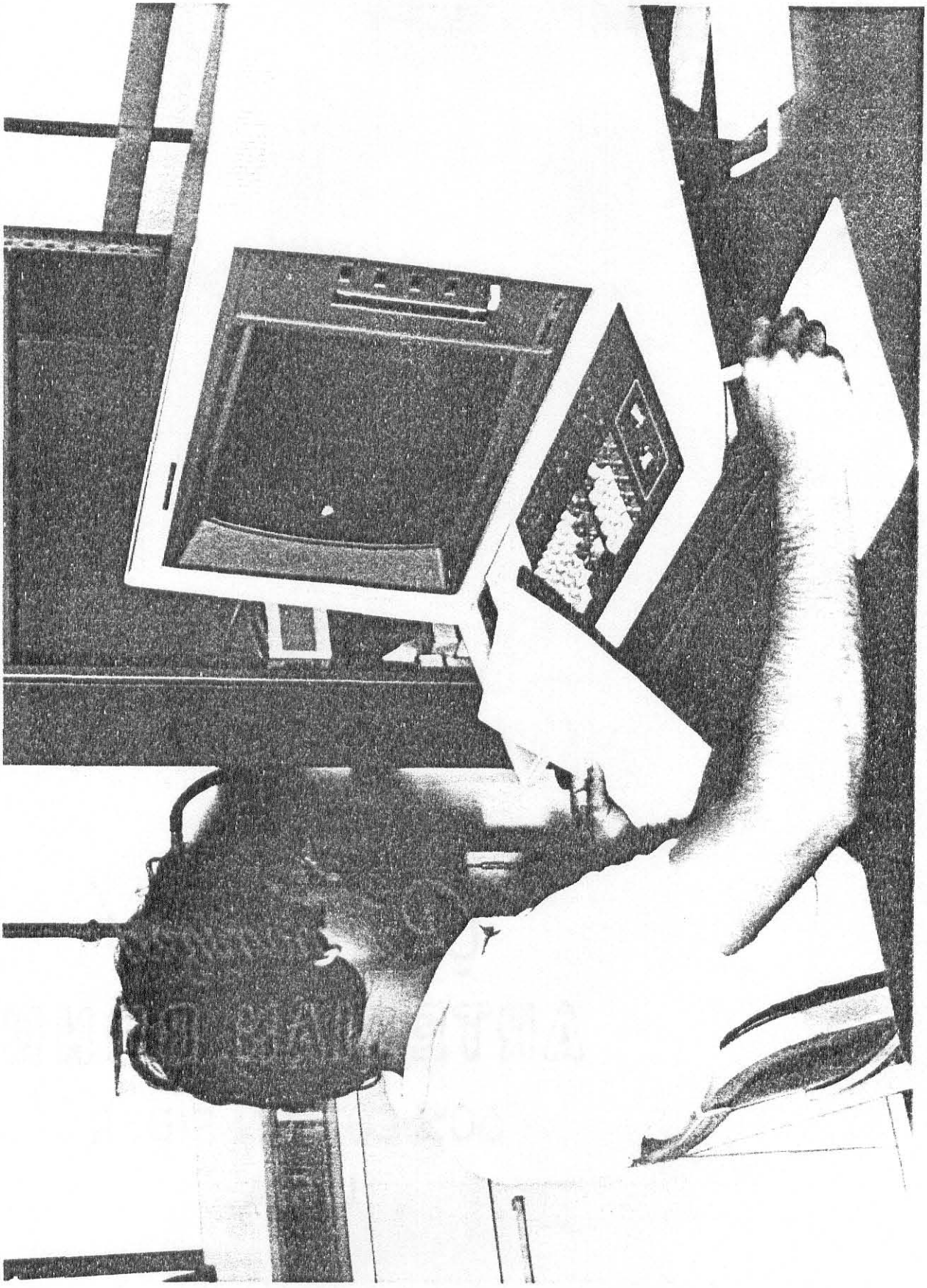


Figure 21: Subject performing VDU task.

The piles of cards were so arranged in front of the subject that the first pile always consisted of the same soluble puzzle, the second the insoluble, the third the same soluble puzzle and fourth the same insoluble puzzle.

The subject was asked to start working from the left hand pile to the extreme right hand side pile. The time alloted for one trial was one minute. If the subject decided to discard his unsuccessful card before the period of one minute was over he was allowed to do so.

The four diagrams used in the second session were entirely different from those used in the third.

The experimentor recorded the trials taken by a subject on each puzzle.

See Figure 22 for instructions and Figures 23 and 24 for the diagrams used in the second and third session respectively.

The number of trials on any puzzle ranged from one to 26.

Stroop color task. This task was adapted from the Stroop (1935) color word task.

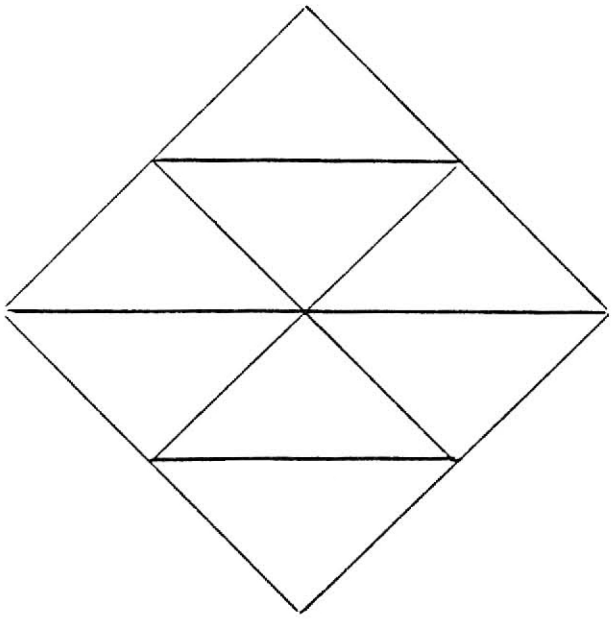
Two decks of 18 cards each were placed in front of the subject. The left hand side (LHS) deck contained cards with words in different colors. Each card in the right hand side (RHS) deck had a pair of words printed on it. Figure 25 shows a LHS card and a RHS card. The word on the LHS card is "Blue" but the "color of the print" is red. The "color of the print" (red) is associated with "blood" on the RHS card. Whereas the "word itself" (blue) is associated with "sky" on the RHS card. The experimentor asked the subject to write down the word associated with the "word itself" or the "color of the print".

FEATHER TASK

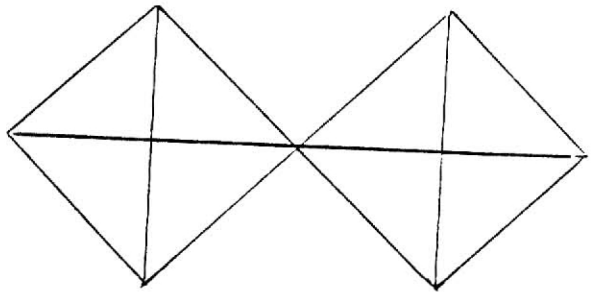
The four piles of cards on the table contain line diagrams. Your task is to trace over all the lines of a diagram without tracing any line twice and without lifting the pencil from the figure. All the diagrams in any particular pile are identical. Please pick up a card from pile 1. You may take as many trials on a given item as you wish. However, there is a time limit on a given trial. I will inform you when your time is up. This does not mean you have to go to a different pile. The decision to move to the next pile is yours. But if you move to a new pile, you will not be allowed to go back to the previously unsolved item. If you want another trial, please discard the unsuccessful card into the bin and take another copy of the same item.

Please proceed from the pile on the extreme left to that on the extreme right.

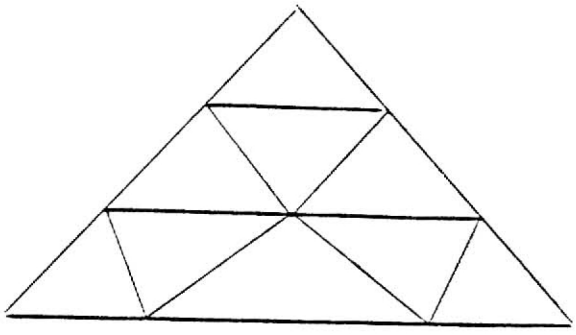
Figure 22. Instructions for the Feather task



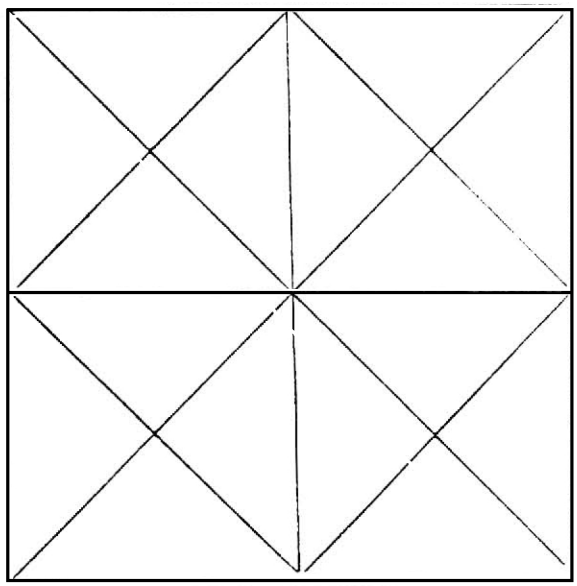
1



2

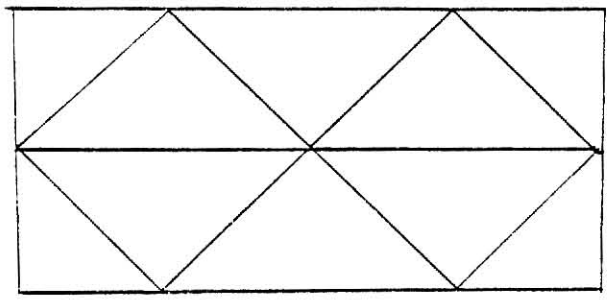


3

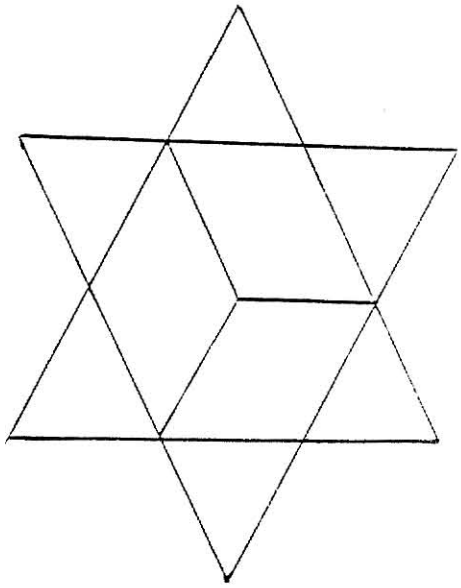


4

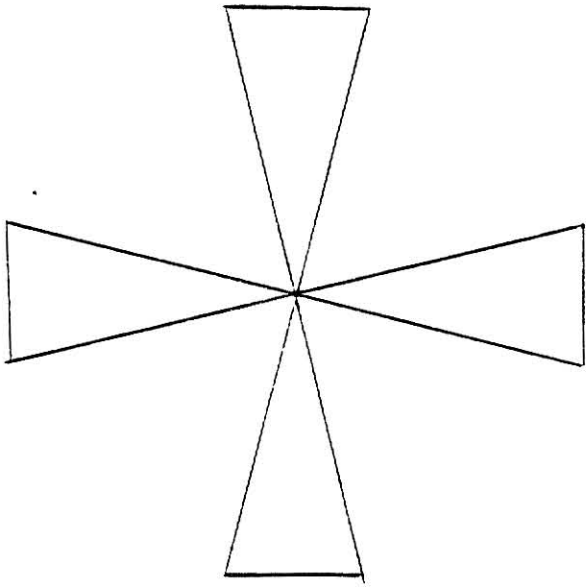
Figure 23: Second session Feather task diagrams



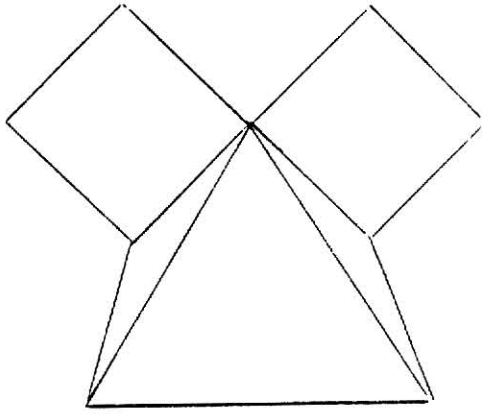
1



2

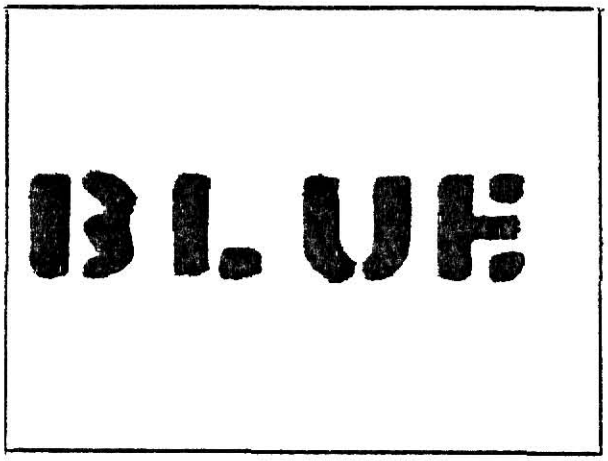


3

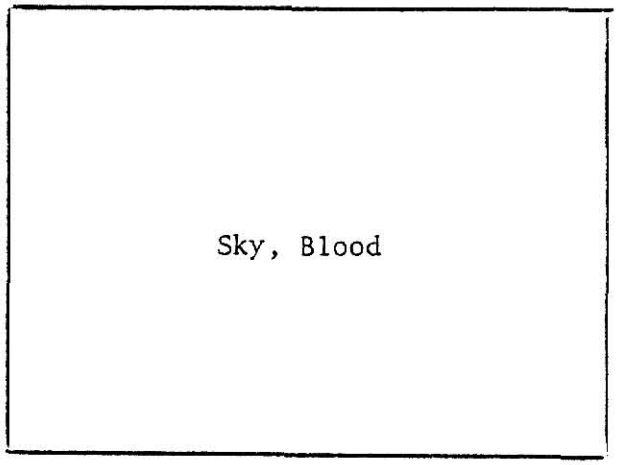


4

Figure 24: Third session Feather task diagrams



LHS Card



RHS Card

Figure 25. Stroop Color Cards

All the cards were placed face down so that the subject could not see what was on a card until he picked it up. He was allowed to look at a LHS card for 5 seconds after which the experimenter would say "face down". This meant the time for looking at the LHS card was over and he should pick up the RHS card. At this point the experimenter asked the "color of the print" or the "word itself". Twenty seconds were allowed for looking at the RHS card and writing the answer. After the twenty seconds were over the experimenter would say "next", which meant that the next LHS card should be picked up.

At no time was the subject allowed to see the RHS and the LHS cards simultaneously.

Instructions for the task are given in Figure 26. The cards used in the second and third session are shown in Figures 27 and 28 respectively.

The number of errors on this task ranged from 0 to 11.

Proof reading task. This was the last post stress test and followed the Stroop color task. A passage of approximately 1200 words was given to the subject and he was asked to identify the errors in the passage but not correct them. The errors had been deliberately introduced in the passage and consisted of misspellings, grammatical mistakes, incorrect punctuation, transpositions, and typographical errors The subject was asked to work as quickly and as accurately as possible; the experimenter would tell him when to stop.

Totally there were 50 errors in the passage. The subject was not told the number of errors nor the amount of time allowed (5 minutes).

Quality of performance was measured as a percentage of "errors not

found" of the total number of errors that could have been detected at the point the subject was told to stop work.

Different passages were used for sessions 2 and 3. The passages were from the Reader's Digest December 1978. The passage used in session 2 is shown in Figure 29 and the one used in session 3 in Figure 30. The score on this test ranged from 5.88% to 88.38%.

STROOP TASK

There are two points that you might observe in the left hand card: (1) the color of the print and (2) the word itself. The "word itself" is blue but the "color of the print" is red. Corresponding to the "color of the print" and the "word itself" two words are given on the right-hand side card. In this example, the "color of the print" is associated with or corresponds to "blood". The "word itself" is associated with "sky".

Turnover to page 2. I will ask you to write down the word associated with either "color of the print" or the "word itself".

You will be allowed to look at each left hand side card for only 5 seconds. After the 5 seconds, I will say "face down". This means that the time for looking at the left hand side card is over, and you are expected to keep it face down. Then I will either say "color of the print" or the "the word itself". This will indicate that you may pick up the right hand card and start writing. Twenty seconds will be available for looking at the right hand side card and writing. At the end of 20 seconds, I will say "next" which means that you must pick up the next left hand side card.

Please let me know when you are ready to begin the task.

Figure 26. Instructions for the Stroop Color Task.

Card Number	Word Itself/Color of the Print
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	

Figure 26: Continued

Word Itself	Color of the Print	Pair of Words
1. Black	Green	Night, Grass
2. White	Purple	Snow, Sky
3. Yellow	Black	Coal, Banana
4. Black	Purple	Royal, Death
5. Red	Brown	Nut, Fire
6. White	Black	Coal, Egg
7. Green	Red	Loss, Money
8. Pink	Brown	Leather, Rose
9. Brown	Green	Chocolate, Moss
10. Black	Red	Dirt, Strawberry
11. Yellow	Red	Anger, Coward
12. Red	Blue	Tomatoes, Sad
13. Green	Blue	Sad, Spinach
14. White	Brown	Milk, Wood
15. Pink	Purple	Plum, Rose
16. Red	Brown	Camel, Rose
17. Violet	Black	Flower, Dirt
18. Red	Purple	Sunset, Plum

Figure 27. Second session - Stroop Color Cards

	Word Itself	Color of the Print	Pair of Words
1.	Black	Green	Night, Lettuce
2.	White	Purple	Snow, Sky
3.	Yellow	Black	Record, Banana
4.	Black	Purple	Grape, Death
5.	Red	Brown	Nut, Fire
6.	White	Black	Africa, Egg
7.	Green	Red	Loss, Peas
8.	Pink	Brown	Wood, Rose
9.	Brown	Green	Chocolate, Moss
10.	Black	Red	Dirt, Strawberry
11.	Yellow	Red	Anger, Coward
12.	Red	Blue	Tomatoes, Moon
13.	Green	Blue	Sad, Spinach
14.	White	Brown	Cloud, Wood
15.	Pink	Purple	Wildcat, Plum
16.	Red	Brown	Camel, Rose
17.	Violet	Black	Flower, Coal
18.	Red	Purple	Sunset, Wildcat

Figure 28. Third session - Stroop Color Cards

PROOF READING

Please read each of the following pages carefully. There may be misspellings, grammatical mistakes, incorrect punctuation, transpositions, and typographical errors. Please underline the errors, but do not correct them. Do the best you can. If you think there is an error but are not sure, mark it wrong.

Please work as quickly and as accurately as possible; I will let you know when to stop.

Figure 29. Proof reading task given in the second session.

Probing the Mysteries of the Galaxies

At the Kitt Peak National Observatory in Arizona, astronomar Allan Sandage was exposing photographic plates on the giant four-meter telescope and talking about galaxie. It was a moonless night. It always is when Sandage is to be found observing, for his interests lie with starlight that has been journeying in space for millions of years. and arrives in so feeble a condition that it can be recorded properly only by the dark of the moon.

The sky over Kitt Peak was full of stars. Sandage could see none? of them. He was sealed in an observer's cage suspended within the telescope tube high above the observatory floor, his vista of the cosmos limited to a single blob of light in the eyepiece that he scrutinised to assure himself that the telescope was tracking correctly while the plate was e*posed. The photographic plate are what matters in viewing galaxies. The human eye is insuficiently sensitive to view galaxies in detail, and deep-space astronomers rarely look at them through telescopes. Instead. they analyze the plates, counting and measuring thousands of star images on them, seeking to dis/ern the anatomy of these cities of stars.

As to the stars in the Arizona sky, Sandage appreciates their spectacle as do the rest of us, but these Milky Way stars are our neighbors. The deep-space astronomers are interested in peering out beyond, to the other galaxies.

Now astronomers are discovering that galaxies are stranger than anyone hadsuspected. They undergo sstartling transformatins. Big galaxies swallow little one. Galaxies collide. Some, it appears, explode. Some dance grand passacaglias, swapping stars by the millions. These transformations ad up to a picture of a universe in evolution, in whose story our own evolution plays a part.

Cosmic Explorers. It is beginning to look as if we are deeply connected with our cosmic surroundings. some matters as mundane as the weather. Several British astronomers suggest that the Ice Age may have been triggered by the solar system's haveing passed through a cloud of dust and gas associated with one of our galaxy's spiral arms.

Still deeper connections betwen ourselves and the galaxies are being discerned. Astrophysicists studying the chemical composition of stars, and biologists investigating The chemical composition of our bodies, have found that we are made up of much the same allotment of elements as is our galaxy: The metals found in trace elments in our bodies appear to have been formed in the explosions of stars that died before the sun was born, seeding space with the metal-rich dust and gas from which our soler system and, eventually, ourselves were formed.

The story of galaxies is beginning to reveal itself through the eyes and ears of new astronomical tools--X-ray satellites, ultravoilet sensors, computer simulation techniques.

"We see the story of the evolution! of galaxies coming to a head in a remarkable way," said Sandage, speaking by intercom from his perch up in the dark. "Problems that had seemed impossible to unerstand are yielding, and a general picture is emerging."

Sandage, who in the estimation of many colleagues possessess the most accomplished mental picture of galaxies of any man alive, can show you--like a guide spotting fishing holes--where in a galaxy to find nurseries churning our young stars, or retirement homes of old stars nearly spent, or slowly winking variable stars that will help you chart a galaxy's distance. He are familiar with giant elliptical halaxies larger than our Milky Way, with paltry irregular galaxies that appear to be no more than thinblefuls of sand, with spirals of elegant beauty and with galaxies whose eventful past has lef them tattered. He can show you two spiral galaxies cocked to each other like an open pockett watch, and note that in such pairs, the two spiral in opposite directions. (Our own galaxy and the great spiral in Andromeda form such a pair.)

By searching for similarities in galaxies, Sandage seeks to im.rove our estimates of the dimensions of the universe and the rate at which it is expanding. These numbers in turn ought to yield a prediction of the fate of the universe--whether expansion will go on forever.

This big-picture approach stands in contrast to that of some younger researchers concerned more with how individual galaxies formed and why they look the way they do. Severl astrophysicists have been looking into the question of why some galaxies seem to be producing no new stars. In a "healthy" galaxy like ours, new stars form with regularity, but some spirals appear to has closed up their star-making shops long ago. Our sun is itself a relatively young star. Had our galaxy stopped forming stars billion year or more ago, we wouldn't be here to ask why.

Two young Kitt Peak astronomers, Karen and Stephen Strom, suggest that the "unhealthy" galaxies may have suffered collisions with other galaxies or with c/oud of intergalaxtic gas--collisions that swept them clean of the dust and gas they needed to make More stars. The Stroms and others have found vidence that "unhealthy" galaxies tend to be found in the crowded inner regions of galaxy clusters, where collisions would be most likely.

Galaxy Genetics. One obstacle to unraveling the evolutionary processes of galaxies has been that they conduct their affairs over such long periods of time. If you want to see two galaxies interact as they pass each other, you'll have to wait a few hundred million years--more than even the most patient astronomers can managed. But computer simulations are now being used to look into the past. and future of galaxies. The computers are programd with data on the mass and size and relative locations of galaxies. Then the programs are run to re-create events that took eons to unfold.

when school began in september 1977, the parents were told that the inegration blueprint required the replacement of the black princple by a white. The patents were upset. Not because the new. Principal was white, but because the old prinicpal was good. Under his direction, the schol had been? One of the first black schools in Chicago to Reach the national Levels in reading. But the change was made.

Then racial balance was sought among teachers. The eight grade teacher was black. She had to be replaced by a white. So the downtown computers picked one out and assigned her to Waker. Unfortunately, she turned, out to be having a babby and wasn't available to teach. So the eighth grade didn't have a teacher.

When this was pinted/out to the kepers of the computers they sent in a substituted to teach the eighth grade. She stayed for a week until a full-time wite teacher was found. That teacher appeared, taught one day and quit. Raxial balance was nice, but she lived at the opposite end of Cook County, and it took her two hours or more to get to the school.

Substitute teacher returned and stayed for four days. She was replaced one again by the woman who lived two hour away. This time she was told she would have to stay. She stayed one day.

PROOF READING

Please read each of the following pages carefully. There may be misspellings, grammatical mistakes, incorrect punctuation, transpositions, and typographical errors. Please underline the errors, but do not correct them. Do the best you can. If you think there is an error but are not sure, mark it wrong.

Please work as quickly and as accurately as possible; I will let you know when to stop.

Figure 30. Proof reading task given in the third session.

Warming Up

Once it was considered good practice to let the car engine ideel a minute or two following cold starts. Today, with modern carburetors, the opposite is true. After you start your car, get going immediately, using slow speeds for the first mile or two. An engine operating under road conditions was warm up faster and lubricate more efficiently than one that is idling. Idling just burns gas (on averege about a gallon an hour).

Turn your engine off completely at long stops-train crossing, drive-in-bank lines, etc. Tests show it is more "gas efficient" to turn an engine off than to let it idle one minute or more.

On the Road

If you have a standard shift, skip a gear whenever conditions permit. The idea is to get into the economical higher gears sooner. Level! Downhill starts are good times to skip second and go directly into third. The opportunities for skipping are even greater with four- and five-speed transmission.

"Jack rabbit" starts are murder on gas milage. So is tailgating, since you must constantly break and accelerate if you let the car in front dictate. How you drive. On the highway, varing your speed--even by as littlle as five m.p.h.--can reduce fuel economy by as much as 1.3 miles per gallon.

Take it easy A car traveling at 70 m.p.h. get only two-thirds the gas ecnomy of a car going 45. The 55-m.p.h. speed limit was ? enacted to help preserve our dwindling petroleum resserves. obey it; you'll do your contry and yourself a service.

Drive with the windows closed whenever you can. Open windows create wind turbulance and have the effect of holding back the car. At highway speeds, open windows can lower mileage as much as ten percent.

Avoi unnecessary stops. It takes up to 20 percent more gas to reach cruising speed from a dead stop than from a speed of just a few miles per hour. So if a traffic light ahead is red, ease off on the gas and give the light a chance to turn gren while you are still moving. And don't ride your clutch to keep your card at a standstill on hills. Use The emergency brake. It saves wear on the clutch and transmission, and conserves foel to boot.

Figure 30 (continued).

Two hundred forty mile above the earth a silent drama in space suspense is unfolding: the 85-ton Skylab space station is threataning to come crashing down as early as a year from now. On the group? American scientists are rasing against time in an attempt to rescue it. The Skylab problem is the latest illustration of how man, in his determination to Harness outer space, is creating new danger for his own planet.

With approximately 4500 pieces of human engineering hurtling in space--900 of them satellites, the rest spatial debris--the law of averages along suggests potential peril to our world. And because both the United State and the Soviet Union, which together hold a virtual monopoly on space traffic, has become dependent on satellites for military defense and for utilitarian purposes (156 payloads were launched in 1977; 95 in the first nine months of 1978), the outlok is for ever-increasing celestial congestion.

Unfortunately, we are dealing in hipothetical science-fiction scenarios, as we discovereed 1st January when a five-ton Soviet nuclear-powered military satellite, Cosmos 954, threatened a major diasaster. On January 6, trackers at the North American Air Defense Command (NORAD) in colorado springs, Colo., realized that the satellite, which had ceased to respond to ground radio commands, was tumble out of control toward earth.

It was possible that Cosmos 954--feuled by 110 pounds of deadly uranium--would come. down over a popuated region in North America, western Europe or Asia, spewing radiation over a city with incalculable consequences. And so a top-secret force had been set up by the ! National Security Council at the White House to monitor the course of the runaway satellite. and coordinate all conceivable disaster, civil-defense and political contingencies. What the White House was facing, then, was a scenario of potential horror almost as frightening as anything that Hollywud has invented.

Uncertainty was the worst element in the Cosmos 954 around-the-clock watch. Normally, the nuclear-reactor section of the satellite should had separated from it a month or two after launch and been propelled by boosters up to a higher orbit where it would remain for centuries before re-entering the atmosphere. But this evidently did not occur. Once it was clear that Cosmos 954 would fal out of orbit in a matter of days or weeks, the first question was whether this blinded but still lethal satellite would disintegrate on atmospheric re-entry or land in radioactive chunks. Finally, the question was where it would crash.

One of the first decision President Carter made was to maintain total secrecy about the crisis. His judgement shared by most senior officials in Washington, were that a major panic could be triggered if the administration went public with the story of a nuclear satellite soon destined to plunge to earth. For one thing the government could not have taken emergency precautions, becuase the Cosmos trajectory could not be predicted even from hour to hour. Every city? obviously could not have been evacuated.

To be sure, the Adminstration was prepared to activate emergency plans if Cosmos 945 or its radioactive fragments hig a populated region of the country. Military "nuclear-response teams" went on standby. Foreign governments were alert by Washington that Cosmos was out of control and could crash in their territory.

The climax of the crisis came at 6:50 a.m., on January 24, when the satellite started rentry over the Queen Charlotte Islands, off Canada's western coast. At 6:53 a.m., in a spectacle of fireballs in the predawn sky, Cosmos 945 disintergrated, showering the show covered ground 100 miles east of yellowknife with radioactive fragments.

At 7:15 a.m., the President telephoned Canadian Prime Minister Pierre Trudau to advise him of the crash and to offer american assistance in launching a search by airborne radiation-detection teams. Some of the debris from Cosmos 945 was highly radioactive, and it took three months to clean up. The possible effects from the radiation are still being studied.

The great good luck, of course, was that the crash occured in an uninhabited area of Canada's Northwest Territories. Have it completed one more pass around the earth, the satellite could have broken up in the general area of New York City.

Because they account for the largest number of operational manmade objects in space, military satellites, particularly nuclear ones like Cosmos, pose the greatest danger to the earth. Yet, the Russians have only delayed, probably not abandoned, their program of nuclear-powered surveillance satellites, despite President Carters proposal for a Soviet-American ban on sending such satellites into space.

There is virtually no likelihood that any of the nuclear reactors now in outer space-the 16 Soviet ones or our one-will re-enter the atmosphere efore their prescribed time, centuries from now. Still it is an eerie notion that they are there.

The reality is that nothing will arrest the progress of space technology, nuclear or not. Defence considerations are uppermost in Washington's and Moscow's space programs. Both governments rely on satellites for vertification of compliance with the 1972 Strategic Arms Limitation Talks agreement. Satellites can dectect military movements on the ground, in the air, and on the seas as well as intercept military communications. Thus, satellites have become an essential part of worldwide intelligence networks; the superpowers can no longer function safely without them.

Questionnaires and Certificates.

A questionnaire was given to the subject at the end of performance tasks, in each of the three sessions. The questionnaires used in the first two sessions were identical and are shown in Figure 31. The third session questionnaire had all the questions asked in the first two but also had an additional question -- "Which lens do you intend to use?" The third session questionnaire is shown in Figure 32.

After the successful completion of sessions 1, 2, and 3 the subject received certificates numbered 1, 2, and 3 respectively. The subject was asked to take these certificates to the optometrist. Certificates 1 and 2 indicated to the optometrist the type of lens (bifocal or Varilux 2) to be given to the subject for wear during the next month. Certificates 1 and 2 are shown in Figures 33 and 34 respectively. Certificate 3 indicated the completion of all research requirements in the study. The subject received a refund on his bifocal lenses and received the Varilux lenses free, when he presented certificate 3. Certificate 3 is shown in Figure 35.

Subject_____ Task Session No. _____

Questionnaire For The End Of Task Sessions

1. Do you have any comments about the tasks you have just completed?

2. Did you find this at all stressful?

3. Do you have any comments about the glasses you have been wearing?

4. Was there anything notably good or bad about them?

Figure 31. Questionnaire for Sessions 1 and 2.

Subject_____ Task Session No. _____

Questionnaire For The End Of Task Sessions

1. Do you have any comments about the tasks you have just completed?

2. Did you find this at all stressful?

3. Do you have any comments about the glasses you have been wearing?

4. Was there anything notably good or bad about them?

5. Which lens do you intend to use?

Figure 32. Questionnaire for the third session.

DATE_____

CERTIFICATE I

This certifies that _____ has completed the intial task work in the bifocal-progressive lens study and is entitled to his/her initial lenses for wear during the first month. These should be the _____ lenses.

_____
Corwin A. Bennett, Ph. D.

Figure 33

DATE_____

CERTIFICATE II

This certifies that _____ has completed the second task work in the bifocal-progressive lens study and is entitled to exchange this initial lenses for wear during the second month. These should be the _____ lenses.

_____
Corwin A. Bennett, Ph. D.

Figure 34

DATE_____

CERTIFICATE III

This certifies that _____ has completed the research requirements in the bifocal-progressive lens study and is entitled to a refund for his/her bifocal lenses and to receive his/her progressive lenses free.

_____
Corwin A. Bennett, Ph. D.

Figure 35

Experimental design.

A same subject design was used in this study, that is, each subject performed under both treatments of the independent variables (lenses). The independent variables were: (a) lens type (bifocal or Varilux-2), (b) Order in which lenses were given (bifocal or Varilux-2 first).

The dependent variables were the score on the seven tasks as well as the responses to the mood form. In the visual and blindfolded pegboard assembly tasks the score was the number of pegs missed or the pegs placed upside down. In the penny inspection task the score was the percentage of defective pennies not identified. In the VDU task it was the percentage of incorrect diagrams not identified. In the Feather task the score was the number of trials on the insoluble diagrams. In the Stroop color task it was the number of errors. In the proof reading task it was the percentage of errors not found of the total that number of errors that could have been detected at the point the subject was told to stop work.

Subjects and recruitment procedures.

An announcement (Figure 36) was placed in a local newspaper and a campus staff paper for subjects, in the age group where they would be needing bifocals. Interested persons were asked to call the Industrial Engineering (IE) Department. When they called the IE Department their names and addresses were taken down and they were told to see the optometrist. Somewhat over a hundred people responded from whom the 40 subjects were selected, generally in order of calling.

When they visited the optometrist they were given the "Instructions for Bifocals-Progressive Lens Study" (Figure 37). People who agreed to participate signed the "Informed Consent for Lens Study" (Figure 38).

Consenting individuals had to take an eye screening examination before they could be considered eligible. The criteria for eligibility were: (a) the subject should need bifocals, and (b) should have no eye disease. Initially, 46 subjects received the optometric examination and 40 were considered eligible. The optometric data form is shown in Figure 39.

Figure 36: Announcement

Volunteers being sought for study involving bifocal eyeglasses

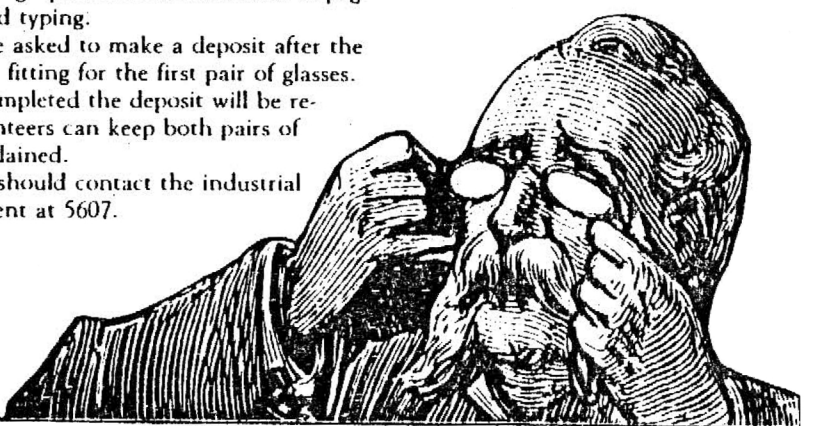
KSU researchers in industrial engineering are seeking volunteers to participate in a study comparing bifocal eyeglasses to progressive lenses.

Some 40 individuals who require bifocals are being sought, said Corwin Bennett, industrial engineering.

Multi-Optics Inc. let a contract with KSU for the study. Individuals will be fitted by a Manhattan optometrist with a new pair of bifocals to be worn for a month. For an additional 30 days they will be fitted with progressive lenses. In both situations the volunteers will be put through performance tests such as peg board, inspection and typing.

"Volunteers will be asked to make a deposit after the eye examination and fitting for the first pair of glasses. Once the study is completed the deposit will be returned and the volunteers can keep both pairs of glasses," Bennett explained.

Interested persons should contact the industrial engineering department at 5607.



Instructions for Bifocal-Progressive Lens Study

This research is being conducted by the Department of Industrial Engineering at KSU with the cooperation of R. E. Janasek, O.D., 1331 Poyntz.

In order to participate, you must require bifocal lenses. We are interested in bifocal lenses and in an alternative type of lens generally known as "progressive lenses". We want you to perform some tasks and make some ratings. In turn at the end of the study you will be paid money equal to what you paid for the bifocal lenses and will also receive the progressive lenses free. (These lenses can be placed in frames which you already own or you may purchase new frames if you need or wish to.)

You will be examined by Dr. Janasek and assuming you are eligible you will come to the Industrial Engineering Department, Room 121, Durland Hall, KSU (Durland is the building which looks like a flash cube - North across the street from Ahearn Fieldhouse. Room numbers are above the doors. This room is on the West side of the building.) You will be given some performance tasks which will take about one hour. These tasks are similar to tasks which people do in jobs. You will be told how to do these tasks.

After completing this initial task work you should pick up your first pair of lenses from Dr. Janasek. These may be either the bifocals or the progressive lenses. You will wear these for one month. At the end of that time, call KSU, Industrial Engineering to arrange an appointment.

Again, you will visit KSU for an hour session to perform some performance tasks and some "post tasks".

After completing this second task work you should exchange your first lenses for the other type from Dr. Janasek. This second type will be the type of lens (bifocal or progressive) which you did not have before. You will wear these lenses for a month. At the end of that time, again call KSU.

Figure 37. Instructions for the Bifocal-Progressive Lens Study.

Informed Consent for Lens Study

By your participation in this study you will take part in three task sessions at the University. Each of these will last about one hour and will involve performing a half dozen tasks which are similar to tasks which people do in actual jobs. You do not have to know how to do these tasks, we will show you how. In general, they are quite simple. Some of the tasks will be carried out at a particular speed such that you will judge it "somewhat hard."

There is no risk and no discomfort to this activity. The purpose of it is to evaluate the lenses which you will be wearing. Your tangible benefits will be a money credit equal to the cost of your bifocal lenses, and, the set of progressive lenses. We all should benefit from learning about the similarities and differences between the lenses.

All information about your participation in this research is strictly confidential--you will not be identified in any reports; records will be safeguarded.

Mr. Raj Jha and Dr. Corwin Bennett are conducting the research at the University (532-5607) and may be contacted if you have questions.

Naturally, you are free to withdraw from the research at any time, but we hope that you will complete the three sessions.

I have read the above instructions and agree to participate:

_____ _____

Signed Date

Figure 38. Informed consent form.

Optometric Data Form

Fill out for each potential subject. These will be research records and separate clinical records should be kept as needed. We will pick these up.

Name:

Degree of Accommodation:

Acuity correctable to 20/____

Binocularity: good other

Eye disease: none other

Eligibility for study: yes no

Comments:

Figure 39. Optometric Data Form.

After being considered eligible for the study the subject was given the "Call-In-Instructions" as shown in Figure 40. He was asked to call the I.E. Department now, i.e., the blank was filled by "Now". He called the IE department and fixed an appointment for the first session. On completing the first session successfully, he was given a certificate and was told to take it to the optometrist. The certificate indicated which lens should be given to him. It took about a week to prepare that particular lens in the subject's frame, after which he was given another "Call-In-Instruction". This time the blank was filled by a date one month in the future. This allowed the subject to wear the lens for one month and then make an appointment for the second session. After completing the second session and receiving the second certificate he went back to the optometrist and exchanged his first pair of lenses for the other type. Another "Call-In-Instruction" was given to him. The date filled was one month in the future.

One subject dropped out just after the optomtric examination for unknown reasons. Another subject dropped out after the first session; he left town. Hence, two more subjects were recruited.

The optometric work, lenses and frames were arranged by Multi Optics Corporation.

Out of the 40 subjects chosen, 16 were males and 24 females. Thirty-four were from Manhattan, Kansas, and 6 from Junction City, Kansas. Eleven were faculty members at Kansas State University. Another 11 were working at KSU, most of these were secretaries. Totally 26 subjects could

be categorized as doing work that involved a lot of reading, writing or typing. The age of the subjects ranged from 44 to 66 and their degree of accommodation is given below in Table 1.

TABLE 1

Diopters	Number of Subjects
1.75	7
2.00	18
2.25	12
2.5	2
2.75	1

CALL-IN INSTRUCTIONS

You should call the KSU Industrial Engineering Department at 532-5606 on or around _____ (date) to schedule a task performance session with them.

Figure 40. Call-In-Instructions.

Apparatus

Conveyor. It was a straight belt conveyor with a variable speed drive. The color of the belt was textured grey. The belt was 12.5" wide and 10 feet long. The height of the conveyor was adjustable. The conveyor was used at a height of 26".

Transformer. The speed of the conveyor was varied by a 115V primary variable transformer. The maximum output current capacity was 2.5 amps.

Voltmeter. This was a VIZ Electronic Instruments voltmeter. The specifications are given below.

Ranges	
AC Voltage	0 to 10, 50 and 250 V
Sensitivity	2,000 ohms per volt
AC/DC	
Dimensions	3 1/8" W x 4 5/8" H x 1 1/2" D
Weight	6 oz.

Pegs and Pegboard. The pegs were 3" long and pointed at one end. The dimensions of the pegboard were 7" x 6" x 3/4".

Blindfolds: Two pairs of blindfolds were used.

Tekronix 4054 microcomputers

19" CRT	
Length	34.75"
Width	26.3"
Height	20.5"
Weight	145 pounds

For further details, please see the Tektronix 4052/4054 service manual.

RESULTS

Subjective Measures

Short Form of the Mood ACL. The means of the Mood factors considering lens type are shown in Table 2. The means of the corresponding Mood factors considering order of sessions shown in Table 3.

The dependent variables (the eleven Mood factors) were analysed by means of the analysis of variance (ANOVA). Significance was established at p=.05.

The ANOVA for all the eleven factors are shown in Tables 4 thru 14.

The only significant differences were those among subjects for the following factors: Agression, Surgency, Elation, Concentration, Social Affection and Egotism.

Appendix 2 and 3 show the scores of all the subjects in their bifocal and Varilux-2 session respectively.

TABLE 2 Means of Mood factors considering lens type.

Lens Type Factor	Bifocal	Varilux-2
Aggression	3.50	3.425
Anxiety	4.225	3.825
Surgency	6.20	5.725
Elation	6.388	6.338
Concentration	8.825	9.075
Fatigue	4.50	4.55
Social Affection	7.30	8.05
Sadness	3.525	3.65
Skepticism	4.42	4.60
Egotism	4.175	4.00
Vigor	8.175	7.55

TABLE 3. Means of Mood factors considering order.

ORDER FACTOR	FIRST LENS	SECOND LENS
Aggression	3.35	3.57
Anxiety	4.15	3.90
Surgency	5.75	6.175
Elation	6.237	6.488
Concentration	9.02	8.875
Fatigue	4.25	4.800
Social affection	7.475	7.875
Sadness	3.425	3.75
Skepticism	4.40	4.625
Egotism	4.10	4.075
Vigor	7.9	8.1

TABLE 4. ANOVA for Mood factor "Aggression".

Source	DF	MS	F Value	PR > F
SUBJ	39	77.3875	1.92	0.0238
GTYPE	1	0.1125	0.11	0.7436
ORDER	1	1.0125	0.98	0.3292

TABLE 5. ANOVA for Mood factor "Anxiety".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	39.950	1.40	0.1494
GTYPE	1	3.200	1.88	0.1779
ORDER	1	1.250	0.74	0.3964

TABLE 6. ANOVA for Mood factor "Surgency".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	263.38750	1.98	0.185
GTYPE	1	4.51250	1.33	0.2568
ORDER	1	3.61250	1.06	0.3095

TABLE 7. ANOVA for Mood factor "Elation".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	302.73750	1.99	0.0178
GTYPE	1	0.05000	0.01	0.9104
ORDER	1	1.25000	0.32	0.5743

TABLE 8. ANOVA for Mood factor "Concentration".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	275.8000	2.00	0.0173
GTYPE	1	1.2500	0.35	0.5556
ORDER	1	0.4500	0.13	0.7232

TABLE 9. ANOVA for Mood factor "Fatigue".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	196.9500	1.44	0.1299
GTYPE	1	0.0500	0.01	0.9055
ORDER	1	6.0500	1.73	0.1963

Fatigue. The score ranged from 3 to 11. The mean was 4.53. The ANOVA is shown in Table 9. There was no significant difference at all.

Social Affection. The score on this factor ranged from 3 to 12. The mean was 7.68. The ANOVA is shown in Table 10. There was significant difference between the subjects but not between lens type.

Sadness. The score on this factor ranged from 3 to 9. The mean was 3.59. The ANOVA is shown in Table 11. There was no significant difference.

Skepticism. The score on this factor ranged from 3 to 9. The mean was 4.512. The ANOVA is shown in Table 12. There was no significant difference.

Egotism. The score ranged from 3 to 9. The mean was 4.09. The ANOVA is shown in Table 13. There was significant difference between the subjects but not between lens types.

Vigor. The score on this factor ranged from 5 to 12. The mean was 7.86. The ANOVA is shown in Table 14. There was no significant difference at all.

TABLE 10. ANOVA for Mood factor "Social Affection".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	337.55000	2.23	0.0075
GTYPE	1	11.2500	2.90	0.0969
ORDER	1	3.2000	0.82	0.3697

TABLE 11. ANOVA for Mood factor "Sadness".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	75.88750	1.51	0.1045
GTYPE	1	0.31250	0.24	0.6256
ORDER	1	2.11250	1.64	0.2087

TABLE 12. ANOVA for Mood factor "Skepticism".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	137.48750	1.23	0.2621
GTYPE	1	0.61250	0.21	0.6465
ORDER	1	1.01250	0.35	0.5557

TABLE 13. ANOVA for Mood factor "Egotism".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	161.88750	2.47	0.0031
GTYPE	1	0.61250	0.36	0.5497
ORDER	1	0.01250	0.01	0.9317

TABLE 14. ANOVA for Mood factor "Vigor".

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	265.98750	1.66	0.0604
GTYPE	1	7.81250	1.90	0.1759
ORDER	1	3.61250	0.88	0.3542

Choice of lens. Twenty three subjects chose bifocals and seventeen chose Varilux-2 at the end of the study. Table 15 shows the type of lenses the subjects had been wearing and the type they finally decided to choose and also the number in each type.

A Chi-square analysis is shown below Table 15. The analysis tests the hypothesis HO.

HO: The number of bifocal and progressive lens wearers before the study will be the same as that at the end of the study.

In other words if there were 35 bifocal wearers and 2 progressive lens wearers before the study, there would be 35 bifocal and 2 progressive lens wearers at the end of the study. The hypothesis implies that the wearing of lenses during the study had no effect on the subjects.

TABLE 15. Choice of lenses.

Initial glasses / Finally chosen glasses	BIFOCAL	PROG.	OTHER	
BIFOCAL	20	1	2	23
PROG	15	1	1	17
	35	2	3	40

Bifocals included trifocals

"Others" include reading glasses and regular glasses.

Ignoring the "other" category, the expect number (E) of bifocal wearer = 35. The expected number of progressive lens wearers = 2. The observed (O) number of bifocal wearers = 21. The observed number of progressive lens wearers = 16.

$$X^2 = \frac{(O - E)^2}{E}$$

$$= 103.6 \text{ with } 1 \text{ df}$$

$$X^2_{0.95} = 5.99$$

$$X^2 > X^2_{0.95}$$

Hence reject HO.

Conclusion: The initial number of bifocal and progressive lens wearer is not the same as that at the end of the study.

This implies that the study did have an effect on the subjects. Almost half the subjects who had been wearing bifocals finally chose Varilux-2 at the end of the study.

Performance and Stress Measures

Analysis considering lens type. The performance tasks data for bifocals and Varilux-2 is shown in Appendix 4. The post stress task results are shown in Appendix 5.

Performance measures. The means according to lens type and order are shown in Table 16 and 17 respectively.

Visual pegboard assembly. The number of pegs missed on this task ranged from 0 to 19, the overall mean was 6.18. The ANOVA is shown in Table 18. There was significant difference between the subjects and lens type. Subjects using Varilux-2 missed a lesser number of pegs.

Blindfolded pegboard assembly. The number of pegs missed ranged from 0 to 22, the mean was 9.11. The ANOVA is shown in Table 19. There was a significant difference between the subjects and lens types. Subjects who had been using and Varilux-2 missed a lesser number of pegs.

Penny inspection task. The percentage of defective pennies not identified ranged from 5.00 to 86.6%, the overall mean was 61.64%. The ANOVA is shown in Table 20. There was a significant difference between the subjects and order but not between lens types.

VDU task. The percentage of defective diagrams not identified ranged from 4.30% to 100%. The ANOVA is shown in Table 21. There was a signifi-

cant difference between the subjects, order and lens types. Subjects while using Varilux-2 performed better.

TABLE 16. Means of performance tasks according to lens type.

TASK \ LENS TYPE	BIFOCAL	VARILUX-2	
Visual pegboard	6.925	5.425	*
Blindfolded pegboad assembly	10.275	7.95	*
Penny inspection task	60.27%	63.1%	
VDU task	45.18%	33.44%	*

* Significantly different at p=0.05

TABLE 17. Means of performance tasks considering order.

TASK \ ORDER OF LENS	FIRST	SECOND	
Visual pegboard assembly	6.675	5.675	*
Blindfolded pegboard assembly	9.425	8.80	
Penny inspection task	64.55%	58.72%	*
VSU task	44.103%	34.527%	*

* Significantly different at p=0.05

TABLE 18. ANOVA for visual pegboard assembly.

Source of variance	DF	MS	F	PR > F
Subject	39	1152.55	4.07	.0001
Lens type	1	45.00	6.20	.0173
Order	1	20.00	2.75	.1053

TABLE 19. ANOVA for blindfolded pegboard assembly.

Source of Variance	DF	MS	F	PR > F
Subject	39	1373.487	1.72	.0481
Lens type	1	108.112	5.29	.0270
Order	1	7.812	0.38	.5401

TABLE 20 ANOVA table for the penny inspection task.

Source of Variance	df	MS	F	Pr > F
Subject	39	10323.91	2.38	.0043
Lens type	1	150.39	1.35	.2520
Order	1	680.88	6.12	.0179

TABLE 21 ANOVA for the VDU task.

SOURCE	DF	MS	F	PR > F
SUBJECT	39	22146.0973950	2.07	0.0135
GTYPE	1	2760.3100800	10.06	0.0030
ORDER	1	1833.8040050	6.68	0.0137

Post Stress Measures. The three variables were analyzed just like the performance measure variables. The means of the tasks considering lens type and order are shown in Tables 22 and 23 respectively.

Feather task. The number of trials on the first insoluble puzzle ranged from 1 to 26 and on the second from 11 to 28. The means on the first and second were 8.925 and 9.98, respectively. The ANOVA for the first and second insoluble puzzles are shown in Tables 24 and 25 respectively. There was a significant difference between the lens types for the first insoluble puzzle.

Stroop color task. The number of errors ranged from 0 to 11, the mean was 2.58. The ANOVA for the task is shown in Table 26. There was no significant difference between lens type and order but significant difference between the subjects.

Proof reading task. The percentage of errors ranged from 5.88 to 6.66%. The mean was 31.97%. The ANOVA for this were significant differences between the subjects and the order.

TABLE 22. Means of the post stress tasks considering lens type.

LENS TYPE TASKS	BIFOCAL	VARILUX-2	
First insoluble puzzle	7.5	9.9	*
Second insoluble puzzle	10.22	9.92	
Stroop color task	2.225	2.925	
Proof reading task	32.82%	31.11%	

TABLE 23. Means of the post stress tasks considering order.

ORDER/TASKS	FIRST	SECOND	
First insoluble puzzle	8.475	8.925	
Second insoluble puzzle	9.35	10.80	
Stroop color task	3.05	2.10	
Proof reading task	29.54	34.40	*

TABLE 24. ANOVA for the first insoluble puzzle.

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	919.8000	0.87	0.6662
LTYPE	1	115.2000	4.25	0.0461
ORDER	1	4.0500	0.15	0.7012

TABLE 25. ANOVA for the second insoluble puzzle.

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	1955.5500	1.74	0.0450
LTYPE	1	1.8000	0.06	0.8039
ORDER	1	42.0500	1.46	0.2343

TABLE 26. ANOVA for the Stroop color task.

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	501.5500	1.92	0.0231
LTYPE	1	9.8000	1.47	0.2336
ORDER	1	18.0500	2.70	0.1087

TABLE 27. ANOVA for the Proof reading task.

SOURCE	DF	MS	F VALUE	PR > F
SUBJ	39	13660.06536875	4.09	0.0001
LTYPE	1	58.77306125	0.69	0.4127
ORDER	1	472.82950125	5.52	0.0241

Analysis considering choice of lens. Further analysis was done by dividing the subjects into two groups. Group 1 consisted of subjects who chose bifocals and Group 2 consisted of those who chose Varilux 2.

The performance and post stress results (bifocal session) of Group 1 were compared with Group 2. Similarly, the performance and post stress results (Varilux session) of Group 1 were compared with Group 2.

Specifically, the comparisons were:

1. Group 1 performance and post stress task results (bifocal session) versus Group 2 performance and post stress task results (bifocal session).
2. Group 1 performance and post stress task results (Varilux session) versus Group 2 performance and post stress task results (Varilux session).

The data for comparison one is shown in Appendix 6. The data for comparison two is shown in Appendix 7.

Comparison One

Performance measures (Bifocal session). The means considering lens types and order are shown in Tables 28 and 29.

Visual pegboard assembly. The number of pegs missed by subjects who chose bifocals ranged from 0 to 19. The score for subjects who chose Varilux-2 ranged from 2 to 18. The ANOVA for the task is shown in Table 30. There was significant difference between the order. Subjects missed less number of pegs while using their second lens than their first.

Blindfolded pegboard assembly. The number of pegs missed in the bifocal session by subjects who chose bifocals and subjects who chose

Varilux-2 ranged from 1 to 22 and 2 to 20 respectively. The ANOVA is shown in Table 31. There was no significant difference.

Penny inspection task. The percentage of pennies not identified by people who chose bifocals and those who chose Varilux-2 ranged from 5% to 70.0%. The mean was 60.26%.

The ANOVA is shown in Table 32. There was a significant difference between the lens types.

VDU Task. The percentage of defective diagrams not identified by Group 1 and 2 ranged from 8.69% to 100.0% and 17.39% to 95.60% respectively. The mean was 45.19%.

The ANOVA is shown in Table 33. There was no significant difference.

TABLE 28 - Means of Performance Tasks Considering Lens Type.

LENS TYPE TASKS	BIFOCAL	VARILUX-2	
Visual pegboard assembly	7.14	6.63	
Blindfolded pegboard assembly	10.95	9.35	
Penny Inspection Task	55.78%	66.33%	*
VDU Task	44.33%	46.35%	

TABLE 29. Means of performance tasks considering order.

TASKS/ORDER	FIRST	SECOND
Visual pegboard assembly	8.30	5.47
Blindfolded pegboard assembly	9.8	10.51
Penny Inspection task	60.06%	62.05%
VDU Task	49.52%	41.16%

TABLE 30. ANOVA for visual pegboard assembly (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	0.05377238	0.00	0.9566
ORDER	1	78.03431663	4.36	0.0438

TABLE 31. ANOVA for blindfolded pegboard assembly (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	28.44558824	0.86	0.3603
ORDER	1	4.93150601	0.15	1.7019

TABLE 32. ANOVA for penny inspection task (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	1024.24077443	5.75	0.0217
ORDER	1	38.95855885	0.22	0.6429

TABLE 33. ANOVA for VDU task (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	106.61646522	0.25	0.6203
ORDER	1	682.73233770	1.60	0.2141

Post Stress measures (bifocal session). The means considering lens type and order are shown in Tables 34 and 35 respectively.

First insoluble puzzle. The number of trials for group 1 and 2

ranged from 2 to 22 and 5 to 21 respectively. The overall mean was 7.5. The ANOVA is shown in Table 36. There was no significant difference at all.

TABLE 34. Means of post stress tasks considering lens type.

LENS TYPE TASKS	BIFOCAL	VARILUX-2
First insoluble puzzle	7.56	7.421
Second insoluble puzzle	8.44	12.63
Stroop color task	2.64	1.66
Proof reading task	34.96	29.94

TABLE 35. Means of post stress tasks considering order.

ORDER/TASKS	FIRST	SECOND	
First insoluble puzzle	7.10	7.88	
Second insoluble puzzle	10.25	10.82	
Stroop color tasks	2.10	2.20	
Proof reading task	27.62%	37.28%	*

Second insoluble puzzle. The number of trials for group 1 and 2 ranged from 3 to 21 and 3 to 36 resectively. The overall mean was 9.925. The ANOVA is shown in Table 37. There was no significant difference.

Stroop color task. The number of colors for group 1 and 2 ranged from 0 to 11 and 0 to 6 respectively. The overall mean was 2.25. The ANOVA is shown in Table 38. There was no significant difference.

Proof reading task. The percentage of errors for groups 1 and 2 ranged from 5.88% to 57.14% and 7.69% to 50.00%. The overall mean was 32.821%. The ANOVA is shown in Table 39. There was significant difference between the order.

TABLE 36. ANOVA for first insoluble puzzle (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	0.63938619	0.03	0.8649
ORDER	1	5.93757716	0.27	0.6046

TABLE 37. ANOVA for second insoluble puzzle (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	165.11822251	3.33	0.0763
ORDER	1	3.28478796	0.07	0.7984

TABLE 38. ANOVA for the Stroop color task (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	0.00313299	0.00	0.9865
ORDER	1	0.65354240	0.06	0.8077

TABLE 39. ANOVA for the Proof reading task (bifocal session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	412.15567560	2.36	0.1327
ORDER	1	911.93613610	5.23	0.0280

Comparison Two

Performance measures (Varilux session). The means of tasks considering lens types and order are shown in Tables 40 and 41.

Visual pegboard assembly. The number of pegs missed by group 1 and 2 ranged from 0 to 14 and 0 to 13 respectively. The overall mean was 5.425. The ANOVA is shown in Table 42. There was no significant difference.

Blindfolded pegboard assembly. The number of pegs missed by group 1 and 2 ranged from 0 to 19 and 0 to 14 respectively. The mean was 7.95. The ANOVA is shown in Table 43. There was no significent difference.

Penny inspection task. The percentage of defective pennies not identified by group 1 and 2 ranged from 16.60% to 86.6% and 40% to 80.0%. The overall mean was 63.01%. The ANOVA is shown in Table 44. There was significant difference in the order.

VDU task. The percentage of defective diagrams not identified by groups 1 and 2 ranged from 4.30% to 65.20% and from 4.30% to 100% respectively. The mean was 33.44. The ANOVA is shown in Table 45. There was no significant difference.

TABLE 40. Means of performance tasks considering lens type.

LENS TYPE/TASKS	BIFOCALS	VARILUX
Visual pegboard assembly	5.57	5.22
Blindfolded pegboard assembly	7.94	7.96
Penny inspection task	61.16%	65.50%
VDU task	29.99%	38.11%

TABLE 41. Means for performance task considering order.

ORDER/TASK	FIRST	SECOND	
Visual pegboard assembly	4.99	5.8	
Blindfolded pegboard assembly	9.05	6.85	
Penny inspection task	69.70	56.96	*
VDU task	39.90	28.19	

TABLE 42. ANOVA for visual pegboard assembly (Varilux session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	0.50645780	0.03	0.8710
ORDER	1	6.29367309	0.33	0.5679

TABLE 43. ANOVA for blindfolded pegboard assembly (Varliux session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	1.01508951	0.04	0.8346
ORDER	1	47.38726651	2.06	0.1592

TABLE 44. ANOVA for penny inspection task (Varilux session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	55.64116238	0.35	0.5593
ORDER	1	1584.72842804	9.89	0.0033

TABLE 45. ANOVA for VDU task (Varilux session).

SOURCE	DF	MS	F VALUE	PR > F
GTYPE	1	390.57285182	0.90	0.3493
ORDER	1	1338.78917353	3.08	0.0876

Post stress measures (Varliux session). The mean considering lens type and order are shown in Tables 46 and 47.

First insoluble puzzle. The number of trials for group 1 and 2 ranged from 2 to 26 and from 1 to 21 respectively. The mean was 9.9. ANOVA is shown in Table 48. There was no significant difference.

Second insoluble puzzle. The number of trials for group 1 and 2 ranged from 1 to 16 and from 4 to 28 respectively. The overall mean ws 9.925. ANOVA is shown in Table 49. There was no significant difference.

Stroop color task. The number of errors for group 1 and 2 ranged from 0. to 11 and 0 to 9 respectively. The mean was 2.92. The ANOVA is shown in Table 50. There was significant difference in the order.

Proof reading task. The percentage of errors for group 1 and 2 ranged from 17.24% to 83.8% and from 12.5% to 50.00% respectively. The mean was 31.11%. The ANOVA is shown in Table 51. There was no significant difference.

TABLE 46. Means of post stress tasks considering lens type.

TASKS \ LENS TYPE	BIFOCAL	VARILUX-2
First insoluble puzzle	9.65	10.23
Second insoluble puzzle	8.91	11.30
Stroop color task	2.99	2.83
Proof reading task	31.65%	30.383%

TABLE 47. Means of post stress tasks considering order.

TASKS \ ORDER	FIRST	SECOND
First insoluble puzzle	9.93	9.95
Second insoluble puzzle	8.80	11.40
Stroop color task	3.97	1.85 *
Proof reading task	31.26%	30.77%

TABLE 48. ANOVA for the first insoluble puzzle.

SOURCE	DF	TYPE I SS	F VALUE	PR>F
GTYPE	1	3.32378517	0.11	0.7442
ORDER	1	0.00160750	0.00	0.9943

TABLE 49. ANOVA for the second insoluble puzzle.

SOURCE	DF	TYPE I SS	F VALUE	PR>F
GTYPE	1	76.10492327	2.98	0.0927
ORDER	1	65.59258982	2.57	0.1176

TABLE 50. ANOVA for the Stroop color task (Varilux session).

SOURCE	DF	MS	F VALUE	PR>F
GTYPE	1	2.28395141	0.26	0.6128
ORDER	1	44.17665069	5.04	0.0308

TABLE 51. ANOVA for the Proof reading task (Varilux session).

SOURCE	DF	MS	F VALUE	PR>F
GTYPE	1	17.74615402	0.07	0.7950
ORDER	1	2.42150293	0.01	0.9235

Comments. A summary of the comments made by subjects is given below.

Some subjects felt that Varilux-2 caused distorted vision. Some of the comments were:

"Work involving working with known geometric shapes can be a bother, e.g. checking squareness, round plates appearing elliptical."

"Distorts vision, have not adjusted to them."

"Not very good for peripheral vision, causes distortion."

"Reading a page more than 8" wide requires me to move my head."

Some subjects felt that adjusting to Varilux-2 was a problem. Some of the comments were:

"Take(s) longer adjustment period. Probably easier for younger people. I am 63."

"After getting used to them - easier on my eyes, the line not being there."

"I could not get used to them and had headaches after two to four hours. I think they would be nice if one could get used to them."

"Missed my progressive lens (even though I had trouble adjusting to them)."

Some subjects who were impressed by Varilux-2 made the following comments:

"I have enjoyed wearing them. No wave effect when I look up and down or back and forth."

"Generally very good."

"Varilux far superior. With regular bifocals more head movement required and often blurry spots result."

"Best I've ever had. They focus at any distance, that is good."

The favorable comments about the bifocals were:

"Things are much clearer."

"They have a wider area of focus."

"Improved vision."

"Less peripheral distortion than Varilux."

"They are good at bringing out the small print."

Some of the unfavorable comments were:

"Have an area which is blurred when changing from one vision area to another.

"Have trouble at sink, ironing, sewing."

"Can't see the shelf item prices at the stores."

"Bifocals are no good for typing, nothing is ever in focus."

"They are fine for reading but there is an awkward distance that can't be seen clearly."

DISCUSSION

Learning

There was significant learning by the subjects. That is, there was a significant order effect in the penny inspection task and the VDU task. In both these tasks the subjects performed better in their third session than in their second. In other words they missed fewer defectives on both these tasks with their second lens than with their first.

These two tasks were the most difficult of the four performance tasks and hence had some scope of learning. Whereas the visual and blindfolded pegboard assembly tasks were simpler, required litle or no visual functioning and had little room for learning. Especially the VDU task seemed complex to many subjects initially. Added to the complxity of the task was their unfamiliarity with computers. By the third sesion they were comfortable with it.

There was an order effect in the Proof reading task also. But this task showed a negative effect. The performance of the subject deteriorated in the third session, that is, they identified fewer errors in the third session than they did in the second session. This may be attributed to a lack of inerest and hence concentration considering that this was the last task of the entire study.

Stress

Answer to the question "Did you find this at all stressful?" indicated the degree of stress felt in each session. Forty-five percent (18) of the subjects felt that both the second and the third sessions were stressful. Fifteen (37.5%) of the subjects felt that none of the sessions

were stressful. Six (15%) of the subjcts felt that the second session was stressful but not the third. One (2.5%) of the subjects thought that the third session was stressful but not the second.

In the first and the second sessions the subjects probably were a little apprehensive which might have added to the stress. But by the third sesssion they knew what to expect and were more likely to be comfortable. Only one subject felt otherwise. Among the subjects who said that they did not feel any stress at all in any of the sessions, there may be some who thought their answer might be used to judge their capabilities.

Choice of Lens

The null hypothesiss that the proportion of the bifocal and progressive lens wearers before the study will be the same as that at the end of the study, was rejected. The initial number of bifocal and progressive lens wearers was not the same as the final number. Initially there were thirty five bifocal wearers and two progressive lens wearers; finally twenty seven subjects chose bifocals and thirteen chose Varilux-2. This is both a statistical and practical difference. Thus, the experience during the experiment of wearing both lenses resulted in an appreciable fraction of bifocal wearers shifting to progressive lenses.

In a similar study done at Indiana University (Barish, Hitzeman and Brookman, 1980), 66.7% of the subjects chose Varilux-2, 25.9% selected the Ultra View and 7.4% chose neither. But this study used subjective measures only.

More subjects might have changed over to Varilux-2 in this study (the present one) if they had been allowed to wear the lenses for more than a month. It is evident from the comments of the subjects that one month was not adequate to totally adapt to Varilux-2. Appendix 8 shows the types of frames used by the subjects.

Performance tasks

There were significant differences in the visual pegboard assembly, blindfolded pegboard assembly and the VDU task. All of them were in favor of Varilux-2. That is the subjects missed fewer pegs while using Varilux-2. In the VDU task the subjects identified more defectives. The hypothesis that function is better with Varilux-2 than bifocals was accepted in three out of the four tasks.

It can be said that visual functioning was better with Varilux-2 in the visual pegboard assembly and the VDU task. The significant difference obtained in the blindfolded pegboard assembly suggests that something other than visual functioning was involved. This may be stress -- all of these performance tasks may, to some degree be stress tasks. Hence less stress was induced while wearing Varilux-2.

But the stress indicated by the performance tasks was that which was induced in a period of one month while wearing a particular lens (i.e., excluding stress induced by the performance tasks). On the other hand the post stress tasks indicated the sum of the stress induced during one month and that induced by the performance tasks.

Post Stress Tasks

In the post stress tasks the only significant difference was in the

first insoluble puzzle of the Feather task. Subjects while using Varilux-2 tried more times (had more tolerance for frustration) than while using bifocals. This may be attributed to more stress being induced in the month they were wearing bifocals than the month they wore Varilux-2.

The Feather task seems to be a more sensitive indicator of stress than the Stroop color task and the Proof reading task. Even in the Pilot Study this was the only stress task that showed a significant difference.

CONCLUSIONS

The lenses did not affect the feeling of the subjects as found by the ACL mood form. But the choice of lenses indicated that Varilux-2 lenses were superior.

Visual functioning was found to be better with Varilux-2 in the visual pegboard assembly and the VDU task. Subjects missed fewer pegs on the blindfolded pegboard assembly while using Varilux-2; possibly this indicated that this was also a stress task.

More stress was induced in the month that the subjects wore bifocals. This was indicated by the greater number of trials on the Feather task while using Varilux-2. It can also be said that Varilux-2 reduces the degree of induced stress.

Based on subjective measures, performance measures and stress measures Varilux-2 was found to be the superior lens.

Future research on evaluation of lenses could be done using the VDU task. The VDU task was the most demanding task and showed a very high significant difference. Besides,in the future more and more people will be using VDUs.

people will be using VDUs.

Subjects could be chosen who use VDUs as a part of their regular jobs. These subjects would wear different lenses for the same time period. It is suggested that this period be more than a month unlike the present study. From the comments of the subjects in the present study, it was obvious that one month was not adequate to adapt to a new kind of lens.

After the time period is over, the performance of the subjects could be measured. Their performance could be the performance on their job or on some tasks. Their performance would indicate which lens was better.

APPENDIX

The following abbreviations have been used:

(1) SUBJ for subject.

(2) LTYPE for lens type. "1" under this column denotes Varilux-2.

(3) VISUAL for the scores on the visual pegboard assembly.

(4) BLIND for the scores on the blindfolded pegboard assembly.

(5) PENNY for the penny inspection task.

(6) VDU for the VDU task.

(7) ONE for the first insoluble Feather puzzle.

(8) TWO for the second insoluble Feather puzzle.

(9) STROOP for the Stroop color task.

(10) PROOF for the proof reading task.

(11) On the Mood ACL form A, B, C, D, E, F, G, H, I, J, K denote Aggression, Anxiety, Surgency, Elation, Concentration, Fatigue, Social Affection, Sadness, Skepticism, Egotism, and Vigor, respectively.

APPENDIX 1

Calibration of Conveyor

VOLTS	FT/MIN
50	4.2
55	8.4
60	13.2
65	18.0
70	22.2
75	27.0
80	30.0
85	35.4
90	40.2
95	44.4
100	49.2
105	54.0
110	58.8

APPENDIX 2

Mood ACL data for the bifocal session.

SUBJ	LTYPE	A	B	C	D	E	F	G	H	I	J	K	ORDER
1	1	3	5	3	3.0	6	3	3	3	6	3	5	1
2	1	3	3	6	4.0	8	3	7	3	3	3	8	2
3	1	3	7	7	11.0	3	8	3	3	3	3	11	1
4	1	3	4	6	5.0	10	7	6	3	5	4	8	2
5	1	6	6	5	6.0	6	6	6	4	5	9	7	1
6	1	3	5	12	12.0	9	4	12	3	6	6	12	2
7	1	3	3	10	11.0	4	7	10	4	4	7	6	1
8	1	3	3	7	5.0	9	5	7	3	3	5	10	2
9	1	3	3	9	9.0	12	3	9	3	3	3	12	1
10	1	5	3	3	3.0	9	3	5	3	3	4	7	2
11	1	3	4	8	9.0	10	3	9	3	3	5	9	1
12	1	3	3	7	8.0	6	3	9	6	6	3	7	2
13	1	3	5	4	6.0	8	5	7	3	3	3	9	1
14	1	8	6	6	7.0	8	7	8	7	8	7	8	2
15	1	5	6	7	9.0	9	7	11	6	5	5	9	1
16	1	3	5	5	4.0	7	3	6	3	5	3	10	2
17	1	3	4	6	7.0	9	4	10	3	3	5	7	1
18	1	3	3	6	6.0	8	3	5	3	3	3	7	2
19	1	3	3	5	6.0	12	3	1	3	3	3	12	1
20	1	3	7	4	7.0	10	9	8	3	3	3	9	2
21	1	3	6	5	3.0	10	5	4	3	7	3	3	1
22	1	3	3	5	6.0	6	3	7	3	3	3	8	2
23	1	3	3	6	6.0	9	3	9	3	4	3	7	1
24	1	3	4	4	6.0	9	4	9	3	3	4	8	2
25	1	3	3	4	5.0	7	3	8	3	4	3	5	1
26	1	3	4	11	9.0	12	5	12	4	5	5	6	2
27	1	3	5	3	3.0	9	5	5	3	3	3	7	1
28	1	3	3	6	8.0	9	3	9	3	3	3	9	2
29	1	3	4	9	7.0	11	3	10	3	3	7	9	1
30	1	4	3	6	8.0	11	8	10	7	9	9	9	2
31	1	3	3	10	5.0	9	4	6	3	6	3	9	1
32	1	3	3	6	4.0	8	6	6	3	5	3	7	2
33	1	9	7	5	7.5	9	11	7	7	9	7	8	1
34	1	3	3	5	6.0	8	3	8	3	3	3	8	2
35	1	4	3	9	9.0	12	3	10	3	4	6	9	1

APPENDIX 2 (continued)

36	1	3	6	4	5.0	10	3	5	3	5	3	5	2
37	1	3	8	7	6.0	12	3	9	3	7	3	12	1
38	1	3	3	4	3.0	9	3	3	3	3	3	4	2
39	1	3	3	3	3.0	10	3	3	3	3	3	12	1
40	1	3	4	10	8.0	10	3	10	3	5	3	9	2

APPENDIX 3

Mood ACL data for the Varilux session.

SUBJ	LTYPE	A	B	C	D	E	F	G	H	I	J	K	ORDER
1	2	3	3	3	3.0	3	9	7	3	3	3	3	2
2	2	3	6	3	3.0	6	3	5	3	7	3	5	1
3	2	3	4	7	5.0	12	3	10	3	8	3	12	2
4	2	3	3	8	11.0	12	3	10	3	5	3	12	1
5	2	3	6	3	3.0	11	8	5	4	9	3	4	2
6	2	3	3	4	5.0	10	3	8	3	5	3	7	1
7	2	3	3	9	11.0	7	9	11	4	2	8	5	2
8	2	3	4	8	4.0	10	6	7	3	3	5	5	1
9	2	5	4	4	4.0	5	9	6	8	7	7	4	2
10	2	3	3	4	3.0	10	3	7	3	3	3	10	1
11	2	5	4	9	7.5	10	4	11	4	3	5	9	2
12	2	3	3	4	6.0	10	4	9	5	5	6	7	1
13	2	3	3	9	8.0	7	3	9	3	3	3	9	2
14	2	3	3	6	10.0	8	3	8	3	3	3	7	1
15	2	3	3	5	8.0	5	5	8	3	3	3	3	2
16	2	3	3	5	5.0	9	5	8	3	6	3	5	1
17	2	3	3	6	7.0	10	3	11	3	5	3	9	2
18	2	3	3	4	4.0	7	4	5	3	4	3	7	1
19	2	4	3	10	10.0	12	3	12	3	4	4	12	2
20	2	3	5	5	8.0	11	3	11	3	3	5	10	1
21	2	3	3	3	5.0	7	5	4	3	4	3	5	2
22	2	3	3	4	4.0	5	5	6	3	3	3	8	1
23	2	3	3	7	6.0	12	5	6	4	5	3	7	2
24	2	3	3	3	7.0	11	3	10	3	3	4	8	1
25	2	3	4	4	6.0	7	3	9	4	5	4	7	2
26	2	3	6	10	10.0	12	3	12	5	4	6	11	1
27	2	8	9	9	10.0	9	9	9	9	6	6	7	2
28	2	3	5	6	7.0	10	3	10	3	8	3	8	1
29	2	3	4	5	6.0	12	3	7	3	7	7	9	2
30	2	5	5	7	8.0	11	8	10	5	7	9	9	1

APPENDIX 3 (continued)

SUBJ	LTYPE	A	B	C	D	E	F	G	H	I	J	K	ORDER
31	2	3	3	7	5.0	7	3	6	3	4	3	9	2
32	2	3	3	4	4.0	9	7	6	3	4	3	8	1
33	2	7	7	4	7.0	10	5	7	5	8	3	8	2
34	2	3	5	5	4.0	4	3	6	3	3	3	8	1
35	2	4	3	9	9.0	12	3	10	3	4	6	9	2
36	2	3	3	6	7.0	10	3	8	3	4	3	10	1
37	2	3	3	7	10.0	12	5	10	3	3	3	10	2
38	2	3	3	3	3.0	9	3	3	3	5	3	3	1
39	2	3	3	4	5.0	9	7	5	3	3	3	6	2
40	2	3	3	6	5.0	10	3	10	5	3	3	7	1

APPENDIX 4

Performance tasks data

OBS	SUBJ	LTYPE	VISUL	BLIND	PENNY	VDU	ORDER
1	1	1	12	21	80.01	56.52	1
2	2	1	11	14	65.00	43.47	2
3	3	1	4	10	55.00	76.60	1
4	4	1	8	22	60.00	30.43	2
5	5	1	6	5	33.30	21.70	1
6	6	1	2	19	75.00	34.78	2
7	7	1	10	8	50.00	30.43	1
8	8	1	4	11	60.00	17.39	2
9	9	1	7	5	46.60	56.52	1
10	10	1	0	6	55.00	47.80	2
11	11	1	18	12	75.00	43.40	1
12	12	1	8	16	81.60	43.48	2
13	13	1	2	12	46.70	52.17	1
14	14	1	13	20	73.30	65.20	2
15	15	1	11	8	71.60	34.80	1
16	16	1	7	15	55.00	26.08	2
17	17	1	19	13	66.60	52.17	1
18	18	1	1	9	53.30	17.39	2
19	19	1	10	14	65.00	60.87	1
20	20	1	6	2	51.60	43.40	2
21	21	1	7	9	53.30	69.60	1
22	22	1	5	22	56.60	47.82	2
23	23	1	0	11	33.30	30.43	1
24	24	1	5	2	63.30	21.73	2
25	25	1	11	10	71.60	21.70	1
26	26	1	8	8	58.30	30.43	2
27	27	1	9	4	63.30	52.10	1
28	28	1	4	15	58.30	39.13	2
29	29	1	4	6	60.00	44.40	1
30	30	1	7	8	66.60	8.69	2
31	31	1	9	11	70.00	47.80	1
32	32	1	5	10	71.66	30.43	2
33	33	1	4	6	65.00	43.40	1
34	34	1	2	2	63.30	39.13	2
35	35	1	3	4	58.30	47.80	1

APPENDIX 4 (continued)

OBS	SUBJ	LTYPE	VISUL	BLIND	PENNY	VDU	ORDER
36	36	1	7	3	5.00	34.78	2
37	37	1	13	14	66.60	61.10	1
38	38	1	4	1	65.00	100.00	2
39	39	1	7	13	70.00	86.90	1
40	40	1	4	10	71.66	95.60	2
41	1	2	14	2	81.60	65.20	2
42	2	2	8	16	73.30	56.52	1
43	3	2	6	10	61.70	39.13	2
44	4	2	6	19	70.00	39.13	1
45	5	2	0	1	21.60	8.69	2
46	6	2	14	16	71.60	21.70	1
47	7	2	2	11	58.30	26.08	2
48	8	2	2	8	53.30	21.70	1
49	9	2	9	5	51.60	52.17	2
50	10	2	0	6	68.30	39.13	1
51	11	2	11	9	70.00	13.04	2
52	12	2	4	14	63.30	52.17	1
53	13	2	6	7	40.00	13.04	2
54	14	2	9	12	76.60	100.00	1
55	15	2	13	0	60.00	39.13	2
56	16	2	8	13	61.60	13.04	1
57	17	2	13	15	65.00	4.30	2
58	18	2	2	13	65.00	34.78	1
59	19	2	6	5	73.30	56.50	2
60	20	2	6	13	63.30	13.04	1
61	21	2	2	5	48.30	4.30	2
62	22	2	2	0	66.60	43.47	1
63	23	2	0	2	16.60	26.08	2
64	24	2	7	7	56.60	26.08	1
65	25	2	4	5	60.00	17.40	2
66	26	2	10	5	75.00	56.52	1
67	27	2	10	8	58.30	26.08	2
68	28	2	4	6	65.00	21.70	1
69	29	2	3	13	66.60	4.30	2
70	30	2	0	4	70.00	21.73	1

APPENDIX 4 (continued)

OBS	SUBJ	LTYPE	VISUL	BLIND	PENNY	VDU	ORDER
71	31	2	4	6	53.30	13.04	2
72	32	2	9	3	80.00	60.86	1
73	33	2	0	6	71.60	26.08	2
74	34	2	2	4	73.30	17.39	1
75	35	2	0	8	56.60	26.08	2
76	36	2	6	4	86.60	47.80	1
77	37	2	9	13	71.66	55.50	2
78	38	2	2	6	71.66	17.39	1
79	39	2	4	6	53.30	47.80	2
80	40	2	0	12	70.00	69.56	1

APPENDIX 5

Post Stress Data

OBS	SUBJ	LTYPE	ONE	TWO	STROOP	PROOF	ORDER
1	1	1	7	10	0	21.05	1
2	2	1	6	6	10	51.80	2
3	3	1	22	21	9	40.00	1
4	4	1	2	3	2	46.34	2
5	5	1	8	10	0	5.88	1
6	6	1	6	5	3	28.90	2
7	7	1	3	9	3	31.60	1
8	8	1	2	5	0	21.60	2
9	9	1	10	8	8	48.80	1
10	10	1	8	2	11	50.00	2
11	11	1	9	10	0	7.69	1
12	12	1	10	6	1	50.00	2
13	13	1	7	11	2	15.70	1
14	14	1	6	3	6	25.00	2
15	15	1	7	23	0	20.00	1
16	16	1	8	10	0	50.00	2
17	17	1	4	5	3	20.00	1
18	18	1	9	27	0	21.42	2
19	19	1	5	10	9	40.00	1
20	20	1	8	8	0	42.00	2
21	21	1	7	12	0	21.73	1
22	22	1	8	6	0	47.82	2
23	23	1	8	14	0	52.90	1
24	24	1	7	18	0	28.10	2
25	25	1	4	7	1	40.00	1
26	26	1	5	9	0	29.78	2
27	27	1	2	10	0	40.00	1
28	28	1	21	15	2	48.48	2
29	29	1	7	5	0	29.40	1
30	30	1	8	3	5	57.14	2
31	31	1	10	9	1	15.00	1
32	32	1	9	36	0	28.00	2
33	33	1	4	5	0	30.76	1
34	34	1	21	20	0	34.61	2
35	35	1	8	6	1	30.76	1

APPENDIX 5 (continued)

OBS	SUBJ	LTYPE	ONE	TWO	STROOP	PROOF	ORDER
36	36	1	3	14	1	53.12	2
37	37	1	5	6	3	25.80	1
38	38	1	6	5	0	8.80	2
39	39	1	5	14	2	15.38	1
40	40	1	5	3	6	37.80	2
41	1	2	10	11	0	26.60	2
42	2	2	10	5	11	83.80	1
43	3	2	2	16	5	42.10	2
44	4	2	5	7	7	17.60	1
45	5	2	7	15	7	17.60	2
46	6	2	8	14	7	23.30	1
47	7	2	8	4	1	21.61	2
48	8	2	10	7	1	27.20	1
49	9	2	3	5	3	66.60	2
50	10	2	7	8	2	36.00	1
51	11	2	6	15	0	12.50	2
52	12	2	6	8	0	46.10	1
53	13	2	21	15	0	31.03	2
54	14	2	7	8	3	25.00	1
55	15	2	22	25	0	17.50	2
56	16	2	6	8	0	36.00	1
57	17	2	26	12	3	31.80	2
58	18	2	11	7	6	30.76	1
59	19	2	12	28	0	47.20	2
60	20	2	14	11	0	20.83	1
61	21	2	6	7	1	30.00	2
62	22	2	5	6	2	21.42	1
63	23	2	2	9	0	31.60	2
64	24	2	13	14	0	13.79	1
65	25	2	7	6	0	56.70	2
66	26	2	12	11	6	17.24	1
67	27	2	1	4	1	35.71	2
68	28	2	11	6	1	33.30	1
69	29	2	8	6	5	22.50	2
70	30	2	14	6	8	58.33	1

APPENDIX 5 (continued)

OBS	SUBJ	LTYPE	ONE	TWO	STROOP	PROOF	ORDER
71	31	2	20	14	0	22.50	2
72	32	2	10	12	0	14.28	1
73	33	2	7	8	5	25.80	2
74	34	2	13	8	9	42.10	1
75	35	2	9	10	2	29.03	2
76	36	2	11	8	1	21.42	1
77	37	2	14	10	3	31.25	2
78	38	2	11	1	3	10.71	1
79	39	2	8	8	1	15.78	2
80	40	2	13	14	8	50.00	1

APPENDIX 6

Data For Comparison One

GTYPE	VISUL	BLIND	PENNY	VDU	ORDER
1	12	21	80.01	56.52	1
1	11	14	65.00	43.47	2
1	4	10	55.00	76.60	1
1	8	22	60.00	30.43	2
1	6	5	33.30	21.70	1
1	2	19	75.00	34.78	2
1	10	8	50.00	30.43	1
1	4	11	60.00	17.39	2
1	7	5	46.60	56.52	1
1	0	6	55.00	47.80	2
1	7	15	55.00	26.08	2
1	19	13	66.60	52.17	1
1	6	2	51.60	43.40	2
1	7	9	53.30	69.60	1
1	5	22	56.60	47.82	2
1	0	11	33.30	30.43	1
1	8	8	58.30	30.43	2
1	4	15	58.30	39.13	2
1	7	8	66.60	8.69	2
1	9	11	70.00	47.80	1
1	7	3	5.00	34.78	2
1	13	14	66.60	61.10	1
1	4	1	65.00	100.00	2
2	18	12	75.00	43.40	1
2	8	16	81.60	43.48	2
2	2	12	46.70	52.17	1
2	13	20	73.30	65.20	2
2	11	8	71.60	34.80	1
2	1	9	53.30	17.39	2
2	10	14	65.00	60.87	1
2	5	2	63.30	21.73	2
2	11	10	71.60	21.70	1
2	9	4	63.30	52.10	1
2	4	6	60.00	44.40	1
2	5	10	71.66	30.43	2

APPENDIX 6 (continued)

GTYPE	VISUL	BLIND	PENNY	VDU	ORDER
2	4	6	65.00	43.40	1
2	2	2	63.30	39.13	2
2	3	4	58.30	47.80	1
2	7	13	70.00	86.90	1
2	4	10	71.66	95.60	2

APPENDIX 6 (continued)

OBS	GTYPE	ONE	TWO	STROOP	PROOF	ORDER
1	1	7	10	0	21.05	1
2	1	6	6	10	51.80	2
3	1	22	21	9	40.00	1
4	1	2	3	2	46.34	2
5	1	8	10	0	5.88	1
6	1	6	5	3	28.90	2
7	1	3	9	3	31.60	1
8	1	2	5	0	21.60	2
9	1	10	8	8	48.80	1
10	1	8	2	11	50.00	2
11	1	8	10	0	50.00	2
12	1	4	5	3	20.00	1
13	1	8	8	0	42.00	2
14	1	7	12	0	21.73	1
15	1	8	6	0	47.82	2
16	1	8	14	0	52.90	1
17	1	5	9	0	29.78	2
18	1	21	15	2	48.48	2
19	1	8	3	5	57.14	2
20	1	10	9	1	15.00	1
21	1	3	14	1	53.12	2
22	1	5	6	3	25.80	1
23	1	6	5	0	8.80	2
24	2	9	10	0	7.69	1
25	2	10	6	1	50.00	2
26	2	7	11	2	15.70	1
27	2	6	3	6	25.00	2
28	2	7	23	0	20.00	1
29	2	9	27	0	21.42	2
30	2	5	10	9	40.00	1
31	2	7	18	0	28.10	2
32	2	4	7	1	40.00	1
33	2	2	10	0	40.00	1
34	2	7	5	0	29.40	1
35	2	9	36	0	28.00	2
36	2	4	5	0	30.76	1
37	2	21	20	0	34.61	2
38	2	8	6	1	30.76	1
39	2	5	14	2	15.38	1
40	2	5	3	6	37.80	2

APPENDIX 7 Data for Comparison Two

OBS	GTYPE	VISUAL	BLIND	PENNY	VDU	ORDER
1	1	14	2	81.60	65.20	2
2	1	8	16	73.30	56.52	1
3	1	6	10	61.70	39.13	2
4	1	6	19	70.00	39.13	1
5	1	0	1	21.60	8.69	2
6	1	14	16	71.60	21.70	1
7	1	2	11	58.30	26.08	2
8	1	2	8	53.30	21.70	1
9	1	9	5	51.60	52.17	2
10	1	0	6	68.30	39.13	1
11	1	8	13	61.60	13.04	1
12	1	13	15	65.00	4.30	2
13	1	5	13	63.30	13.04	1
14	1	2	5	48.30	4.30	2
15	1	2	0	66.60	43.47	1
16	1	0	2	16.60	26.08	2
17	1	10	5	75.00	56.52	1
18	1	4	6	65.00	21.70	1
19	1	0	4	70.00	21.73	1
20	1	4	6	53.30	13.04	2
21	1	6	4	86.60	47.80	1
22	1	9	13	71.66	55.50	2
23	1	2	6	71.66	17.39	1
24	2	11	9	70.00	13.04	2
25	2	4	14	63.30	52.17	1
26	2	6	7	40.00	13.04	2
27	2	9	12	76.60	100.00	1
28	2	13	0	60.00	39.13	2
29	2	2	13	65.00	34.78	1
30	2	6	5	73.30	56.50	2
31	2	7	7	56.60	26.08	1
32	2	4	5	60.00	17.40	2
33	2	10	8	58.30	26.08	2
34	2	3	13	66.60	4.30	2
35	2	9	3	80.00	60.86	1
36	2	0	6	71.60	26.08	2
37	2	2	4	73.30	17.39	1
38	2	0	8	56.60	26.08	2
39	2	4	6	53.30	47.80	2
40	2	0	12	70.00	69.56	1

APPENDIX 7 (continued)

OBS	GTYPE	ONE	TWO	STROOP	PROOF	ORDER
1	1	10	11	0	26.60	2
2	1	10	5	11	83.80	1
3	1	2	16	5	42.10	2
4	1	5	7	7	17.60	1
5	1	7	15	7	17.60	2
6	1	8	14	7	23.30	1
7	1	8	4	1	21.61	2
8	1	10	7	1	27.20	1
9	1	3	5	3	66.60	2
10	1	7	8	2	36.00	1
11	1	6	8	0	36.00	1
12	1	26	12	3	31.80	2
13	1	14	11	0	20.83	1
14	1	6	7	1	30.00	2
15	1	5	6	2	21.42	1
16	1	2	9	0	31.60	2
17	1	12	11	6	17.24	1
18	1	11	6	1	33.30	1
19	1	14	6	8	58.33	1
20	1	20	14	0	22.50	2
21	1	11	8	1	21.42	1
22	1	14	10	3	31.25	2
23	1	11	1	3	10.71	1
24	2	6	15	0	12.50	2
25	2	6	8	5	46.10	1
26	2	21	15	0	31.03	2
27	2	7	8	3	25.00	1
28	2	22	25	0	17.50	2
29	2	11	7	6	30.76	1
30	2	12	28	0	47.20	2
31	2	13	14	0	13.79	1
32	2	7	6	0	56.70	2
33	2	1	4	1	35.71	2
34	2	8	6	5	22.50	2
35	2	10	12	0	14.28	1
36	2	7	8	5	25.80	2
37	2	13	8	9	42.10	1
38	2	9	10	2	29.03	2
39	2	8	8	1	15.78	2
40	2	13	14	8	50.00	1

APPENDIX 8

NUMBER	OLD R_x	NEW R_x	TYPE OF R_x PREVIOUSLY WORN
1	R +0.37-1.25x67 L -0.75-0.50x130 +1.25Add	R +0.75-1.50x65 L -0.50-0.50x120 +2.00Add	FT 25 Bifocal
2	R +0.75-0.62x138 L +0.50-0.25x44 +1.00Add	R +0.75-0.50x137 L +0.25-0.25x45 +1.75Add	FT 28 Bifocal
3	R -1.12-3.00x117 L -1.37-3.00x78 +2.62Add	R -0.75-3.25x122 L -1.25-3.50x70 +2.50Add	FT 25 Bifocal
4	R -1.50-0.25x2 L +0.12-0.62x167 +1.50Add	R -1.50 D.S. L +0.25-0.50x165 +2.25Add	FT 25 Bifocal
5	R +0.75-0.25x180 L +0.75-0.62x178 +2.00Add	R +1.50-0.25x109 L +1.25-0.50x25 +2.00Add	FT 35 Bifocal
6	R -3.75D.S. L -3.75D.S. +2.25Add	R -3.50-0.50x143 L -3.50D.S. +2.00Add	Executive Bifocal
7	R Pl L PL +1.50Add	R +0.25D.S. L +0.50-0.25x25 +2.00Add	Executive Bifocal
8	R +1.00-3.25x150 L +1.12-3.87x37 +2.00Add	R +1.00-3.25x150 L +1.00-3.50x41 +2.00Add	FT 25 Bifocal
9	R +0.50-0.50x88 L +0.50-0.50x95 +2.25Add	R +1.00-0.25x109 L +1.25-0.75x82 +2.25Add	FT 25 Bifocal
10	R -0.50-0.25x90 L -0.75-0.25x115 +1.25Add	R -0.25-0.50x93 L -0.75-0.25x110 +2.00Add	FT 25 Bifocal
11	R -3.00-1.25x80 L -2.25-1.00x145 +1.25Add	R -3.00-1.25x80 L -2.75-0.75x140 +2.00Add	Ultravue

12	R -0.75D.S. L -0.62D.S. +1.50Add	R -0.75D.S. L -0.75D.S. +2.00Add	FT 25 Bifocal
13	R +1.00D.S. L +0.75D.S. +2.25Add	R +1.50-0.25x75 L +1.00-0.25x150 +2.25Add	FT 7/25 Trifocal
14	R +0.50-0.25x90 L +0.25-0.50x90 +2.00Add	R +0.75D.S. L +0.75-0.75x123 +2.25Add	Executive Bifocal
16	R -2.00-1.25x2 L -2.50-3.00x145 +1.50Add	R -2.25-1.25x2 L -2.25-3.50x147 +1.75Add	Ultravue
17	R +0.25-0.75x176 L PL-0.25x169 +2.25Add	R +0.25-0.75x5 L -0.25-0.25x170 +2.25Add	FT 7/25 Trifocal
18	R -4.25-0.75x43 L -4.50-0.75x151 +2.00Add	R -4.75-.75x30 L -5.00-.75x157 +2.00Add	FT 8/35 Trifocal
19	R +0.37-1.75x156 L +0.37-0.37x3 +2.00Add	R +0.50-1.50x160 L +0.75-0.50x2 +2.00Add	FT 25 Bifocal
20	R - 5.00-0.50x163 L -4.75-0.25x114 +2.25Add	R -4.75-0.50x165 L -4.50-0.25x115 +2.25Add	Executive Bifocal
21	R -7.00-0.50x48 L -7.25-1.00x150 +1.50Add	R -6.50-1.00x45 L -7.25-1.00x150 +2.00Add	FT 25 Bifocal
22	R +2.75-0.25x7 L +2.37-0.50x169 +2.00Add	R +3.00-0.25x7 L +3.00-0.50x175 +2.25Add	FT 6/22 Trifocal
23	R -2.75-2.25x15 L -2.75-2.50x180 +1.75Add	R -2.75-2.25x19 L -2.75-2.50x176 +1.75Add	FT 25 Bifocal
24	R -3.25-0.75x111 L -3.00-1.00x74 +2.00Add	R -2.75-0.75x118 L -2.75-0.25x90 +2.00Add	FT 28 Bifocal
25	R -0.50-0.25x20 L -0.50-0.50x19	R -0.7-0.25x162 L -0.75-0.25x12	S.U. Distance Remove R_x for reading

26	R +2.00-0.75x115 L +2.25-1.00x80 +2.25Add	R +2.00-0.75x115 L +2.25-1.00x80 +2.25Add	FT 7/25 Trifocal
27	R -0.25-1.75x94 L PL -1.12x82	R -0.50-1.75x90 L PL-1.25x88	21 1/2 mm Round Bifocal
28	R +1.50-.12x38 L +1.25-0.25x175	R +0.50D.S. L +0.50-0.25x124 +1.75Add	S.U. Reading
29	R +1.75-0.75x73 L +1.50-0.50x100 +2.00Add	R +1.75-0.75x75 L +1.25-0.50x85 +2.00Add	FT 28 Bifocal
30	R +2.50-0.50x88 L +2.25-0.25x95 +2.50Add	R +2.50-0.25x130 L +2.75-0.25x108 +2.25Add	FT 35 Bifocal
31	R +0.75-4.00x5 L +1.00-4.00x160 +1.75Add	R +1.25-3.75x6 L +1.25-3.75x164 +2.25Add	FT 25 Bifocal
32	R +1.50-0.25x36 L +1.50-0.25x167 +2.00Add	R +1.25-0.25x70 L +1.25-0.25x145 +2.25Add	FT 25 Bifocal
34	R -3.75D.S. L -4.00D.S. +2.25Add	R -3.50D.S. L -3.75D.S. +2.75Add	FT 25 Bifocal
35	R -3.75-3.75x13=1/2 DBdum L -5.62-1.75x156 +1.75Add	R -3.50-4.25x16=1D L -5.50-2.00x157=LDB +2.50Add	FT 35 Bifocal
36	R -4.75-2.00x77 L -5.00-1.00x95 +1.50Add	R -5.00:2.00x81 L -5.00-1.00x99 +2.00Add	Ft 7/25 Trifocal
37	R -.25D.S. L -.12D.S. +1.75Add	R +0.25-0.25x67 L +0.25-0.25x130 +2.00Add	FT 25 Bifocal
38.	No R_x	R +1.25-0.25x180 L +0.75D.S. +2.25Add	No Previcus R_x
39	R +0.25D.S. L +0.50D.S. +1.75Add	R +0.25D.S. L +0.50D.S. +2.00Add	Executive Bifocal

40	R +0.50-0.25x175 L +0.25-0.25x157 +1.25Add	R +0.50-0.25x172 L +0.25-0.25x180 +2.00Add	FT 35 Bifocal
41	R -4.75-0.75x40 L -2.25-1.50x164 +1.75Add	R -4.75-0.75x39 L-2.50-1.50x145 +1.75Add	FT 28 Bifocal
42	R -0.25D.S. L -1.00-0.25x143 +1.75Add	R +0.50D.S. L -0.50-0.50x137 +2.00Add	Ft 25 Bifocal

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PERFORMANCE AND PSYCHOLOGICAL TESTING OF BIFOCALS AND PROGRESSIVE LENSES

by

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AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

The purpose of this study was to contrast bifocal lenses and Varilux-2 progressive lenses. Subjective, Performance and Stress measures were used for comparison.

Forty subjects selected a single frame to be used for the two types of lenses and at random half wore Varilux-2 and half bifocals for one month. Then they were tested, and then wore the other lens for one month and were tested again.

At the beginning of the research and at the end of each month of lens usage, each participant was given a battery of performance tasks. The tasks were: (1) Visual pegboard assembly, (2) Blindfolded pegboard assembly, (3) Penny inspection task, and (4) VDU task.

The performance measures provided a direct comparison of the lenses and were also used to induce stress. The lens that produced less stress would be the superior lens.

Psychological stress measures were used to indicate the degree of stress. These were: (1) Feather tolerance for frustration, (2) Stroop color task and (3) Proof reading task.

According to the subjective measure, which was the final choice of lenses by the subjects, Varilux-2 was the superior lens. Out of the four tasks which were used as performance measures, three favored the Varilux-2. Subjects performed better on (1) Visual pegboard assembly, (2) Blindfolded pegboard assembly and (3) VDU task, while using Varilux-2. The Feather task which was used as a stress measure also indicated that Varilux-2 was the superior lens.