parallax of) A—from which the gradient is required. Thus, with no control and no knowledge of H, the only inaccuracy in the result will be that due to the existence of tilt and inclination of the air base.

THE FACTORS IN HUMAN VISION APPLICABLE TO PHOTOGRAMMETRY

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INTRODUCTION

MOST present day writers in the field of photogrammetry have either ignored or given such scant treatment, to the visual requirements of modern photogrammetry, as to leave a gap in our essential knowledge.

When Mr. Eliel quoted Mr. Cottrell on "5 second eyes," at the Fifteenth Annual Meeting of the American Society of Photogrammetry, he aroused interest and discussion about visual and stereoscopic acuity which indicated that many misconceptions, concerning the various kinds of "acuity," prevail among a large number of photogrammetrists.

The following article is an attempt to survey the existing knowledge of vision, giving some background material but treating only those phases which could conceivably be applicable in the field of photogrammetry. This paper is to be followed by another, currently in preparation, dealing more specifically with how this knowledge could possibly be adapted to photogrammetry. Many readers may not wait for it, determining their own applications in the interim. An excellent recent example of applying visual knowledge to photogrammetry is H. C. Ryker's article, "The Human Eye as a Center of Perspective," in PHOTOGRAMMETRIC ENGINEERING, Vol. XIII, No. 1, March, 1947, pp. 115–119.

New terms will be defined as they are introduced in the article.

VISUAL SENSITIVITY AND VISUAL ACUITY

Visual sensitivity is the ability to respond to stimuli, that is, the capacity the eye has for continuing to respond to light as the intensity of that light is slowly changed. The terminal case of sensitivity involves what the psychologists and physiologists call "threshold of illumination," that is, the least perceptible light to which the eye will respond.

Visual acuity, however, is the ability to continue to see separately and unblurred the details of the visual object as those details are made smaller and closer together. It involves what the physicist and optician call "resolving power."

THE PUPIL

The functions of the pupil are twofold in that: 1) it must fix the immediate illumination of the retina, if it can, at a value above the threshold of stimulation and below the point of dazzlement or injury; 2) it must restrict the perceived light-pencil, as much as possible, to the center of the lens.

THE DIOPTRIC MEDIA

The cornea (the transparent part of the coat of the eyeball which covers the iris and pupil and admits light), the aqueous humor (the limpid fluid occupying the space between the cornea and the crystalline lens of the eye), the crystalline lens, and the vitreous humor (the clear colorless transparent jelly which fills the posterior chamber of the eyeball) make up the dioptric media of the human eye.

Refraction is most accurately defined in terms, not of any bending of the light rays, but of their change in speed and wavelength. The refractive index of the dioptric media follows:

cornea	1.376
aqueous	1.336
lens (effective)	1.42
vitreous	1.336

This figure, 1.42, for the effective index of the lens, does not exceed the index of the aqueous (1.336) by as much as the latter value exceeds the index of air (1.00). This, together with the fact that the anterior surface of the lens is not as sharply curved as the cornea, is responsible for the fact—often overlooked—that the cornea does most of the job of placing the image on the retina. In the optically normal eye, the lens acts like the fine adjustment of a microscope—it adjusts the position of the image only in a minor way.

Since both surfaces of the lens are in contact media whose refractive index are the same, and the posterior surface of the lens is more sharply curved than the anterior, the posterior face is the more important of the two in the static refraction of the eye.

Within twenty feet, however, the refracting power of the media must somehow be increased to keep the image in the visual-cell layer of the retina. The anterior surface of the lens is sharpened in curvature to accomplish this, and the structures most involved are the lens capsule, the zonule fibers, and the muscle cells in the ciliary body. The latter must contract to focus the eye for nearby objects, relax partially for more distant objects up to twenty feet away, and relax completely for objects beyond twenty feet. This is why it is restful to the eyes to gaze out of a window at distant objects for a few moments occasionally, when doing close work of any kind.

A decrease in accommodating power comes with age. It is not caused by any weakening of the ciliary muscle, but by a perfectly normal, progressive hardening of the lens. The actual molding force, the elasticity of the lens capsule, is quite weak at best, and becomes wholly inadequate to its task when the body of the lens reaches a certain stage of firmness. The hardening of the lens is so gradual, however, that few of us live long enough to allow the process to reach zero accommodation.

THE RETINA

The retina, unlike the photographic film is not equally sensitive throughout. Polyak's careful study[1] has shown that the density per unit area of the light sensitive elements (cones and rods) varies according to regional zones of the retina. (See Figure 1.) Because of the sphericity of the retinal surfaces, it has been generally recognized[2] that only a small central region of the image is focused exactly (in the fovea centralis, a small pit or depression at the back of the retina forming the point of sharpest vision), and that the peripheral or forward regions of the image are somewhat out of focus. Recent evidence[3] has emphasized that the eye is a cumulative organ in which considerable integration of stimuli occurs at the retinal level as well as at the brain. Stimuli from

[1] Polyak, S. L., "The Retina," *University of Chicago Press*, Chicago, 1941.

[2] Gullstrand, A., "Helmholtz's Treatise on Physiological Optics," *Optical Society of America*, Rochester, 1924, edited by G. P. C. Southall, Vol. 1, p. 357.

[3] Clark, W. E. Le Gros, *Physiol. Rev.* 22, 205–232, 1942.

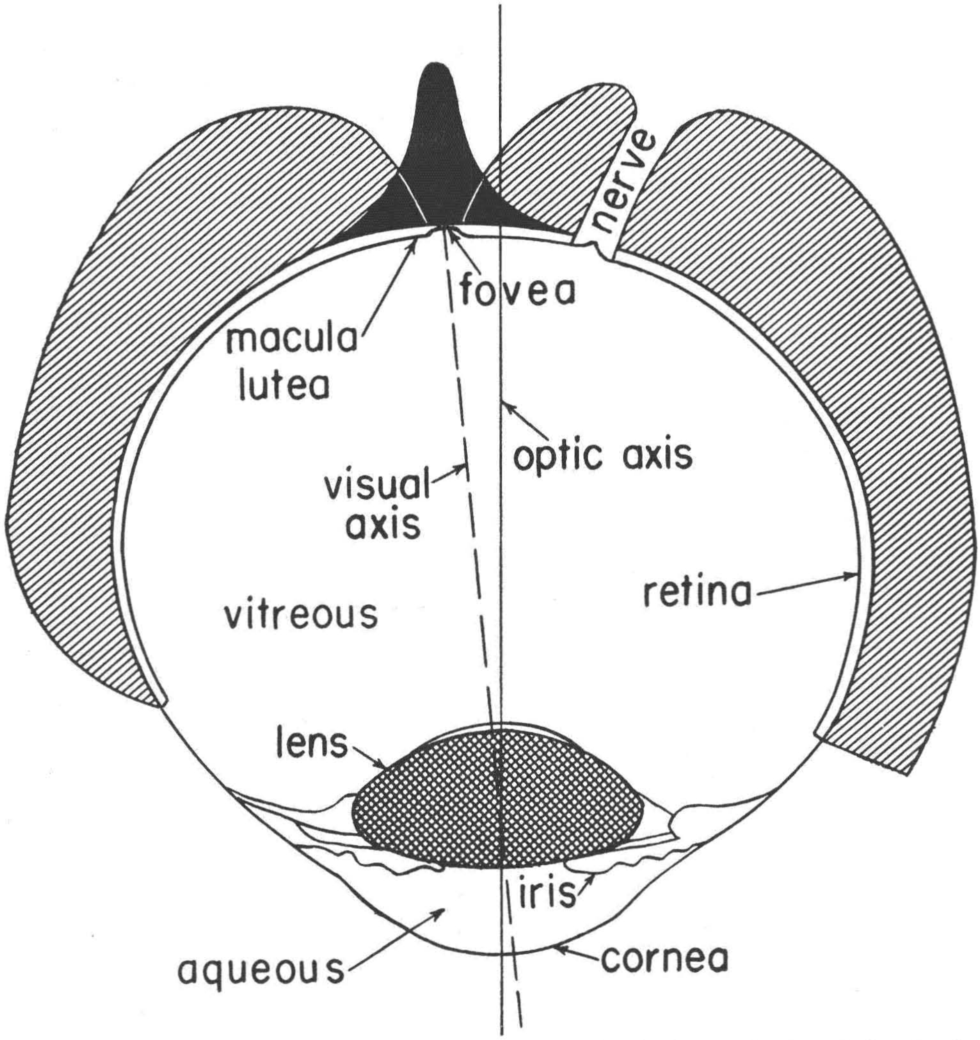

FIG. 1. The Human Eye. The relative concentration of retinal cones (black region) and rods (diagonal shading) for the horizontal meridian of the retina is represented as a polar graph surrounding the eyeball. (Osterberg's data[4])

the 6–7 million cones and the 110–125 million rods, estimated to be present in the eye, are transmitted to the brain by only one million optic nerve fibers.[5]

It is believed that photopic vision (cone vision) is used exclusively in photogrammetric work, and inasmuch as the author has been unable to discover any photogrammetric requirements for scotopic vision (rod vision) it will not be discussed.

VISIBILITY OF POINTS AND LINES

The visibility of a bright point or line against a dark background depends only upon its brightness. There is not even a theoretical linit to the smallness of an effective stimulus provided it is bright enough. A very small object will

[4] Osterberg, G., *Acta Ophthalmologica, Suppl.* 6, 102 pp. 1935.
[5] Bruesch, S. R. and Arey, L. B., *J. Comp. Neurol.* 77, 631–665, 1942.

appear to grow if it is brightened. This accounts for the scale of star "magnitudes," which are brightnesses falsely perceived as sizes. A very bright star may appear to subtend several minutes of arc at the eye, but the angularly largest star (Mira) subtends only 0.056″ at the earth.

The perception of a dark point or line upon a bright ground is more complex. It has been most accurately described as the perception of a difference between the background brightness and the sum of the fractions of that brightness which are displaced into the geometrical territory of the image, from either side of it, by diffraction at the pupil and the dioptric errors of the eye.

The dark line is not sharply imaged, but yields on the retina a shadow-like stripe. The center of the shadow is much darker than its borders; and, if the line of retinal cones on which it falls, receives a sufficient reduction of illumination—as compared with cones alongside, receiving the background brightness practically unchanged—the stimulus-line will be perceived.

Barnard (1898), whose predecessors had all secured values of many seconds, placed a 0.0009-in. wire against the sky as a background and found that it could be "distinctly seen" at 356 feet, when its subtense was 0.44″ arc. Other observers did not do quite as well, and the variable values they obtained reflect the variability and unreliability of the sky background, discovered by Hecht and Mintz[6] early in their work. These workers adopted, instead, wires stretched across a trans-illuminated opal glass disk two feet across and two meters away. Hecht could see a wire whose subtense was 0.5″, but did not regard this as a limit. Hecht and Mintz suggested two possible theories to explain the high visual acuity values which they obtained for individual black lines viewed through a 3.0-mm. aperture. One of these theories requires that the illumination differential between two adjacent rows of cones be approximately 0.01, or about the same as $\Delta I/I$—the ratio of the just perceptible change in illumination (ΔI) to the prevailing illumination (I)—for a bipartite field. Another observer, Hendley[7] however, found that only over a short range is visual acuity directly proportional to $\Delta I/I$, and that, at high contrasts, visual acuity reaches a maximum which cannot be exceeded.

The alternate theory of Hecht and Mintz requires small eye movements to produce about this same differential in a short interval of time, in a single row of cones which would move in and out of the blurred image. If Hecht and Mintz were referring to voluntary eye movements, their theory appears to be supported by O'Brien and O'Brien;[8] the results of their tests of ocular tremor appear to eliminate involuntary tremor as a factor in visual acuity, but support the belief that voluntary scanning improves acuity.

It is interesting to note that the subtense of a pattern of seven dots, graded in size from 0.15 to 0.90 mm, on tracing cloth trans-illuminated by skylight, are grouped closely about an average of 33.6″. This value is many times the threshold width for lines; but this is to be expected since a line can affect a great number of visual cells, in proportion to its length. An interesting observation given by Duke-Elder[9] is that a row of dots can be seen when, individually, they are below visible size.

[6] Hecht, S. and Mintz, E. U., "The visibility of single lines at various illuminations and the retinal basis of visual resolution," *J. Gen. Physiol.* 22, 593–612, 1939.

[7] Hendley, Charles D., "Relation between visual acuity and brightness discrimination" (paper presented at the Thirty-First Annual Meeting of the Optical Society of America. October 1946).

[8] O'Brien, Brian and O'Brien, E. Dickerman, "A test of ocual tremor and the scanning theory of visual acuity" (Paper presented at the Thirty-Third Annual Meeting of the Optical Society of America. October 1948).

[9] Duke-Elder, W. S., "Text Book of Ophthalmology," C. V. Mosby Co., St. Louis, 1933, Vol. 1.

VISUAL ACUITY

The resolution of parallel lines is the classical problem of "visual acuity." The minimal detail of the test pattern is converted to minutes of arc, and the reciprocal of this value then expresses the visual acuity. It was once customary in physiological optics, as it is today in the examination of photographic objectives using the Foucalt test object, to take as the "minimal detail," the distance from the center of one black stripe to the center of the next. Currently, however, the distance considered to be resolved is the width of the space between the lines.

One's ability to perceive the gap is influenced by the widths of the confining lines. The threshold width of the gap decreases when the lines are widened into bars, and as the bars are widened indefinitely, one then approaches a simple visibility task—of seeing a bright line on a dark, or a dark line on a bright background.

For two black lines of just-perceptible width, a theoretical limit of resolution can be calculated from the optical constants of the eye. Depending upon the choice of constants and upon the criterion of resolution, this limit will be from 36″ to one minute or more. Helmholtz, in 1867, chose 64″, which he considered to be the subtense of a foveal cone. It has long been known that foveal cones subtend something more like 45″ than 64″, and there is strong belief that their dimensions are not the limiting factor in resolution, inasmuch as thresholds as low as 25″ have been obtained experimentally with such test objects as the Snellen hook, the Landolt broken circle, or a single pair of parallel lines. Such low thresholds can never be attained with a grille ("grating"). Helmholtz, and many an investigator later on, employed grilles or what is worse, grids.

Absorption in the dioptric media of the eye is considerable, and varies with age, so that the age of the subject can never be ignored. In general, older eyes (40 years) require greater illumination than those of younger persons (20–30 years) for equivalent acuity values.[10] Individual differences in the density of the intra-ocular filters (the yellow pigmentations of the lens and the macular region of the retina), in the diameter of the foveal cones, and in the conformation of the foveal depression, are considerable and have some influence. Refractive errors are of course important.

The spectral character of the illumination can influence visual acuity considerably. There are clear indications that light of the blue and red ends of the spectrum is visually inefficient, and that green or yellow-green light is as good or better than white light of the same intensity.[11] The inferiority of red and blue is lessened somewhat when the considerable refractive errors which they introduce are compensated.

In crude tests employed clinically, binocular visual acuity is usually found to be exactly equal to the acuity of the better eye used alone; but in refined laboratory experiments, binocular "summation" of acuity is claimed to take place. Since binocular luminosities are higher than monocular,[12] one should perhaps expect acuity to be summated. Kravkov's original demonstration of an effect on monocular acuity through the illumination of the other eye, and even through stimulation of other senses, has been repeatedly confirmed.[13] In the

[10] Ferree, C. E., Rand, G., and Lewis, E. F., *Trans. Illum. Eng. Soc.* 29, 296–313, 1934.

[11] Shlaer, S., Smith, E. L., and Chase, A. M., "Visual acuity and illumination in different spectral regions," *J. Gen. Physiol.* 25, 553–569, 1942. Ferree, C. E. and Rand, G., "Color and composition of light in relation to the blackout," *J. Aviation Med.* 13, 193–215, 1942.

[12] Bartley, S. H., "Vision," D. Van Nostrand Co., Inc., New York, 1941.

[13] Hartman, G. W., "The increase of visual acuity in one eye through illumination of the other," *J. Exper. Psychol.* 16, 383–392, 1933. Kravkov, S. V., "Changes in visual acuity in one eye under

most recently reported experiment,[14] the subject looks through a monocular eyepiece, with his right eye, at groups of black dots on a white background, of a size bordering on the limit of discrimination. His task is to count, as rapidly as possible, the number of dots in each group. The left eye is either obstructed by a white screen, or illuminated by a surface of brightness equal to that of the background of the test, or to a brightness double the latter. The illumination of the left eye by a brightness equal to that of the test yields the greatest number of dots counted in the unit of time and the smallest number of errors. All the subjects are likewise in accord as to these conditions of observation being the most comfortable.

The means by which the energy in a light stimulus is converted into a visual sensation is exceedingly complex, but a comparatively simplified scheme of the process explains much of the data of visual acuity. The receptors convert the energy of light into energy of such a form, probably electrical in nature[12,15], that the nerves can transmit it to the visual cortex of the brain. Aneuro-physiological approach, in which most of the emphasis is on the post-retinal system, has been advanced by Marshall and Talbot.[16] According to this point of view, neural mechanisms play an important part, and visual acuity and contour recognition are achieved to a large extent in the visual cortex and associated systems. They point out that the grain of the visual cortex is in effect much finer than the grain of the retina, and attribute certain accomplishments of the visual system, such as the perception of the vernier offset, to both the fineness of the cortical grain and the operation of certain neural mechanisms. This would mean that the cortical image and the test object would have in common certain energy differentials which would be lacking in the retinal and photo-chemical images, which therefore, would be equivalent to obtaining a sharp enlargement from a blurred photographic negative by manipulating the focusing mechanism of the enlarger so as to obtain an "equal and opposite blur."

Visual acuity has been measured in terms of the reciprocal of the angle in minutes subtended by the individual lines in a parallel-line test object at the limit of perception of the lines. In tests by Higgins and Stultz,[17] wherein both the clear and opaque lines of the test object were of equal width, it was found that the limit of perception of the lines in such a test object depends upon the orientation of the lines. Visual acuity, measured with the lines passing diagonally through the visual field at an angle of 45 degrees to the horizontal, is between 10 and 20 percent lower than that measured with the parallel lines passing vertically or horizontally through the visual field.

The author has been unable to discover a single determination of visual acuity for colored targets on colored grounds of equal brightness. In only one investigation has visual acuity been studied with colored targets on gray grounds of equal brightness.

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the influence of the illumination of the other or of acoustic stimuli," *J. Exper. Psychol.* 17, 805–812, 1934. Ryan, T. A., "Interrelations of the sensory systems in perception," *Psychol. Bull.* 37, 659–698, 1940.

[14] Gassovski, L. N., "Illumination of the retina of the non-utilized eye during work at monocular visual apparatuses," *Prob. Fiziol. Opt.* (*Psychological Abstracts*, 22, #5269, Dec. 1948)

[15] Hartline, H. K., *J. Opt. Soc. Am.* 30, 239–247, 1940.

[16] Marshall, W. H., and Talbot, S. A., "Recent evidences for neural mechanisms in vision leading to a general theory of sensory acuity," *Biological Symposia* (Vol. 7 Visual Mechanisms), 117–164, The Jacques Cattell Press, Lancaster, Pa., 1942.

[17] Higgins, G. C., and Stultz, K., "Visual acuity as measured with various orientations of a parallel-line test object," *J. Opt. Soc. Am.* 38, 756–758, 1948.

It should be remembered that visual acuity must be considered relative to the distance at which the eyes are to be used. There is no high correlation between acuity in near and far vision. There is ample evidence, for instance,[18] of an inverse relationship between visual acuity tested at 20 feet and production in the case of hosiery loopers, the operators with the poorer vision being the more productive. However, when these workers were tested at a distance of 13 inches, they had such good vision that the tests employed failed to differentiate between them.

VERNIER AND STEREOSCOPIC ACUITY

It has slowly come to be seen that the perception of a line and the resolution of a gap between two lines have a similar basis. Likewise, since the turn of the century, vernier and stereoscopic acuity have been considered to have a great deal in common, despite the fact that one is a monocular capacity and the other, binocular. Both are spatial perceptions, to some extent independent of illumination and contrast, and quite independent of the dimensions of retinal elements.

VERNIER ACUITY

Vernier acuity may be defined as the minimum lateral displacement necessary for two portions of a line to be perceived as discontinuous, or the accuracy of detection of a misalignment or of a variation in width.

Volkmann, in 1863, found that a difference in width of two narrow rectangles could be perceived with an error of only 7–11″ arc (Figure 2 a). Wulfing, in 1892, discovered the high value of acuity for the simple two-line alignment situation, and obtained thresholds of 10–12″ for trans-illuminated slits and for black lines on a white card (Figure 2 b). Titchener[19] cites Hering as having obtained a value of 5″ of arc, and Hartridge[20] reported the following values:

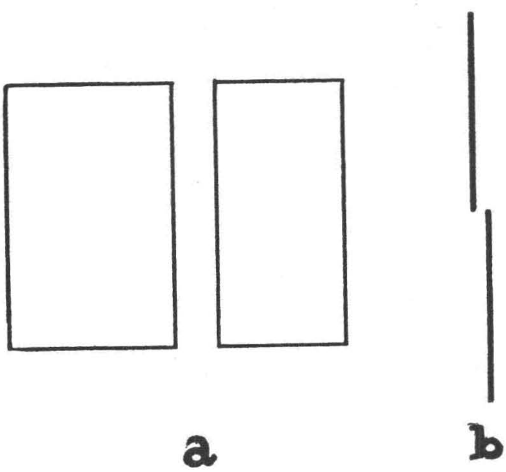

FIG. 2. Vernier Acuity. a) Perception of the difference in width between two narrow rectangles. b) Perception of a misalignment in a simple two-line alignment situation.

Bryan and Baker (1912)	Black lines	12″
Bryan and Baker	White lines	9.5″
Bryan and Baker	Split lines	8″
Bryan and Baker	Bisection lines	8.5″
Hartridge (1922)	Black lines	8.5″
Stratton (1900)	Black lines	7″

Wright[21] gives the vernier threshold as 2″ of arc, and Polyak[1] cites values for vernier acuity as low as 2.5″.

[18] Tiffin, J., "Industrial Psychology," 139–140, Prentice-Hall, Inc., New York, 1942.

[19] Titchener, E. B., "A textbook of psychology," Macmillan, New York, 1910.

[20] Hartridge, H., "Visual acuity and the resolving power of the eye," *J. Physiol.* 57, 52–67, 1922.

[21] Wright, W. D., "The functions and performance of the eye," *J. Sci. Inst.* 19, 161–165, 1942.

STEREOSCOPIC ACUITY

Stereoscopic acuity may be defined as the just perceptible difference in binocular parallax of two objects or points, or the accuracy of detection of differences in distance from the observer. In Figure 3, the threshold is θ minus ϕ when the depth disparity of A and B is just perceptible. The minimum values obtained for stereoscopic acuity are quite similar to those obtained for vernier acuity. In the last century, stereoscopic thresholds less than the subtense of a foveal cone were not attained, and were not expected due to confusion of thought regarding the basis of the performance. Stratton[22] was the first to break

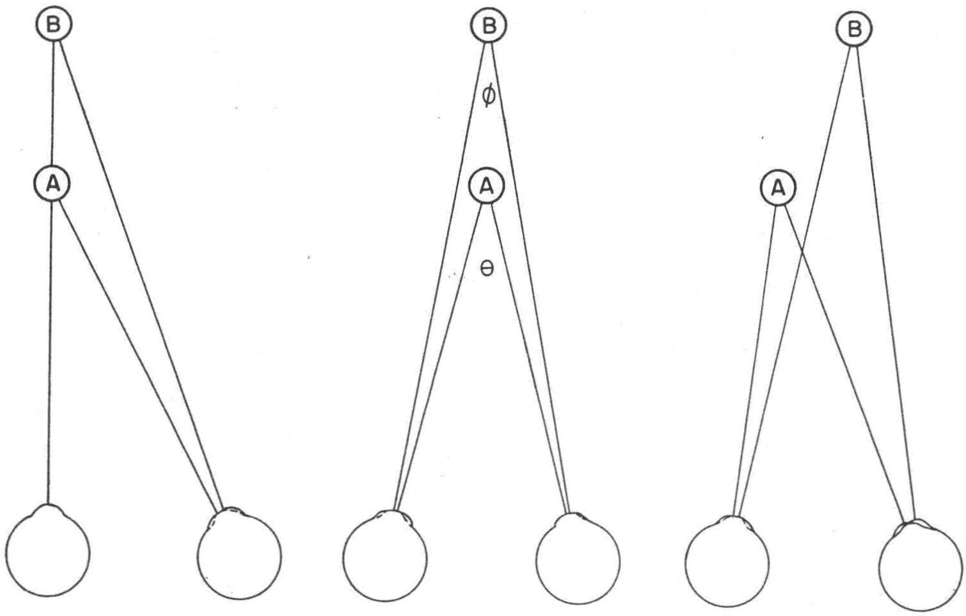

FIG. 3. Stereoscopic Acuity. The threshold is minus when the depth disparity of A and B is just perceptible.

this mental deadlock, with a threshold of 24″ obtained by an indirect method. Around 1900 it was considered remarkable when Pulfrich reported a subject whose threshold was 10″; and in 1922 Hartridge[20] reported the following:

Heine	6″–13″
Bourdon	5″
Crawley	3″
Breton	4″

In the last decades, values of two seconds, or a bit less have been regularly obtained. One-third of all of Howard's[23] observers performed this well, as did Woodburne[24] in a careful experiment in which the angular subtenses of the target elements were kept constant for all positions. As with vernier acuity, however, a working value of about 12″ is used in American instrumental practice; and the allowable error in the Boward-Dolman test of the Army Air Corps was 10″.

[22] Stratton, G. M., "A mirror pseudoscope and the limit of visible depth," *Psychol. Rev.* 5, 632–638, 1898.

[23] Howard, H. J., "A test for the judgment of distance," *Am. J. Ophthal.* 2, 656–675, 1919.

[24] Woodburne, L. S., "The effect of a constant visual angle upon binocular discrimination of depth differences," *Am. J. Psychol.* 46, 273–286 1934.

Fry and Kent[25] made studies of the effects of base-in and base-out prisms on stereo-acuity. They found that even though minus lenses maintain sharp focus, they reduce stereo-acuity, and that a disturbance of the normal associations between convergence and accommodation is a contributing factor to the reduction in stereo-acuity and gave evidence of fatigue effects.

Stereoscopic acuity for various levels of illumination was explored by Mueller and Lloyd[26] and their results indicate that the minimum resolvable difference angle (the measure of acuity) is large at low intensities and decreases at high intensities. They also found that depth discrimination appears possible at intensities below cone threshold. Gassovski and Nikolskaya[27] checked the effects of the duration of the observation on discrimination of depths. They found that when the duration of observation was lowered from 3 to 1.5 seconds, the threshold of steresocopic discrimination remains unchanged; when lowered from 1.5 to .5 second it rises slowly to augment very rapidly for durations still shorter. Between .5 and .05 second, the angle limit passes from 10″ to more than 300″.

RELATION OF VERNIER AND STEREOSCOPIC ACUITIES

The stereoscopic situation gives the appearance of being much more complex than the vernier one, owing in large part to the existence, in binocular vision, of the horopter (the geometrical figure containing all spatial points which are seen without physiological diplopia (doubling) together with the fixation point of the moment, or the locus of points in external space whose images are formed on corresponding places of the two retinas and which are therefore seen single). In the usual laboratory stereo-test-object, either two rods are used (Figure 3), or more commonly three equal-spaced wires or rods are used, with the middle one made movable in and out of the plane of the other two. The stereo-threshold is then the difference between θ and ϕ (Figure 4) when B is just perceptible behind or in front of the plane of A and C. It will be minimal when all three rods are close to the horopter, but it will then be subject to a sort of constant error since the "null point" is on the horopter itself. That is, in the situation shown in Figure 4, all three rods would appear to lie in one plane and B would have to be placed outside the Muller circle, or inside of it by an equal amount, to appear disparate in distance compared with A and C.

In Figure 5 a, if the right eye is covered, the left eye cannot detect rod B. With both eyes in use, the stereo-threshold is θ minus ϕ as usual; but all of this difference-angle exists for the right eye alone. That eye, if the left one be covered, has no way of distinguishing whether A has indeed been displaced forward, or in a purely vernier fashion into the position A'. Angularly, AB and $A'B$ are entirely equivalent, for both are measured as θ-ϕ.

Consider now, however, the arrangement in Figure 5 b, where the target is centered and the stereo-displacement is made along the median visual axis. If the displacement $B \rightarrow A$ is just liminal, and since the equivalent vernier displacements $B \rightarrow A'$ and $B \rightarrow A''$ here are only half of the $B \rightarrow A'$ of Figure 5 a, neither may be perceptible monocularly. Only the displacement in depth, "straight on" will be discernible, for this is created from two vernieroid displacements which, separately, should be sub-liminal since they represent the

[25] Fry, G. A. and Kent, P. R., "The effects of base-in and base-out prisms on stereo-acuity," *Amer. J. Optom.* 21, 492–507, 1944.

[26] Mueller, C. G. and Lloyd, V. V., "Stereoscopic acuity for various levels of illumination," *Proc. Nat. Acad. Sci.*, Wash., 34, 223–227, 1948.

[27] Gassovski, L. N. and Nikolskaya, N. A., "The action of the duration of observation on the threshold of discrimination of depth," *Prob. Fixiol. Opt.* (*Psychological Abstracts*, 23, #54, January, 1949).

just-liminal $B \rightarrow A'$ of Figure 5 a, halved between the two eyes instead of being placed entirely in one eye. The essence of this idea is far from new, for Stratton in 1898 was perhaps the first to point out that stereoscopic acuity arises from differences which may not of themselves be perceptible.

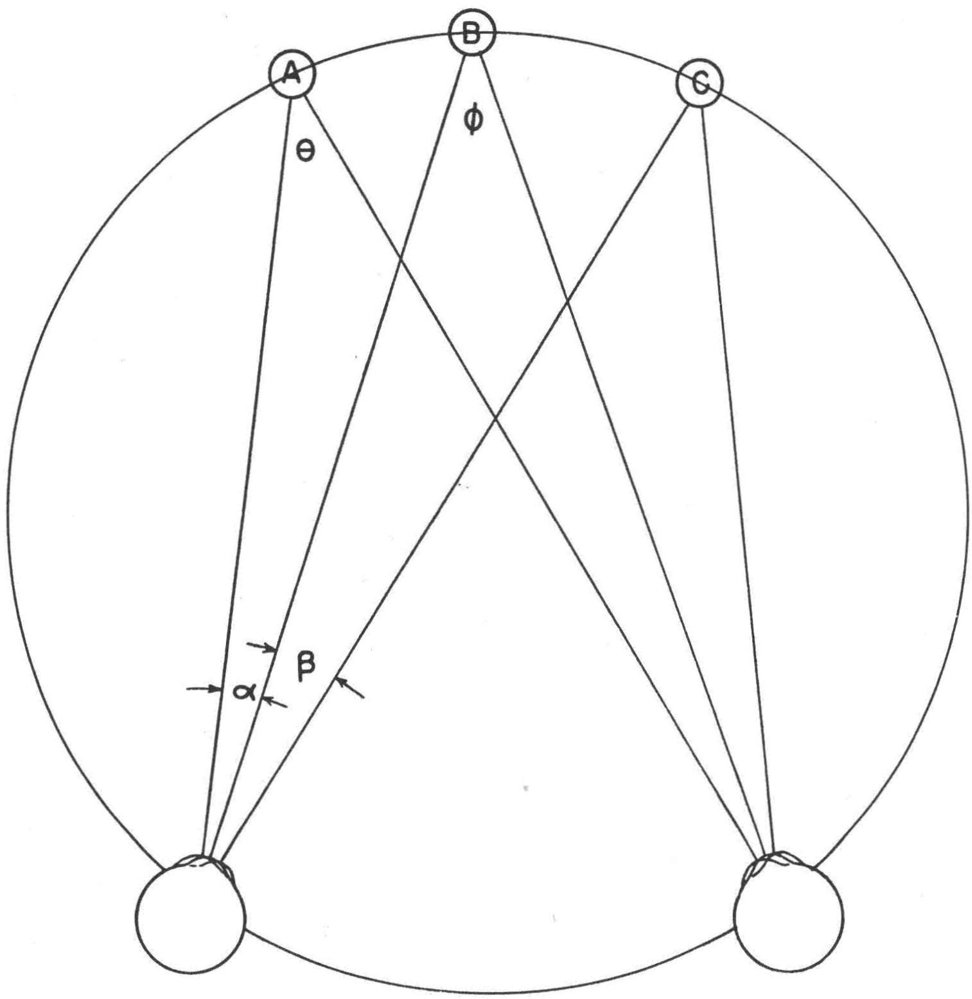

FIG. 4. The Horopter. All three rods appear to lie in one plane and *B* would have to be placed outside the Muller circle, or inside of it by an equal amount, to appear disparate in distance compared with *A* and *C*.

HETEROPHORIA

Heterophoria is the insufficient action of one or more of the muscles of the eye so that one eye tends to deviate from the correct direction. Except in strabismus, this tendency to deviation can be overcome by extra muscular effort. Hyperphoria, or vertical phoria is the tending of the visual axis of one eye above that of the other. In esophoria the visual lines tend inward, whereas in exophoria the visual lines tend outward.

Pronounced inability in convergence known as squint, is very obvious, and interferes seriously with depth perception. Minor deviations, the phorias, may or may not interfere with efficient seeing, depending upon the extent to which

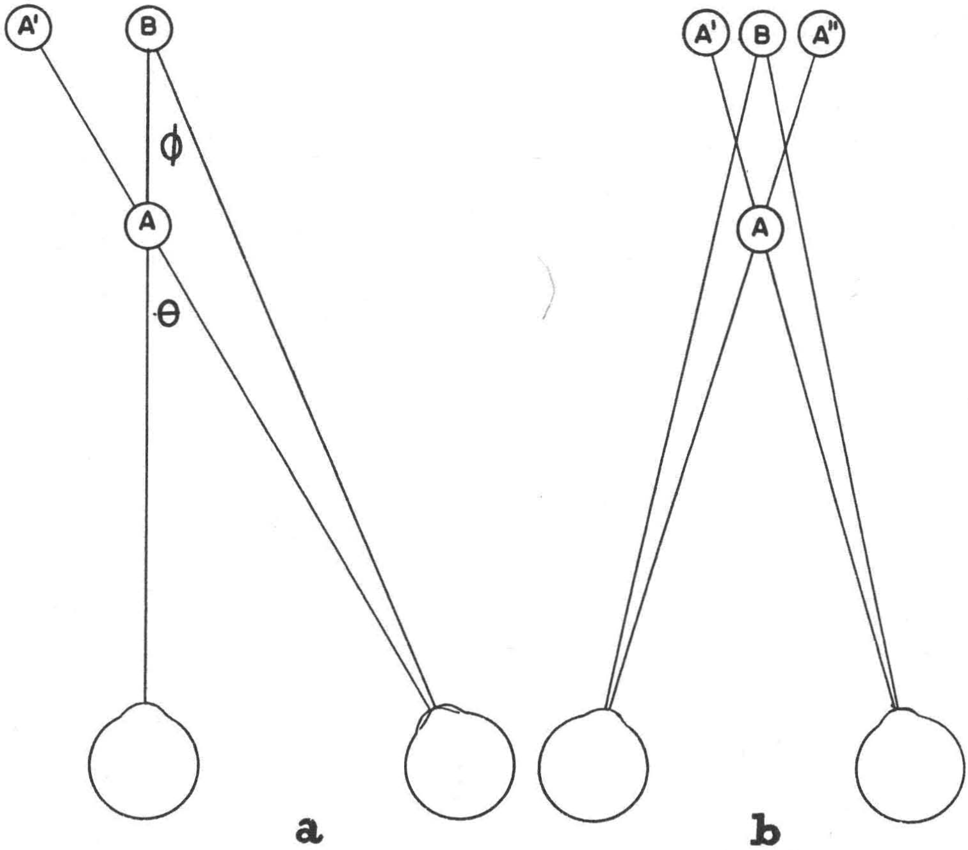

FIG. 5. Relation of Vernier and Stereoscopic-Acuities. (See text)

the individual is able to compensate for them. Such deviations may be due to faulty habits or to organic conditions; and they often impose severe strain on the seeing mechanism, giving rise to serious inaccuracies of perception that, as Tiffin[18] has shown, may influence efficiency on the job.

Faulty stereopsis, or depth perception, is often produced by the habit of suspension, the image of one eye being disregarded so that vision becomes essentially monocular. Stereopsis can be improved through orthoptic training.