1-1-1954

A relative convergence home training device

Irwin Sicherman
Pacific University

Clarence Larry
Pacific University

A relative convergence home training device

Abstract
To design an instrument with a battery of cards which is suitable for home training or relative convergence function. The instrument should incorporate features of the card and string, physiological diplopia devices, and the ortho fusoro It should retain simplicity and minimum cost. It should have a wide performance range to allow the poor performer a starting point and the good performer room for improvement.

Degree Type
Thesis

A RELATIVE CONVERGENCE HOME TRAINING DEVICE

A THESIS

PRESENTED TO THE FACULTY OF THE

COLLEGE OF OPTOMETRY

PACIFIC UNIVERSITY

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE

DOCTOR OF OPTOMETRY

BY

IRWIN SICHERMAN
AND
CLARENCE LARRY

A RELATIVE CONVERGENCE HOME TRAINING DEVICE

PROBLEM:

To design an instrument with a battery of cards which is suitable for home training of relative convergence function. The instrument should incorporate features of the card and string, physiological diplopia devices, and the ortho fusor. It should retain simplicity and minimum cost. It should have a wide performance range to allow the poor performer a starting point and the good performer room for improvement.

INTRODUCTION:

In designing an instrument for home training purposes, our main interests were simplicity and minimum expense. It has been the belief of the designers that home training is a very important part of visual training therapeutic procedures, and has not been used to its fullest extents because of lack of simplicity in instrument design.

An attempt was made to design an instrument that could, with a few minutes explanation, be recommended for use by persons of practically any age above six.

This instrument should prove inexpensive to the Optometrist in that it can be built with minimum cost and the simplest of materials.

DESIGN PRINCIPLES:

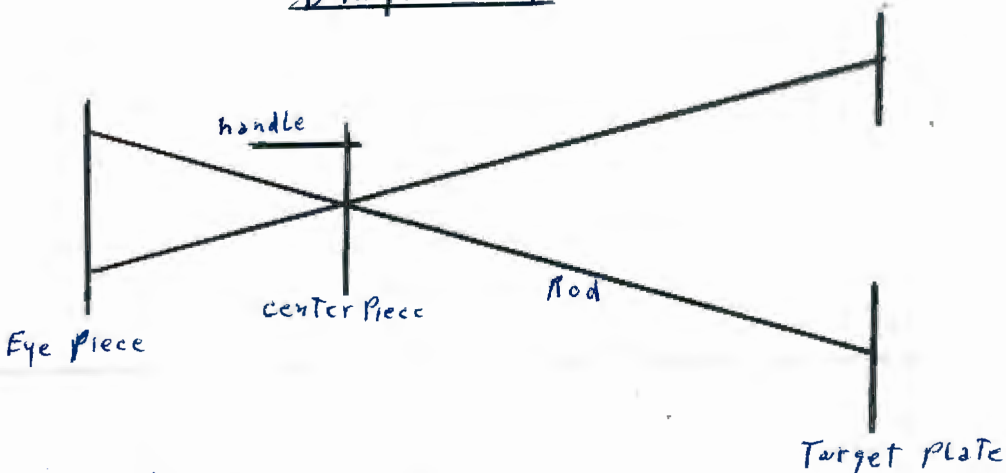
The instrument as conceived attempts to apply principles of projection demonstrated by Hering in a simple experiment. The experiment was as follows: With one eye closed, the subject fixates a distant object A. A pencil is introduced on the line of sight at arms length from the subject. The fixating eye is then closed and the other eye opened. The subject sights through the pencil, which has not been allowed to move, to a distant object B. If the subject now opens both eyes and fixates the pencil, objects A and B will be superimposed over one another, and will be seen at a distance, directly beyond the pencil.

The projection principle to be drawn from this experiment is that when the two foveas are stimulated the source of this stimulation is normally projected to the straight ahead position.

It may be noted that while fixating the pencil, the clarity of the distant objects A and B in Hering's experiment varies for different observers. It is assumed in order to see the pencil singly, the lines of sight of the two eyes must meet at the pencil, or very close to it. It is further assumed that in order to see the distant objects clearly the eyes must be in conjugate focus with these distant objects. For the subject to see objects A and B clearly and the pencil singly, his accommodative system must be postured at a different plane than his convergence system. This situation is foreign to the normal demands on our visual system. It is a visual skill developed in varying degrees in the population. It has been clinically demonstrated that when this facility is poorly developed, subjective complaints are often present. It is assumed that the accommodative convergence relationship is not operating to the best interests of efficient binocular seeing. It has further been demonstrated, clinically, that this facility of relation convergence can be modified by visual training procedures. It has been observed that this modification has served the interests of comfortable, efficient, binocular seeing.

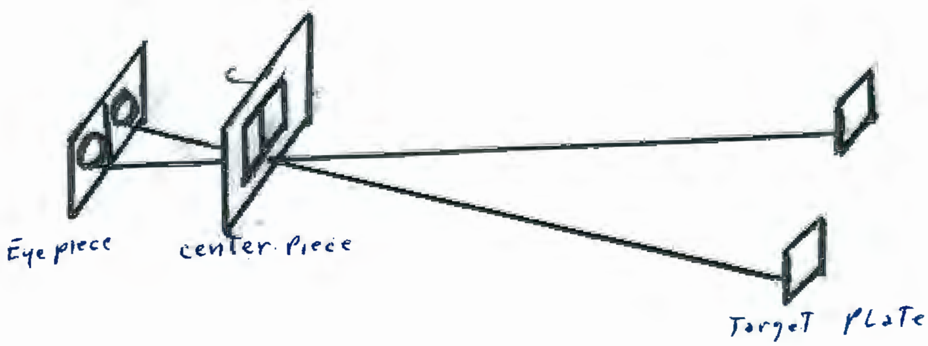
Hering's experiment served to demonstrate that when corresponding visual points are stimulated, single binocular vision results. At any rate, the space localization of corresponding visual points are the same. We have used this principle plus our knowledge of the convergence-accommodation relationship in the design of a home training instrument.

Diagram A



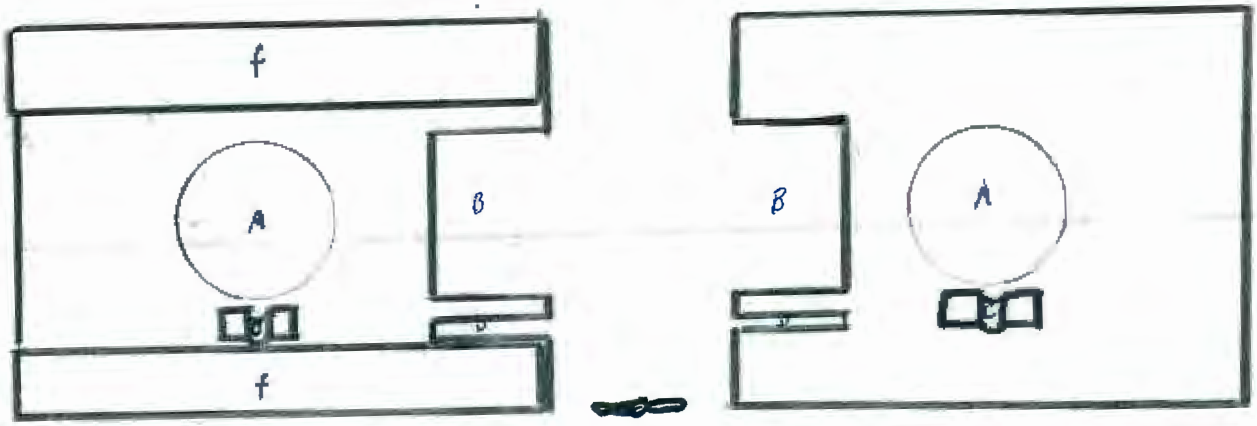
View of Instrument from Above

View of Instrument from the Side



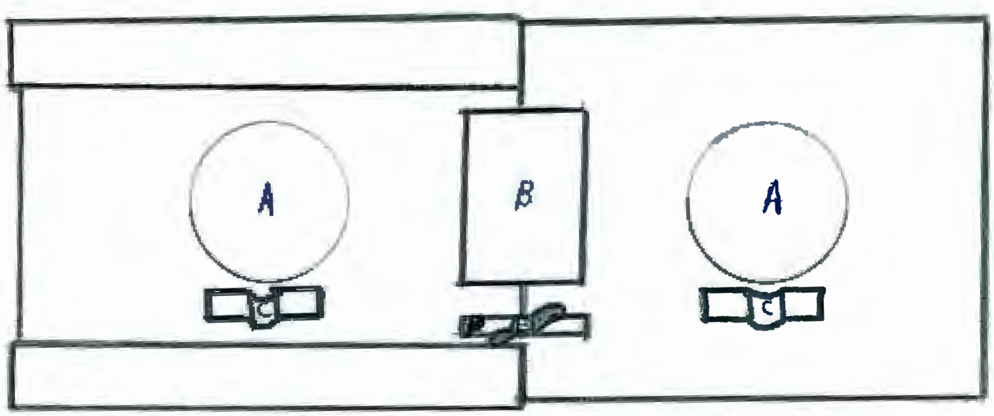
View of Instrument Presenting Surfaces

Diagram B



EYEPIECE (Dismantled)

A - Sight holes
B - Cutouts To increase minimum P.D.
C - Groove for insertion of rod end
D - Cutout for wing nut
E - Wing nut

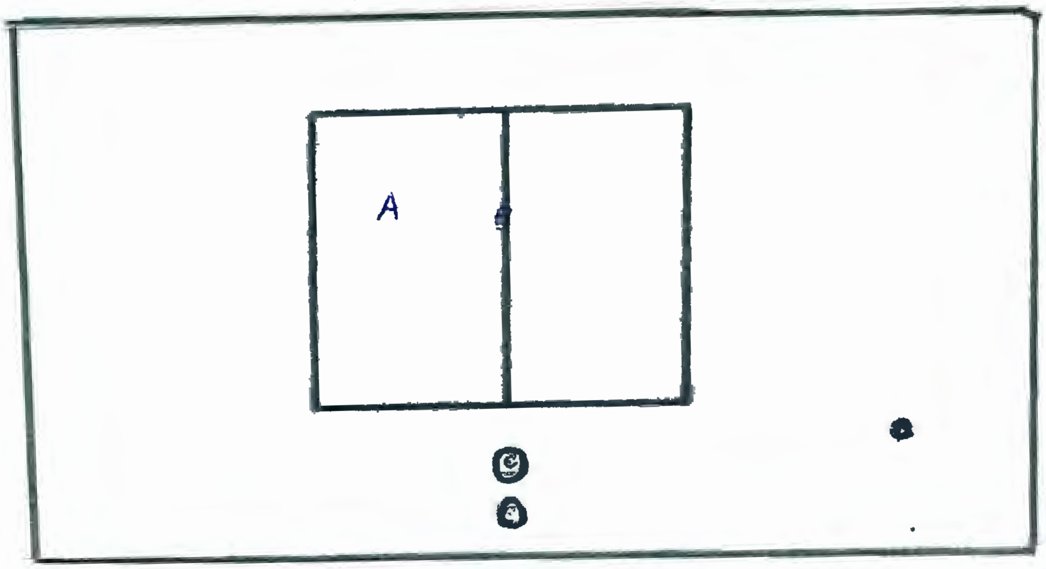


EYEPIECE (Assembled)

A - Sight holes
B - Cutout To increase minimum P.D.
C - Groove for insertion of rod end
D - Cutout for Wing Nut
E - Wing Nut

(9)

Diagram C



CENTER PIECE

A - Center piece window

B - Fixation Target

C - Opening for passage of rod

D - point of attachment of center piece handle

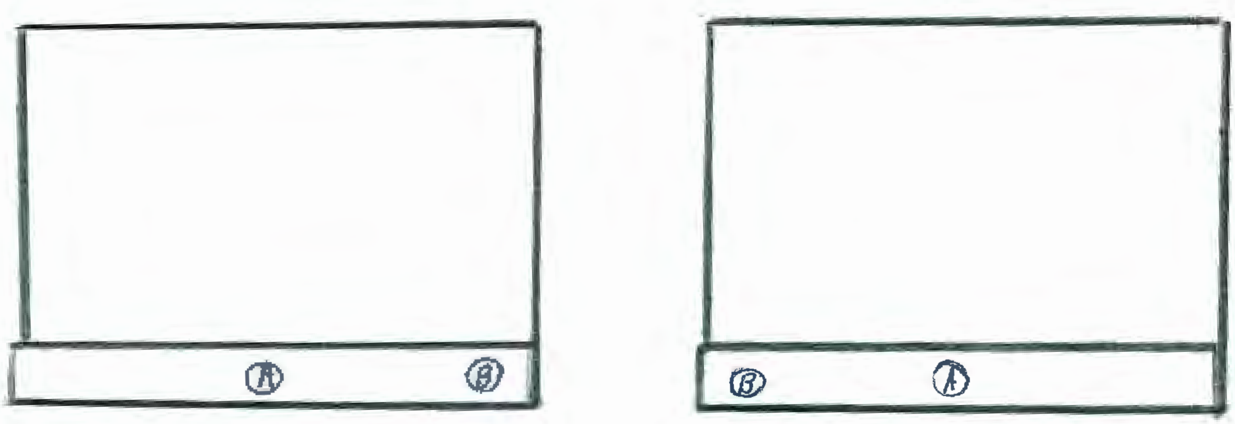
Diagram D

Rod

A-Threaded end for attachment of Target Plate

B-Bend for attachment to eye piece

Diagram E



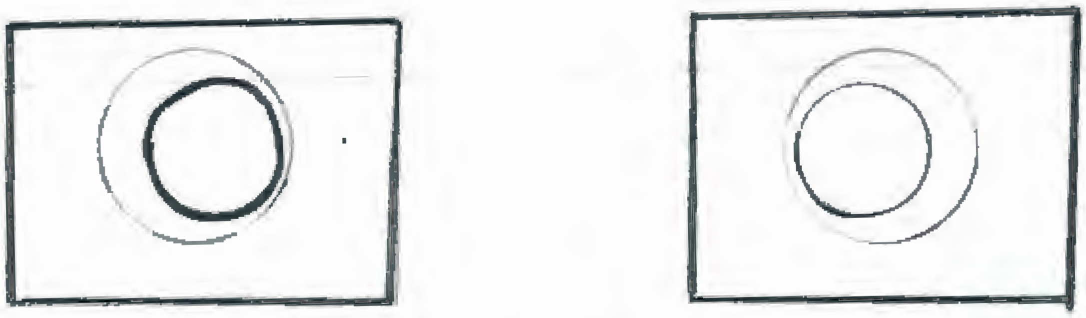
Target Plates

A-Centered opening for attachment of rod

B-Opening for rod attachment for minimum Target separation

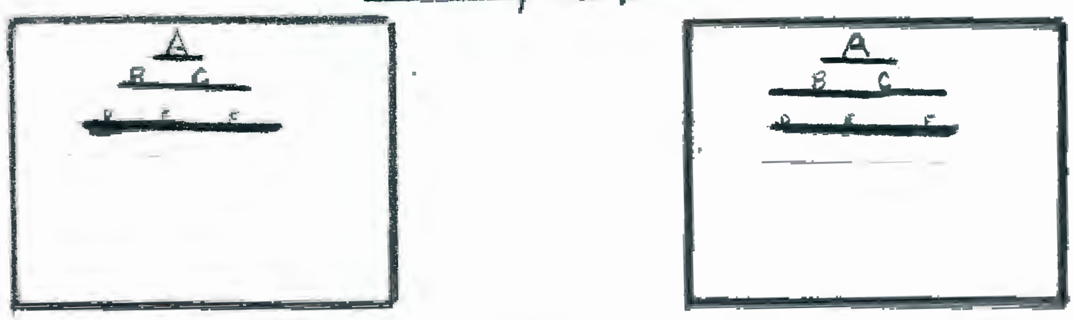
Diagram F

Targets

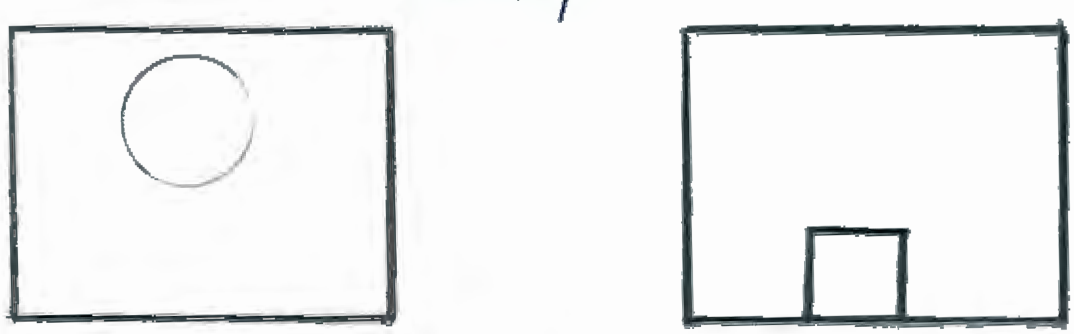


Stereo-Target

Minimum Target Separation



Acuity



Gross Target

FIGURES "A" - Complete Model

The completed model consists of four major parts: (1) eyepiece (2) centerpiece (3) rods and (4) target plates. Once the eyepiece is adjusted for the interpupillary distance, the bent ends of the rods are placed or fixed in two holes, one below each ocular. The rods in this position can move, swivel-like, to the left and right, but not up and down. Targets are placed on the target plates. The distance between the two targets is determined by the movement of the centerpiece. When the centerpiece is moved toward the eyepiece, the distance between targets is increased. The distance between targets decreases when the centerpiece is moved away from the eyepiece.

FIGURES "B" - Eyepiece

The eyepiece consists of three parts, two separate tin plates and a wing-nut with bolt. These parts are so constructed that they can be moved and fixed to accommodate patients with pupillary distances varying from 50 to 68 mms.

FIGURES "C" - Centerpiece

This part does not have any movable sections, and is described as having a window with a centrally located fixation target of cotton thread. This fixation target is thin, yet large enough to allow for clear and comfortable binocular fixation.

Immediately below the center of the window and fixation target are two small vertically placed holes through which pass the rods. The size and position of these holes are extremely important, because they determine the fineness and extent of separation of the target plates when the centerpiece is moved.

FIGURE "D" - Rods

The brass rods, 3/16" diameter, are two in number, and are constructed with ninety degree bends at the ends nearest the eyepiece. There are threads on the ends nearest the target plates. These threads allow for the fastening of the target plates.

FIGURE "E" - Target Plates

The lower edges of the target plates have three holes. The bottom portion of the plates are curved around in front so as to have a 1/4" over-lapping on the lower front margin. The three holes in the target plates allow for a greater or lesser separation of targets, thus increasing the ranges of function of the instrument.

FIGURE "F" - Targets

Three classes of targets may be used.

In the first class are gross targets not requiring stereopsis or fine acuity. These targets may be used on patients who do not have standard acuity or stereopsis with best lens correction, but do have simultaneous perception.

In the second class are acuity targets to be used with patients with little or no stereopsis but good acuity. Simultaneous perception is a requirement. These targets help insure proper accommodative posture.

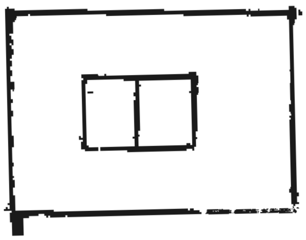
In the third class are stereo-targets which are constructed to be used on two classes of patients, those having fine stereo and those having gross stereo. The fine stereo targets allow for less distance between the targets. This can be of great advantage in patients with a very disturbed accommodative and convergence relationship.

PROBLEMS:

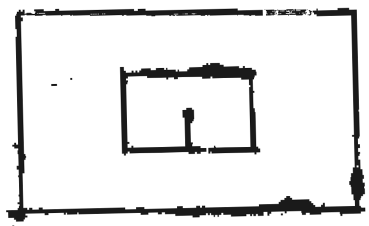
In attempting to convert the idea for the instrument into an efficient working tool, a number of problems presented themselves.

Visual projection is straight line projection. The rods must remain perfectly straight during movement of the centerpiece, or the lines of sight will deviate from the positions of the target plates and fusion may be lost. The factors leading to the bending of the rods are the friction of the target plates on the working surface, and the length and thinness of the rods themselves. A possible solution to this difficulty is as follows: The thickness of the rods may be increased. The only objection to increasing the thickness of the rods, thereby decreasing its flexibility, is increasing the total weight of the unit. To what extent this may be done may prove to be a matter of trial and error. Tubing or square rods rather than solid rods may be helpful in this area, as would choice of material. In regard to the friction of the target p lates, rollers would help here, as would a tract for the target plates to move in. These possible solutions again have the disadvantage of making the instrument more cumbersome, which the designers believe is a decided disadvantage in a home training device. A further problem created by the suggested solutions might be the reduction in minimum target disparity obtainable, due to a target track or rollers.

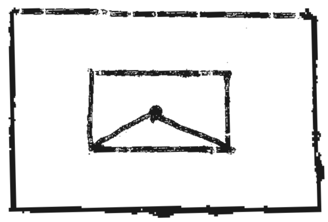
A problem presents itself in choice of fixation targets. A vertical white cotton thread extending the length of the centerpiece window was used. This choice of fixation target had the disadvantage of being hard to fixate for prolonged periods. It also seemed to interfere with viewing of the end plates. Following are diagrams of the fixation targets used and suggested targets that may prove more effective.



Target used



Hat pin target



Target avoiding vertical line.

A part of the instrument that causes some difficulty are the openings in the centerpiece for the passage of the rods. These should be so constructed that any movement of the centerpiece is associated with a movement of the target plates. The movement should be easy, to prevent jerking and tilting of the centerpiece. Snug holes were used in the working model, but did not prove to be ideal in terms of the sought after effect. As the rods must pass through the holes obliquely, and at an angle that is constantly changing, the solution is not easy. Use of a thicker centerpiece bevelled at the holes may prove helpful. This would, of course, increase the total weight, as would the following suggestion. The use of a double bearing to allow the rods to pass smoothly at a changing angle should result in a smoother working instrument.

There is a problem to which the designers see no perfect solution. As the eyes converge, the interpupillary distance of the instrument should decrease to maintain the lines of sight along the rods. The instrument is so designed that rigidity of the eyepiece is essential for movement of the target plates. The conflicting needs are evident. On a practical level the problem is not too difficult to handle. If the pupillary distance of the instrument is set for the patients near pupillary distance, the instrument pupillary distance is found to be slightly too small for minimum target separation and slightly too large for maximum target separation.

If the subject holds the eyepiece at a tilt, the distance of the target from each eye will be different. Fusion may be effected, as well as the accommodative posture. A suggested solution would be an eyepiece stand, which of course, presents the objection of increased weight, complexity, and expense.

Tilting of the eyepiece offers the same problems and same suggested solutions.

One of the greatest possible sources of difficulty lies in vertical target disparity. The eyes have a very limited tolerance to this disparity before loss of fusion results. One rod must lie directly above the other at the fixation plane. If both rods are expected to remain horizontal at the eyepiece and target plate planes, as was the case in the working model, one of the rods must develop a vertical bowing. This causes a tendency toward vertical disparity. A possible solution to this difficulty would be placement of the rod attachments at the target plates and eyepiece to compensate for the vertical problem created at the centerpiece.

The choice of the best rod length is questionable. A long rod has the advantage of demanding less convergence at the start of training. It must be limited by the length of the patient's arm, the increased flexibility of the long rod, and the fact that a long rod is more cumbersome.

CONCLUSION:

The working model of the instrument was encouraging in that it showed the potential of a good home training device. When operated by a skilled subject the desired results were obtainable. The many difficulties previously discussed were made apparent in the making of the trial models. It is also clear that much remains to be done before a clinically effective home training device is achieved. An effective balance must be sought to avoid complexity and maintain effectiveness. The need for such an instrument is clear and makes further effort to attain the goal necessary.