THE ROLE OF INTROVERSION-EXTRAVERSION AND SENSATION-SEEKING IN THE ETIOLOGY OF MYOPIA

BY

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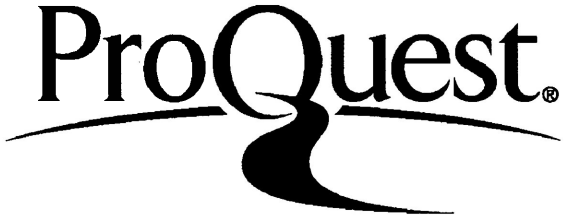

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ABSTRACT

The scientific investigation of myopia has been intense but has failed to establish a definite etiology. However, chronic intraocular pressure resulting from over-accommodation appears crucial in the development of the major myopic physiological feature; a lengthened vitreous chamber. The autonomic nervous system of introverts typically over-reacts to stimuli and since accommodation is controlled by the ANS, psychological variables may be involved in over-accommodation. Though introversion has often been cited as a characteristic of myopes, no confirmation has been made utilizing the Eysenck Personality Inventory (EPI). After completing an Information Questionnaire, 80 suitable Introductory Psychology students were assigned evenly into 4 groups according to their sex and gross visual acuity (myopic or emmetropic). After their level of visual acuity was measured by viewing a series of Landolt 'C's each subject completed an EPI and a Sensation-Seeking Scale (SSS). Emmetropes were more extraverted than myopes, as indicated by both a significant correlation and a significant analysis of variance. Though emmetropes were not greater sensation-seekers than myopes as indicated by a non-significant analysis of variance, the correlation was near significance.

INTRODUCTION

Within the complexity of the human visual system reside valuable as well as vulnerable qualities. The various components interact to provide the sensitivity and adaptation critical to efficient vision. Any disruption in the harmony among the components will cause a loss in visual efficiency. Myopia is a consequence of such a disruption.

The scientific investigation of myopia has been intense but has failed to confirm a definite etiology. The inability or reluctance to control the numerous variables has resulted in many conflicting theories. According to Sloane (1970):

> Nearly everything in medicine has been blamed as a cause of myopia - malnutrition, obesity, endocrine disturbances, allergy, posture, chemical deficiencies (such as calcium and vitamin deficiencies), heredity, lighting, wearing glasses too much, not wearing glasses enough, excessive close work, and so on. In fact, the cause is unknown. Considerable experimental work has been done, but the frequently premature conclusions have not stood the test of time. (p.43)

These circumstances may be altered by Francis A. Young (1975) who for 25 years has investigated myopia in a comprehensive systematic manner. He concluded:

> These studies tend to show that heredity plays little or no role in the development of the type of myopia

> usually found in children, either in human subjects or in monkeys. These studies demonstrate that it is possible to create virtually any amount of myopia desired by placing monkeys in a near-point visual situation or in a position with the head lower than the rest of the body. Carefully controlled studies of effects of diet, light level, age level, sex, etc. demonstrate that monkeys duplicate the relationships found in humans, males and females. These studies suggest the possibility that there is an increase in pressure in the vitreous chamber with accommodation and/or convergence, and that if this increase in pressure is maintained long enough there will be a concomitant increase in the size of the vitreous chamber which leads to the development of myopia. (p.16)

Hence, myopia is thought to progress from an extended period of "over-accommodation" during the formative years. The mechanism of accommodation involves the interaction of the ciliary muscle, suspensory ligaments, and lens, The ciliary muscle innervated by both parasympathetic and sympathetic fibers alters the tension on the approximately 70 ligaments attached radially along the lens. Combined with the natural elasticity of the lens these factors allow it to vary in shape from moderately convex to very convex. Accommodation is regulated by the Autonomic Nervous System through a poorly understood negative feedback system dependent upon the distance

of the light source. This system is designed to eliminate blurred images upon the retina through the correct refraction of entering light.

A survey of the medical literature relating to myopia and other ocular anomalies indicates a definite neglect of psychological factors. Aldous Huxley (1943) commented:

> Ever since ophthalmology became a science, its practitioners have been obsessively preoccupied with only one aspect of the total process of seeing - the physiological. They have paid attention exclusively to the eyes, not at all to the mind which makes use of the eyes to see with. (p. vii)

Evidence supporting the role of psychological factors has been provided by Graham and Leibowitz (1972) who investigated the effects of suggestion on visual acuity. They found that:

> Direct hypnotic suggestion in conjunction with post-hypnotic suggestion led to a significant improvement in myopic vision....An important point underlying the present study is that vision involves a series of complex processes, only part of which are anatomical. It is not the refractive state of the eye alone, but the interaction of the dioptric and neural mechanisms which enable us to see as well as we do. This interaction was apparent when it was demonstrated that although the eye remained essentially constant before, during, and

> after the experimental treatment in terms of where it focused the image of the acuity targets, ie., no change occurred in refractive power, vision improved significantly. (pp.182-183)

Personality variables related specifically to myopes have not been extensively investigated. The available literature however, has been summarized by Lanyon and Giddings (1974) who found:

> A fairly consistent core of personality characteristics has been attributed to myopic individuals. In general, they have been seen as introverted and shy, socially awkward, and as having few friends. (p.243)

These observations have been supported by various descriptive personality studies. Utilizing the Bernreuter Personality Inventory, Mull (1948) found the following:

> In conclusion it may be stated that in the case of college students at least, myopes show a slight but consistent tendency towards greater introversion than normal-visioned students, though the average difference in introversion between the two groups is not reliable. (p.576)

Optometry students were studied by Schapero and Hirsch (1952) using the Guilford-Martin Temperament Test. They described myopes as having inhibited dispositions, over-controlled emotions, inertness, and disinclination for motor activity, and (in contrast) social leadership. Beedle and

Young (1976), administered the Omnibus Personality Inventory to introductory psychology students and found that:

> Male myopes had higher mean scores than did emmetropes or hypermetropes [far-sighted] on the TI [thinking introversion] scale, and this difference became significant with the myope-hypermetrope comparison. (p.738)

It should be noted that neither Mull nor Beedle and Young found significant myope-emmetrope differences on introversion. However, the use of the Bernreuter by Mull is open to question in light of the following criticisms. Veldman (1965) stated:

> A review of recent investigations...reveals a disquieting number of failures of the instrument to accomplish its intended purposes.... Many more carefully constructed, more adequately standardized, and more thoroughly validated personality inventories are currently available. (p.345)

Becker (1965) added:

> The Bernreuter can also be criticised on other grounds besides its failure to do any job well enough to justify its existence....The consumer seeking a personality inventory would be well advised to look elsewhere. (p.345)

A more modern and efficient test is the Eysenck Personality Inventory (EPI). The validity of the EPI has been investigated by Vingoe (1968) who found:

> Correlations for males and females between self-ratings on extraversion and scores on the Extraversion scale were 0.65 and 0.60 ($P < .01$)....The results from the present study provide further support for the validity of the E scale in that the self-rated criterion groups obtained significantly different mean scores on Extraversion ($P < .005$). (p.708)

In addition Jensen (1958) stated:

> The MPI [Maudsley Personality Inventory] in its present form can be recommended for research purposes as being perhaps the best questionnaire measure of introversion-extraversion and neuroticism available at the present time. (p.324)

In view of these claims, the EPI was used in the present study to examine the relation between acuity and extraversion/introversion. In addition this present research utilized a very accurate measurement of visual acuity; that being the viewing of carefully constructed and illuminated Landolt 'C's.

Another approach to the relation between personality and acuity was taken by Palmer (1966) who investigated visual acuity and excitement using the Gough Adjective Check List. He found the personality of myopes involved calmness, suppression of excitement, and resistance to environmental stimulation. In contrast, high-acuity individuals had greater predilection for excitement and novelty of experience. He stated:

> The present investigation [indicates]...that for some individuals, unrestricted visual input leads to painfully high levels of excitement, and that these individuals develop a myopic norm of vision or other visual impediment as a means of "gating" controlling, or reducing stimulus input so to avoid being overwhelmed with large quantities of "unmastered" excitement. The high acuity subject would seem to find excitement pleasurable and, if anything, to depend too much upon environmental stimulation for the maintenance of arousal. The low acuity individual, on the other hand, would seem to have achieved considerable success in avoiding completely the experience of excitement; for him the reduction in visual input presumably reduces the possibility of painfully high levels of stimulation and excitement and brings about the desired state of internal equilibrium. (p. 371)

Palmer (1970) used the Sensation Seeking Scale (SSS) to confirm his previous conclusions. He found the correlation between visual acuity and scores on the SSS ranged from .23 ($p<.05$) to .44 ($p<.01$). Therefore, individuals with high visual acuity demonstrated greater sensation-seeking tendencies than individuals with lower visual acuity. Palmer's study was limited to males. The present study undertook to replicate Palmer with males as well as females.

Relations between the SSS and the Eysenck Personality

Inventory (EPI) were investigated by Farley and Farley (1967). They found a product-moment correlation of .47 ($p<.01$) between the SSS and E-scale. Bone and Montgomery (1970) supported these results with a product-moment correlation yielding a significant r of .23 between SSS and E ($p<.01$).

Since these personality measures are correlated one might predict that individuals with high visual acuity would demonstrate higher extraversion tendencies than individuals with lower visual acuity. If so, these results would concur with the most common personality trait attributed to myopes: Introversion. This author has not found a study that has directly utilized the Eysenck Personality Inventory to confirm the relationship between introversion and visual acuity.

Eysenck (1967) stated;

> The theory ... asserts that introversion is a product of cortical arousal mediated by the reticular formation; introverts are habitually in a state of greater arousal than extraverts, and consequently they show lower sensory thresholds, and greater reactions to sensory stimulation. (p.384)

Since accommodation is regulated by the autonomic nervous system (ANS), and over-accommodation appears crucial to the development of myopia, the overreaction to stimuli by the ANS of introverts may prove to be an important factor in the etiology of myopia.

The main hypotheses of this study were as follows:

(a) Extraversion would be correlated with visual acuity, and as a consequence, emmetropes would exceed myopes on this factor.

(b) Correlations between visual acuity and sensation-seeking as obtained by Palmer (1970) would be replicated.

METHOD

Subjects. The majority of available Introductory Psychology students at Lakehead University completed an "Information Questionnaire" which is contained within the Appendix. Certain difficulties arose in filling the desired subject quota and 14 other students who had taken Intro. Psych. in the past and also fulfilled the established criteria were included. Participants were selected on the basis of age, sex, self-reported gross visual acuity, and length of corrective lens use if myopic. A total of 80 subjects were assigned into 4 groups of 20 each according to the following criteria.

Group 1 - Males - Emmetropic Group 2 - Females - Emmetropic

Group 3 - Males - Myopic Group 4 - Females - Myopic

Apparatus. Visual acuity was measured using apparatus similar to that of Graham and Leibowitz (1972) and was considered to be the smallest gap (in minutes of arc) able to be detected in a Landolt 'C'. A chart consisting of black, single-break Landolt 'C's viewed against a white background was produced photographically and arranged in 19 rows of 10 Cs each. The break in the Cs ranged from 1.0 minutes of arc to 9.8 minutes of arc (20/20 - 20/200) at a viewing distance of 20 feet. Each C had eight randomly chosen positions, vertical and at 45 degree intervals. The positions were reported by reference to cue cards consisting of a sample C illustrating

the possible break positions with corresponding letters. To facilitate accurate reporting, subjects were allowed to choose between two identical cue cards, one situated on the right of the main chart and one 2 feet to the left of the subject. Illuminated by flood lamps the luminance level of the light portion of the acuity test chart was maintained at 100 ft. L. as measured by a Macbeth Illuminometer.

Procedure. Subject selection was contingent upon the data gathered in the Information Questionnaire. Actual visual acuity was confirmed before any subjects were assigned to their respective groups.

Sitting in a comfortable chair and without corrective lenses, each subject viewed the acuity chart binocularly from a distance of 20 feet. While viewing the chart subjects were advised not to squint or to move their heads. Each subject became familiar with the reporting procedure by reading the 20/200 line first, (from left to right), and then the line above the lowest line perceived clearly. The subject then continued to view progressively lower lines until 50 per cent or more errors were made. Subjects with visual acuities of 2 minutes of arc (20/40) or worse were considered myopic.

Following this procedure, each subject was led to a separate room where he/she completed an EPI - form A (Eysenck & Eysenck, 1968) and a SSS - form 2 (Zuckerman, Kolin, Price, & Zoob, 1964).

RESULTS

The mean age of the subjects was 20.4 years. All emmetropic subjects were able to perceive at least 1.0 minutes of arc (20/20). The mean visual acuity of the male myopes was approximately 7.1 (20/40) minutes of arc (s.d. 3.08) and ranged from 2.0 to 9.8+ (20/40 - 20/200+). The mean visual acuity of the female myopes was approximately 7.2 minutes of arc (s.d. 3.02) with a similar range as male myopes.

The 2 X 2 factorial design consists of independent factors of Sex, (male and female) and Visual Acuity (emmetropic and myopic). The primary dependent variables are the E-scores (extraversion) of the Eysenck Personality Inventory and the General Scores of the Sensation-Seeking Scale. All data were analyzed using the Statistical Package For The Social Sciences (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). Neuroticism data as provided by the EPI are included, though they were not the subject of any afore-mentioned hypothesis.

Extraversion. The first 2 X 2 analysis of variance determined whether there were significant differences in extraversion as related to sex or vision. Table 1 contains a summary of this analysis of variance followed by the means and standard deviations for all groups. The hypothesis that emmetropes would obtain significantly higher extraversion scores than myopes was supported. There were no significant sex differences, nor was there a significant interaction.

Table 1: Extraversion

Source of Variation	SS	df	MS	F	Probability
SEX (S)	19.012	1	19.012	1.247	0.268
VISION (V)	99.012	1	99.012	6.494	0.013
S X V	12.012	1	12.012	0.788	0.378
Error	1158.843	76	15.248		
Total	1288.881	79	16.315		

		Emmetropes	Myopes	Total
Males	M	14.05	11.05	12.55
	SD	(3.41)	(4.29)	(4.11)
Females	M	14.25	12.8	13.52
	SD	(3.67)	(4.19)	(3.95)
Total	M	14.15	11.93	13.04
	SD	(3.50)	(4.28)	(4.04)

Neuroticism. The second 2 X 2 analysis of variance determined whether there were significant differences in neuroticism as related to sex or vision. Table 2 contains a summary of this analysis of variance followed by the means and standard deviations of all groups. As indicated, females scored significantly higher on neuroticism than males. There were no significant vision differences, nor was there a significant interaction.

Table 2: Neuroticism

Source of Variation	SS	df	MS	F	Probability
SEX (S)	117.612	1	117.612	4.601	0.035
VISION (V)	1.012	1	1.012	0.040	0.843
S X V	59.512	1	59.512	2.328	0.131
Error	1942.743	76	25.562		
Total	2120.881	79	26.847		

		Emmetropes	Myopes	Total
Males	M	10.2	11.7	10.95
	SD	(3.46)	(6.16)	(4.99)
Females	M	14.35	12.4	13.38
	SD	(5.82)	(4.31)	(5.15)
Total	M	12.28	12.05	12.17
	SD	(5.17)	(5.26)	(5.18)

Sensation-Seeking. The third 2 X 2 analysis of variance and breakdown of the sensation-seeking data are contained in Table 3. As indicated, differences between the groups on this factor were non-significant.

Pearson correlation coefficients were calculated for the following four variables: Extraversion (Ex), Sensation-Seeking

Table 3: Sensation-Seeking

Source of Variation	SS	df	MS	F	Probability
SEX (S)	14.55	1	14.45	0.646	0.424
VISION (V)	28.80	1	28.80	1.288	0.260
S X V	42.05	1	42.05	1.880	0.174
Error	1699.692	76	22.364		
Total	1784.992	76	22.595		

		Emmetropes	Myopes	Total
Males	M	15.2	15.45	15.33
	SD	(3.71)	(4.17)	(3.90)
Females	M	17.5	14.85	16.18
	SD	(4.98)	(5.79)	(5.50)
Total	M	16.35	15.15	15.75
	SD	(4.49)	(4.99)	(4.75)

(SSS), Visual Acuity (V. A.), and Age. These data are contained within Table 4 (A, B, C) for the myopic and emmetropic groups combined as well as separately.

Table 4: Correlations

(a) Combined (N=80)

	SSS	V.A.	AGE
EX	.50***	.23*	-.30**
SSS		.18	-.05
V.A.			.30**

(b) Myopes (40)

EX	.60***	-.002	-.27*
SSS		.19	-.04
V.A.			.21

(c) Emmetropes (40)

EX	.34*		-.25
SSS			.01

*p < .05
**p < .01
***p < .001 All are one-tailed tests of significance.

DISCUSSION

Confirmation of the hypothesis that extraversion/introversion is significantly correlated with visual acuity corresponds well with much of the previous research as outlined within the Appendix. However, the existence of a correlation does not necessarily clarify the function of this variable within the etiology of myopia and alternative hypotheses still remain. The effects of refractive error on personality have been diminished by Young (1967) who stated:

> From a psychologist's point of view the basic personality pattern is probably determined before the individual ever becomes myopic. Thus, for Freud, the basic personality pattern would be developed within the first five years of life, and for most personality theorists the basic pattern would certainly be developed within the first ten years of life. A number of studies have demonstrated, however, that myopia does not occur in any measurable proportion of the cases before age 9 or 10. Thus it is likely that the personality precedes the development of the refractive changes. (p.200)

Assuming this perspective, certain response patterns characteristic of introverts may tend to predispose them toward the development of myopia. According to the general theory of extraversion as proposed by Eysenck (1967), an individual's position on the E-I continuum is ultimately contingent upon

his particular state of autonomic arousal. As a consequence, the degree of an individual's sensitivity to stimuli directly affects the pattern of their physiological and behavioral responses.

Introverts tend to prefer solitary activities of which reading is certainly prevalent. Reading skills improve with practice and in fact, Hirsh (1959) attributed the superior scores obtained by myopes on the California Test of Mental Maturity to their superior reading ability. Additional time spent reading would place greater stress upon the eyes as they would remain accommodated to near-work for longer periods of time. Television viewing and playing indoors are other solitary activities that would add to the total accommodative effort of the introverted child.

Pheiffer (1955) and Young (1975) demonstrated that accommodation can vary with the interest quality of visual stimuli even though they may remain a fixed distance from the eye. The use of pictorial stimuli in vision research has been criticized by Janisse (1973) as too open to light reflex and contrast effects. Consequently pupillary response may in fact be partially responsible for the obtained pressure changes. However, even though the stimuli remained stable, pressure changes decreased slightly after repeated presentation; a fact which may moderate potential criticism.

Further evidence presented by Stelmack and Mandezys (1975) indicates that pupillary response is related to arousability.

Affective, taboo, and matched neutral words were presented aurally to male introverts, ambiverts, and extraverts as measured by the Eysenck scale. The introverts demonstrated the largest average pupil size and the greatest increase in size from the prestimulus to the post-stimulus period. This held for all three types of stimuli, though was less pronounced for the taboo words. Speed of pupillary dilation and constriction in 49 female subjects were measured by Holmes (1967). Fast constrictors were more introverted than slow constrictors as measured by the EPI and peer rating. Fast dilators had higher E-scale scores than slow dilators.

The evidence indicates that variability exists in the quality of total ocular response with the introvert's response being the more extreme. Chronic over-response of the intraocular apparatus would place greater stress upon the components involved perhaps leading to further pressure increases. Coleman and Trokel (1969) directly measured intraocular pressure and found unexpectedly high pressure changes during normal activities. Intraocular pressure rose 10mm Hg. during blinking and rose 90mm Hg. when the eyes were squeezed shut. These circumstances indicate that the state of the eye need not be radically altered to substantially affect intraocular pressures. Subtle differences in the ocular function of introverts may predispose them to higher than normal intraocular pressures and concommitent axial length change.

The evidence presented so far suggests that certain characteristics peculiar to introverts precede the development of myopia. However, it is feasible that myopic vision alters certain vulnerable personality traits and that within this process, the crucial factor may be the total length of time spent in an uncorrected state. In general, the gradual progression of myopia continues unnoticed until classroom participation is compromised by a reduction in the ability to clearly see the blackboard etc. This interval plus the aversion children initially have towards the wearing of eyeglasses adds to the total time spent in a myopic condition.

Persons capable of recognizing an approaching individual have an advantage over myopes in a similar situation in that they have more time to prepare appropriate responses. In contrast, the myope must wait a considerably longer period of time to decide whether to respond at all! This myopic author can distinctly remember avoiding the gaze of others out of "range" simply because they could not be recognized. Not knowing whether to respond caused considerable anxiety easily reduced by looking elsewhere and avoiding the encounter altogether.

This obvious form of avoidance learning may modify an individual's character by reducing his/her total interaction with others. This in turn will reduce the opportunities to master subtle social skills and cause further awkwardness.

Thus a vicious circle may ensue with the individual retreating even further in an introverted manner. In addition, responses that reduce anxiety are noted for their resistance to extinction and thus may establish near permanent changes in personality.

This study obtained a significant sex difference in neuroticism which corroborates statements by Eysenck (1969, p. 15) who described a tendency for females to obtain higher N-scores than men.

The lack of a strong correlation between sensation-seeking and visual acuity may in part be due to the testing conditions as Palmer (1970) found the correlation between these factors dropped from .44 to .23 when subjects were placed in a more controlled testing situation. However, the strong correlation of sensation-seeking with extraversion, $r=.50$ ($p<.001$) replicates Farley and Farley (1967).

Attempts have been made to improve myopia through hypnosis, relaxation exercises, surgical procedures, and cornea reshaping (orthokeratology) etc. Considerable controversy surrounds some of these procedures because of the potential risk of eye damage. In addition it appears that almost all myopia is a consequence of permanent changes in the physiological structure of the eye, and improvement would necessarily require a shrinking of previously stretched scleral coats. Consequently at this time it would appear more reasonable to concentrate efforts upon the early detection

and prevention of myopia rather than its treatment.

The numerous potential etiological factors and their possible interactions signal a need for sensitive detection devices capable of screening "pre-myopic" individuals. Ideally, school children of the ages when progressive myopia usually begins to appear should have their eyes examined on a regular monthly basis. However, sheer numbers render this proposition impractical. Pending confirmation of an autonomic role in the etiology of myopia an alternative approach might involve the administration of the Eysenck Personality Inventory (or Junior EPI) to children at the ages of 9 or 10. Those children who obtain low extraversion scores might have their visual acuity carefully monitored for signs of the precursor of myopia, the ciliary spasm. Early detection of this ocular anomaly would improve the chance of success in a program utilizing preventative measures of a chemical or optical nature. In addition, myopic children should be compelled to wear their corrective lenses during all waking hours in order to avoid the increased ocular pressure caused by squinting.

The results of this study indirectly implicate involvement of the autonomic nervous system in the etiology of myopia. However, lacking a direct measure of autonomic reactivity (e.g. pupillary response) the role of this potential causal agent remains unverified. It is therefore suggested that future research utilize concomitant psychological and physiological measures.

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LIST OF APPENDICES

Appendix 1

Information Questionnaire

Please complete this questionnaire to the best of your ability. This information will be used to select subjects for an experiment dealing with visual acuity and personality variables.

Name . . . . . Age ... Sex ...

Phone Number - Home . . . . . Business . . . . .

Program . . . . . Year ... Total years of Post-Secondary Education . . . .

Check Appropriate Boxes	Yes	No	?
Do you wear eyeglasses or contact lenses? . . .	☐	☐	☐
Is your eyesight 20/20 or better?	☐	☐	☐
Are you far-sighted? . . . . . (e.g. find it easier to see distant objects)	☐	☐	☐
Are you near sighted? . . . . . (e.g. find it difficult to see distant objects)	☐	☐	☐

How long have you worn corrective lenses? (eyeglasses or contact lenses) years . . . .

When do you primarily wear your corrective lenses? . . . . . .

How long ago was your last prescriptive lens change? Years ... Months ...

Are you aware of any visual problems other than the one previously mentioned?	☐	☐	☐

Appendix 2

Instructions to Subjects

Sit down and remove your eyeglasses.

In front of you is a chart designed to measure your visual acuity.

You are to scan each line and report the position of the gap in each figure in relation to the near and far reference figures.

It is very important that you do not squint or move your head in an effort to see the figures more clearly.

Look at the chart. On line number one on the top, the first figure in relation to the reference figure is A.

Continue along that same line, calling out the position of each figure.

....

Now scan the vertical line under the first figure until you have difficulty perceiving the position of the gap.

....

Indicate approximately what line that it is in relation to the large numbers along the side of the chart.

....

Look at the line directly above that one. What is the position of the first figure?

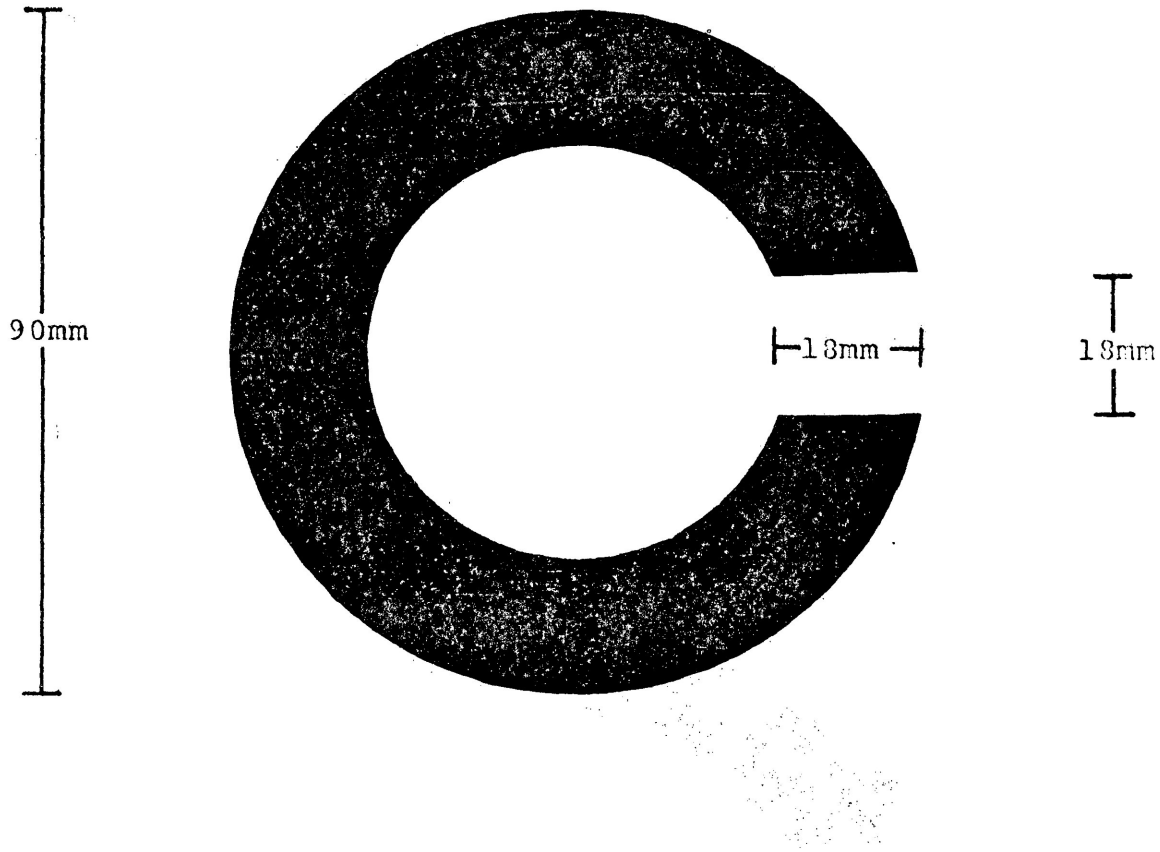
....

Continue along that line.

....

Appendix 3

Landolt 'C'



Each figure is constructed so that the thickness of the line segment is one-fifth the height of the 'C' and equal to the gap.

Appendix 4

Glossary

Accommodation. Adjustment of the focus of the eye for distinct vision at varying distances.

Ciliary Muscle. Ringlike muscle, located within the eyeball behind the iris, that controls the shape and thickness of the lens and, therefore, the focusing power of eye.

Ciliary Spasm. Characterized by an increased tonus of the ciliary muscle resulting in a constant accommodative effort.

Convergence. Rotation of the eyes necessary to bring the images of a near object formed in them on to the fovea of each eye.

Divergence. Ability to adjust the pointing of the eyes to a more distant object.

Emmetropia. Condition in which there is no refractive error.

Extraocular Muscles. Those muscles that support the eyeballs in protective bony sockets and control the pointing of the eyes toward any given object in space. They are arranged in opposing pairs, one pair in each eye producing lateral movements and two pairs in each eye producing vertical movements.

Hyperopia or Hypermetropia. Refractive error in which the light rays tend to focus behind the retina, due either to an abnormally short eyeball or to a deficient refracting apparatus. Commonly called farsightedness.

Intraocular Muscles. Pupillary and ciliary muscles.

Iris. Circular, colored portion of the eye lying in the space behind the cornea.

Lens. Nearly spherical, transparent body suspended just behind the iris. Its shape and thickness are changed by the contraction and relaxation of the ciliary muscle.

Myopia. Refractive error in which the light rays are brought to a focus in front of the retina. Commonly called nearsightedness.

Pupil. Aper ture or opening in the center of the iris through which light is admitted into the eyeball.

Pupillary Muscles. Muscles that control the pupil. One, whose fibers are arranged circularly, contracts the pupil, the other whose fibers are radial, dilates the pupil.

Visual Acuity. Sharpness of vision. The thickness of the line segment of a Landolt 'C' is one-fifth its height. A measure of visual acuity is assigned by multiplying by 20, the minimum visual angle that can be discriminated at a distance of 20 feet. Normal visual acuity of 20/20 means the ability to perceive the gap in a 'C' whose line subtends 1 minute of arc at a distance of 20 feet. Throughout this study, subjects with a visual acuity of 2 minutes of arc (20/40) or worse were considered myopic.

Appendix 5

Personality/Visual Acuity Research

Author	Year	# of Subjects	Sex	Measure of Visual Acuity	psychological Tests
Mull	1948	100	not provided	personal optometrists	Bernreuter Personality Inventory
Schapero & Hirsch	1952	119	not provided	optometrist	Guilford-Martin Temperament Test
Young	1967	694	398 males 296 females	self-report	Edwards Personal Preference Schedul
Beedle & Young	1976	782	339 males 443 females	self-report	Gough Adjective Check List (ACI) Heist and Young Omnibus Personalit Inventory (OPI)
Palmer	1966	(a) 35	males	projected 5-word phrases	Gough-Adjective Check List
		(b) 24	males	Snellen Letters	Value Profile
Palmer	1970	(a) 125	males	Orthorater	Sensation-Seeking Scale
		(b) 55	males	Snellen Letters	T.A.T.

Summary of Results

emmetropes obtained higher scores on extraversion, but the difference was not significant.

myopes have inhibited dispositions, overly-controlled emotions, inertness, disinclination for motor activity and social leadership.

myopes were oriented towards abasement while non-myopes were oriented towards exhibitionism and change.

myopes obtained higher mean scores than emmetropes on thinking-introversion (OPI) though the differences were non-significant.

(a) ambiguous results due to ad hoc visual measurement.

(b) low visual acuity subjects obtained significantly higher scores on psychological inertia (A & B), perseveration, suppression and concealment.

(a) high visual acuity significantly correlated with high sensation-seeking.

(b) high visual acuity subjects obtained significantly higher scores on story interest and novelty of production plus lower scores on psychologic inertia.

RAW DATA

Male Emmetropes

#	Age	Minutes of Arc	E	N	SSS
1	22	1.0	14	11	15
2	19	1.0	18	11	17
3	19	1.0	13	17	13
4	20	1.0	18	11	20
5	24	1.0	6	5	12
6	20	1.0	11	15	11
7	19	1.0	7	13	17
8	19	1.0	16	11	10
9	23	1.0	14	10	20
10	19	1.0	14	9	14
11	22	1.0	12	10	18
12	23	1.0	14	8	15
13	19	1.0	19	9	11
14	19	1.0	16	7	18
15	23	1.0	11	9	18
16	20	1.0	14	18	7
17	18	1.0	17	6	15
18	20	1.0	15	8	19
19	22	1.0	17	10	20
20	18	1.0	15	6	14
Range	18-24	-	6-19	5-18	7-20
Mean	20.4	1.0	14.05	10.2	15.2

Female Emmetropes

#	Age	Minutes of Arc	E	N	SSS
21	18	1.0	17	13	19
22	18	1.0	11	1	17
23	21	1.0	14	5	19
24	19	1.0	18	12	18
25	19	1.0	14	23	13
26	21	1.0	19	17	20
27	19	1.0	17	19	17
28	19	1.0	21	16	23
29	19	1.0	12	20	18
30	19	1.0	11	8	17
31	19	1.0	14	19	11
32	18	1.0	18	15	24
33	19	1.0	8	12	11
34	20	1.0	18	19	23
35	19	1.0	14	21	9
36	19	1.0	11	8	15
37	19	1.0	14	11	22
38	20	1.0	7	18	14
39	20	1.0	14	19	12
40	19	1.0	13	11	28
Range	18-21	-	7-21	1-23	9-28
Mean	19.2	1.0	14.25	14.35	17.5

Male Myopes

#	Age	Minutes of Arc	E	N	SSS
41	18	2.0	13	9	22
42	20	2.0	7	5	17
43	20	2.0	11	15	16
44	20	2.5	12	24	16
45	26	3.0	16	18	18
46	25	5.5	7	4	10
47	21	6.0	15	14	20
48	20	7.0	18	10	21
49	24	7.5	8	5	12
50	21	7.5	11	13	14
51	18	9.0	7	20	10
52	25	≥ 9.8	10	5	11
53	27	9.8	9	18	12
54	21	9.8	18	13	18
55	25	9.8	12	4	21
56	28	9.8	4	4	15
57	19	9.8	9	15	13
58	31	9.8	7	11	13
59	21	9.8	8	19	9
60	21	9.8	19	8	21
Range	18-31	2.0-9.8	4-19	4-24	9-22
Mean	22.55	7.1(approx.)	11.05	11.7	15.45

Female Myopes

#	Age	Minutes of Arc	E	N	SSS
61	20	2.0	13	13	13
62	19	2.5	6	15	14
63	19	2.5	7	13	15
64	19	4.0	11	13	14
65	20	4.0	19	10	20
66	19	4.5	12	4	15
67	19	5.0	14	13	14
68	19	5.5	16	16	16
69	20	6.0	18	18	21
70	20	≥ 9.8	14	13	16
71	19	9.8	11	11	10
72	20	9.8	18	10	22
73	20	9.8	15	15	16
74	20	9.8	12	14	21
75	19	9.8	10	15	19
76	19	9.8	19	9	26
77	19	9.8	7	18	4
78	20	9.8	8	10	9
79	19	9.8	17	17	6
80	18	9.8	9	1	6
Range	18-20	2.0-9.8	6-19	1-18	4-26
Mean	19.35	7.2(approx.)	12.8	12.4	14.85