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Department of Psychology
New Mexico State University

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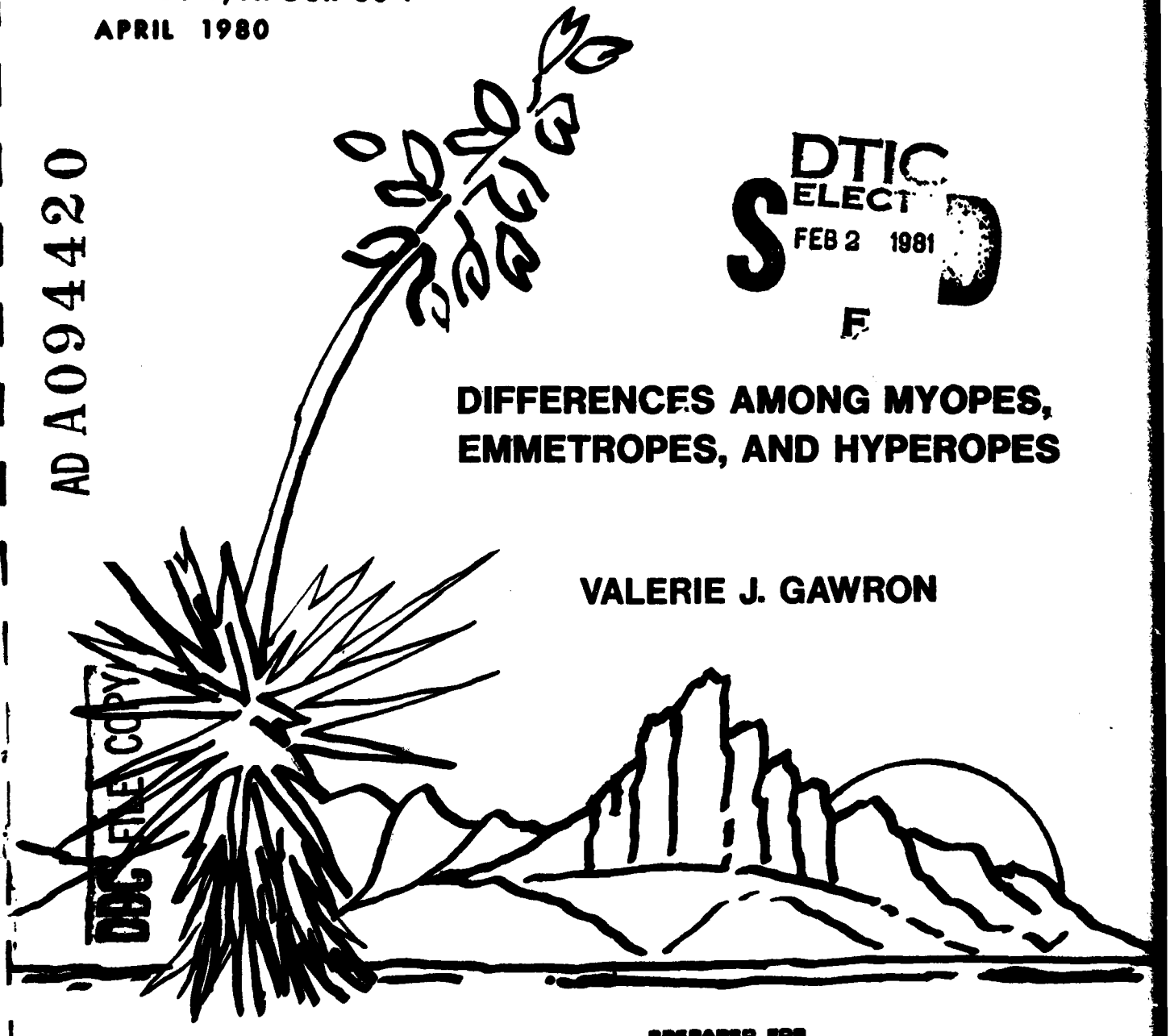
DIFFERENCES AMONG MYOPES, EMMETROPES, AND HYPEROPES

VALERIE J. GAWRON



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BACKGROUND

In the normal, emmetropic eye focused at its far point, parallel rays of light are refracted to focus on the retina--the result is a clear, sharp image. Two visual abnormalities that cause the image to be out of focus are hyperopia (hypermetropia) and myopia. In the hyperopic or far-sighted eye, parallel rays of light remain unconverged when they reach the fovea, and so the image is blurred. Conversely, in the myopic or near-sighted eye, parallel rays of light converge in the vitreous humor before they reach the fovea, again resulting in an out-of-focus image (Thorington, 1904). Both hyperopia and myopia have been linked to individual differences in physical characteristics, scholastic achievement, and personality traits.

Physical Characteristics

Henderson (1934) suggested that myopia is due to an inherited weakness in the ocular muscles. He also implied that this muscular weakness may be more general, that the myope is not "robust." These statements were based on his clinical impressions. Shultz (1960) compared the ponderal indices (height/cube root of weight) of myopes, emmetropes, and hyperopes. He found that hyperopes had the largest indices and that myopes the smallest. This suggested to him that myopia may be related to an endocrine imbalance. Morgan (1960) rated the physique of 111 individuals on adrogyny. He then calculated a rank order correlation coefficient between these ratings and the measured refractive error. For the men, high androgyny was related to hyperopia (+.27). This correlation was lower (+.10) for the women. More recently, Beedle and Young (1976) compared the height, weight, and physical condition of myopes, emmetropes, and hyperopes. They reported no differences among these groups after measuring 782 individuals.

Scholastic Achievement

Many have associated the myope with scholastic achievement and the hyperope with athletic achievement. From casual observation based on years of clinical experience, Thorington (1904) stated that the "myopic child at school soon ranks high in the class, is fond of study, of books, music, or needlepoint, according to the sex. The myope, in other words, is usually literary in taste. Myopes avoid out-of-door sports..." (p. 118). Myopes are "more punctual, attentive at school, ... have more academic hobbies and less interest in sports than their normal-sighted fellows" (Douglas, Ross, & Simpson cited in Trevor-Roper, 1970, p. 16). Morgan (1960) reported that higher ratings of bookishness were reliably correlated with increasing myopia. This relationship, however, was reliable for the women tested but not for the men.

Young investigated the relationship between scholastic achievement and refractive error in a series of three studies. In the first (Young, 1967), several standardized college entrance scores (ACE Q, L,

and total; English and math placement) and grade point averages (GPAs) were compared between self-stated myopes and nonmyopes. There were no reliable differences on these scores, however, a higher percent of Juniors than Freshmen were myopic. Moreover, 57 percent of the men and 60 percent of the women in the honors program were myopic. Young, Singer, and Foster (1975) reported that myopes had higher verbal scores on a college entrance exam and higher GPAs than nonmyopes. Beedle and Young (1976) found that myopes had higher GPAs than either hyperopes or emmetropes.

Personality Traits

Many have linked visual abnormalities, especially myopia, with personality characteristics. Many of the early reports were based on clinical impressions. In one such study (Gould, 1918) myopes were described as egotistical, self-willed, dogmatic, and tyrannical. Similar descriptions have been given by others: selfish, "bad-mixer" (Butler, 1929); having few friends (Pimentel, 1943, cited in Lanyon & Giddings, 1974); introjective, demanding (Gesell, Ilg, & Bullis, 1949); defensive and perseverative (Randle, cited in Roscoe & Benel, 1978).

Rice (1930, cited in Trevor-Roper, 1970) provided an expanded description of myopes:

> A near-sighted child...is not dependent on others for entertainment and is liable to grow rather contemptuous of the abilities of others. He does not adapt himself to the surroundings and is not willing to make compromises. He is often severe in his righteousness and his rightness and may become a disagreeable personage (pp. 14-15).

and hyperopes:

> ...nearly always a jolly good fellow...he has a ravenous appetite because of his activity, he scarcely knows fatigue.... He is tanned, masculine, very aggressive and is likely to be a devil with women (pp. 15-16).

However, Godard (1927, cited in Lanyon & Giddings, 1974) described myopes quite differently: optimistic, euphoric, and ardent. Also, more recently Brandt (1977) suggested that myopes are calmer and more emotionally inhibited than emmetropes while hyperopes are effusive and willing to take risks. Nadell (1954, cited in Young, Singer, & Foster, 1975) compared the incidence of tardiness and truancy between myopic and nonmyopic students and found myopes were more punctual and less delinquent. Using the Rorschach, Van Alpern (1952, cited in Young, Singer, & Foster, 1975, p. 680) concluded that myopes have "less concern about the outside world, increased thinking in abstractions, and ... better control over emotions." However, Rosannes (1967) using

the same instrument came to a different conclusion: myopes have greater anxiety.

Many paper-and-pencil tests have been used to study the relationship between refractive error and personality. Even with this objective technique there have been contradictions in the findings. Beedle and Young (1976) reported that male hyperopes had lower scores on the thinking introversion scale of the Omnibus Personality Inventory than myopes. However, female hyperopes had higher scores on this scale than either myopes or emmetropes. Also Young (1967) and Young, et al. (1975) found contradictory results on the abasement scale of the Edwards Personal Preference Schedule. In the 1967 study, myopes scored higher on this scale than nonmyopes. In 1975, they scored lower.

From other research in this area, however, consistent personality patterns seem to emerge. In a 1974 review paper, Lanyon and Giddings conclude that "it has been rather consistently shown that myopes tend to be, in comparison to nonmyopes, somewhat more introverted, overcontrolled, and tolerant of anxiety" (p. 279). Myopes tend to be cautious and conservative (Greaves, 1977); accurate (Stevens & Woeff, 1965, greater ranking accuracy on Schematizing Test); inhibited and overcontrolled (Shapero & Hirsch, 1952, low rhathymia score on the Guilford-Martin Temperament Test). They view the world as noxious, irrational, and pressing on them (Zeiger, 1977, Noxious World Test) and wish to dominate (Young, Singer, & Foster, 1975, high dominance score on the Edwards Personal Preference Schedule) or, failing that, to withdraw from the group (Mull, 1948, high introversion score on Bernreuter Personality Inventory).

Conversely, hyperopes are impulsive, active, and socially passive (Shapero & Hirsch, 1952, high rhathymia, high general activity, and low ascendance-submission scores, respectively, on the Guilford-Martin Temperament Test). In a clinical population, hyperopes are more neurotic (Schultz, 1956-57, score higher on the Cornell Index, a paper-and-pencil neurosis test). They also score higher than emmetropes on the psychopathic deviate scale of the MMPI (Shultz, 1960).

Physiological Differences

Personality types similar to those attributed to myopes and hyperopes have been related to physiological patterns.

> Predominance of sympathetic activity will be associated with and facilitative of emotional behavior, impatience, activity, fatigue, and related behavior. Predominance of parasympathetic activity will be found associated with and facilitative of stolidity, and a tendency to withdraw from the group or to dominate it when withdrawal is impossible or undesirable (Wenger, 1947, p. 308).

Eysenck's (1953) Introversion-Extraversion theory of personality extended Wenger's statement.

Three indicies of autonomic nervous system activity have been developed. The first, $\bar{A}$, was introduced by Wenger and Ellington (1943). It was based on scores from seven physiological tests. Low scores reflect sympathetic activity; high scores, parasympathetic activity (see Wenger & Cullen, 1965). The second index, Cw, is a coherence statistic (a normalized function with values ranging between zero and one) estimating the amount of covariance between respiratory and heart period activity. Greater covariance has been theoretically linked to greater central parasympathetic nervous system activity. Finally, vagal tone ($\hat{V}$, derived from Cw) may reflect peripheral autonomic functioning (Porges, Bohrer, Keren, Cheung, Franks, & Drasgow, in press).

Other Visual Differences

Myopes, emmetropes, and hyperopes by definition vary in far point. But another major determiner of accommodation to external stimuli is the resting state. The resting position or dark focus is the dioptric power of the eye in the absence of an external stimulus. Originally the resting position was hypothesized to be at optical infinity. This has been demonstrated not to be the case (Campbell & Primrose, 1953; Johnson, 1976). Although resting position varies among individuals, the mean is generally between 1 and 2 diopters (Otero, 1951, 1.12 tc 1.24 D; Leibowitz & Owens, 1975, 1.7 D; Owens & Leibowitz, 1975, 1.98 D). Miller (1978), however, reports a value of 2.76 D. This discrepancy may be based on differences in the populations sampled. A case in point is reported by Simonelli (1979). He found a reliable difference in dark-focus measures of military recruits (1.2 D) and undergraduate students (2.7 D) although both groups were comparable in age. Dark-focus measures have been shown to be reliable over two or three days (Miller, 1978, $\underline{r}$ = +.95) and over three weeks ($\underline{r}$ = +.85). Mershon and Amerson (1980) report differences in dark focus measured after one week averaged only .3 D.

Owens and Leibowitz (1975) found correlations of the resting state with fixation state to a small luminous stimulus at near (2D) and far (.25D) distances to be +.92 and +.90, respectively. They concluded that the accommodative response to the light was determined primarily by the resting position and not the distance to the stimulus. Leibowitz and Owens (1975) and Leibowitz, Hennessy, and Owens (1975) came to the same conclusion from similar correlations of resting position with accommodation to stimuli of varying luminosity. Near point (the closest distance at which an individual can focus) and visual amplitude (range of accommodation, near point minus far point) may also vary across refractive errors. Finally, Simonelli (1979) introduced a new visual measure, relative dark focus. It is the algebraic difference between resting position and far point.

Summary

Investigations of differences among myopes, emmetropes, and hyperopes have included comparisons of physical characteristics, scholastic achievement, and personality traits. In the first area, there seems to be no support for the caricature of the small, weak myope and the tall, strong hyperope. Research relating scholastic achievement to refractive error, however, reinforces the popular stereotype of the studious myope. Finally, myopes and hyperopes seem to have distinct personalities. Myopes are overcontrolled and introverted; hyperopes, impulsive and extraverted. These personality types and thus perhaps myopia and hyperopia, may be associated with distinct patterns of physiological functioning. Finally, myopes and hyperopes may vary in dark focus, near point, and visual amplitude. The purpose of the present research was to examine differences in these five areas among myopes, emmetropes, and hyperopes.

METHOD

Subjects

The subjects of this experiment were 152 military trainees at Chanute Air Force Base, Illinois. Individuals were 17 to 28 years old.

Procedure

Subjects were tested individually. Each began by completing the Eysenck Personality Inventory and a short personal history questionnaire. Dark focus and far point were measured using a polarized-vernier optometer (see Simonelli, 1979). Near point was measured using the RAF Near Point Rule. A rubber bellows was placed securely around the subject's chest. Pressure changes produced within the bellows by breathing movements were transduced into voltage levels by a Grass Model PT 5A volumetric pressure transducer. This signal was monitored by a Beckman 9806A A-C coupler set in a Beckman RB Dynagraph. A two-minute recording was made with an Ampex SP 700 FM tape recorder.

The pads of the subject's middle fingers, forearm surface of the right arm, and the inside calves of both legs were swabbed with rubbing alcohol to remove surface oils and salts. Beckman standard-size Ag/AgCl electrodes were then attached to these surfaces with electrode collars. Skin conductance was recorded from the finger pads relative to a constant 0.5v DC reference imposed by a Beckman 9842 Galvanic Skin Response coupler (1 mm = 1 micromho). The electrodes on the pads were filled with K-Y surgical jelley. The other three electrodes were filled with Beckman electrode paste. EKG was measured from active right-forearm and left-calf electrodes using a second Beckman 9806A A-C coupler. The right-calf electrode served as a ground. Intermittently during this procedure, systolic and diastolic blood pressures were measured six times from the left brachial artery.

RESULTS

The physiological recordings of 27 subjects were eliminated from the data base due to the poor quality of these recordings. For the remaining 135 subjects, $\overline{A}$ was calculated by the procedure described by Wenger and Ellington (1943). However, only four of the original seven tests were used to determine $\overline{A}$. These were heart and respiration periods, skin conductance, and pulse pressure. Cw and $\hat{V}$ were calculated from heart and respiration periods in the manner described by Porges, Bohrer, Cheung, Drasgow, McCabe, and Keren (in press).

Subjects were classified into one of three groups based on their measured refractive error. Those with negative far points were termed hyperopes; those with far points nearer than 1 diopter (D), myopes. All others were classified as emmetropes. A series of one-way analyses of variance based on this classification was used to search for differences among myopes, emmetropes, and hyperopes. Newman-Keuls post hoc comparisons were calculated for variables that differed reliably among the groups. The means and F values from these analyses are given in Tables 1 and 2, respectively.

Table 1

Variable Means For Groups Defined by Refractive Error

	Hyperopes	Emmetropes	Myopes
Height (in inches)	69.58	68.45	68.67
Weight (in pounds)	153.63	149.73	146.44
Introversion/Extraversion	12.40	11.86	12.61
Neuroticism	8.40	8.36	9.74
Lie	3.17	3.74	3.15
Last Grade Completed	11.97	11.75	12.23
$\overline{A}$	71.77	72.23	67.75
Cw	.54	.61	.53
$\hat{V}$	8.64	8.59	8.46
Heart-Rate Variability	8.05	8.08	8.10
Near Point*	9.32	10.62	11.88
Measured Dark Focus*	.28	.90	3.37
Relative Dark Focus*	.77	.54	.87
Visual Amplitude*	9.81	10.25	9.38
Mode N	65	40	39

* in diopters

Table 2

Results of One-Way ANOVAS Comparing Hyperopes, Emmetropes, and Myopes

Variable	df	F	p
Height*	2,126	1.58	.21
Weight*	2,127	1.66	.19
Introversion/Extraversion	2,143	.60	.55
Neuroticism	2,143	1.29	.28
Lie	2,143	1.75	.18
Last Grade Completed	2,141	4.72	.01
$\overline{A}$	2,141	3.66	.03
Cw	2,130	2.21	.11
$\hat{V}$	2,130	.26	.77
Heart-Rate Variability	2,139	.05	.96
Near Point	2,144	8.36	.00
Measured Dark Focus	2,144	145.53	.00
Relative Dark Focus	2,144	4.26	.02
Visual Amplitude	2,144	.75	.47

* based on male scores only

As can be seen in Table 2, differences in physical characteristics, specifically height and weight, among the male subjects in the three groups were not reliable. Nor were there reliable differences among the groups on any of the three scales of the Eysenck Personality Inventory. The groups did differ, however, in amount of education. Myopes completed more grades than emmetropes. Physiologically, myopes had lower $\overline{A}$ scores (sympathetic dominance) than emmetropes, but the groups did not differ in Cw or $\hat{V}$. Visually, the groups varied in both near point and dark focus. Myopes had reliably nearer near points than hyperopes. Myopes also had reliably closer measured dark focuses than hyperopes and larger relative dark focuses. The groups, however, did not differ in visual amplitude.

Further differences among myopes, emmetropes, and hyperopes were tested by several stepwise discriminant analyses. The variables that reliably differed among the groups were entered into the first stepwise discriminant function. These variables included: last grade completed, $\overline{A}$, near point, measured dark focus, and relative dark focus. In this analysis, the first function was reliable ($\Lambda = .224$, $p < .0001$) and accounted for 96.85 percent of the total variance:

$$-.127(\text{grade}) + .093(\overline{A}) - .193(\text{NP}) - 1.20(\text{DF}) + .651(\text{RDF})$$

Using this function,86.52 percent of the individuals were correctly classified. Myopes completed the most grades, had the nearest near points and dark focuses, and the largest relative dark focuses.

The second discriminant analysis was based on information from the personal history questionnaire and the scores from the Eysenck Personality Inventory. In this analysis, the first function was reliable (Λ = .873, p = .0047) and accounted for 82.71% of the total variance:

$$-.002(\text{weight}) + 1.112(\text{grade}) - .453(\text{lie score}) - 11.785$$

Using this function 43.36% of the individuals were correctly classified. Hyperopes were the heaviest, myopes the lightest. Myopes completed the most years of schooling, emmetropes the fewest. Finally, emmetropes scored the highest on the lie scale, myopes the lowest.

A third discriminant analysis was calculated using four physiological indices: HRV, $\overline{A}$, Cw, and $\hat{V}$. The first function of this analysis was also reliable (Λ = .800, p = .0042) and accounted for 80.75% of the total variance:

$$-.446(\text{HRV}) + 5.305(\text{Cw}) - .429(\hat{V}) + 1.126$$

Myopes showed the greatest heart-rate variability, hyperopes the least. Emmetropes had the highest Cw estimates, hyperopes the lowest. Finally, hyperopes produced the highest $\hat{V}$ estimates, myopes the lowest. This function enabled 44.53% correct case classification.

The last analysis was calculated from four vision measures: near point, measured and relative dark focus (RDF), and visual amplitude. The first function in this analysis was also reliable (Λ = .239, p < .0001) and accounted for 98.22% of the total variance:

$$.010(\text{near point}) + 1.180(\text{dark focus}) - .261(\text{RDF}) - 1.415$$

Myopes had the nearest near points and dark focuses; hyperopes had the farthest in both. Finally, myopes had the largest relative dark focuses, emmetropes the smallest. Using this function, 86.39% of the cases were correctly classified.

DISCUSSION

One major area of investigation of differences among myopes, emmetropes, and hyperopes has been physical characteristics. Some, for example, Henderson (1934) and Schultz (1960), have speculated that myopes may be smaller and lighter than hyperopes. Beedle and Young (1976), however, found no support for this speculation. The present data can be used to support both of these opposing results depending on the type of analysis. No reliable relationship was found with two analyses of variance. However, the earlier speculations were supported by discriminant analyses in which weight was a reliable discriminant variable; hyperopes were indeed the heaviest and myopes the lightest individuals.

The second area of investigation has been scholastic achievement. Clinical impressions and popular stereotypes consistently link myopia with academic achievement. Empirical examination has not been as consistent. Although Young (1967) found that the majority of individuals in an honors program were myopic, myopes did not score reliably higher on several standardized college entrance tests. But Young, et al. (1975) and Beedle and Young (1976) report that myopes had higher GPAs than nonmyopes. In the present study the quantity rather than the quality of educational performance was compared among myopes, emmetropes, and hyperopes. Myopes completed more grades than emmetropes. This difference was evidenced by the ANOVAS and the second discriminant analysis.

The third area of possible differences among individuals of varying refractive error is personality. Most researchers have found myopia to be related to introversion. For example, Mull (1948) using the Bernreuter Personality Inventory, reported that myopes were more introverted than emmetropes. Also, Beedle and Young (1976) found myopes were more introverted than hyperopes as measured by the Omnibus Personality Inventory. In the present study, however, the groups did not differ in introversion. Since the Eysenck Personality Inventory did not yield results comparable to others found in the literature, it may be a poor measure of introversion. Conversely, it may measure something that the other tests do not. As often occurs in science, constructs with the same name may not be equivalent.

A second personality difference, impulsivity, has been consistently related to refractive error. Hyperopes are impulsive (Shapero & Hirsch, 1952) while myopes are cautious (Greaves, 1977), inhibited and overcontrolled (Shapero & Hirsch, 1952). And yet, in the present study there were no reliable differences between these groups on the neuroticism scale of the Eysenck Personality Inventory, a scale measuring lability and impulsivity. A measure of consistency of response, the lie score from the Eysenck Personality Inventory, was a reliable discriminant variable, however. Emmetropes were the least consistent, myopes the most. This is compatible with other reports (Gould, 1918; Greaves, 1977).

Personality types similar to those attributed to myopes and hyperopes have been associated with parasympathetic- and sympathetic-dominant individuals. Physiological differences among myopes, emmetropes, and hyperopes were reliable. Myopes had lower $\bar{A}$ scores than emmetropes, indicating sympathetic rather than parasympathetic dominance. This is opposite to expectation and may be due to the modifications in the $\bar{A}$ battery. However, two reliable discriminant variables in the third analysis also suggest that myopia may be related to heightened sympathetic activity. Myopes had the greatest heart-rate variability and lowest $\hat{V}$ while hyperopes displayed the opposite tendencies. These findings do, however, add to the growing nonsupport for the Eysenck theory of personality. But hyperopes did have the lowest Cw estimates, as expected. These findings may not be as inconsistent

as they first appear. Of the four physiological measures, Cw is the only one hypothesized to be related to central rather than peripheral autonomic functioning. This dichotomy merits further investigation.

Finally, myopes, emmetropes, and hyperopes are visually distinct in more than far point. Both the ANOVAS and the fourth discriminant analysis suggest that the visual range of myopes is shifted inward; they have by definition the nearest far points but also the nearest near points and dark focuses and the largest relative dark focuses of the three groups. Although their range is closer it is not reliably shorter since there were no reliable differences in visual amplitude among the groups, possibly because the diopter scale weights near distances more heavily than farther distances.

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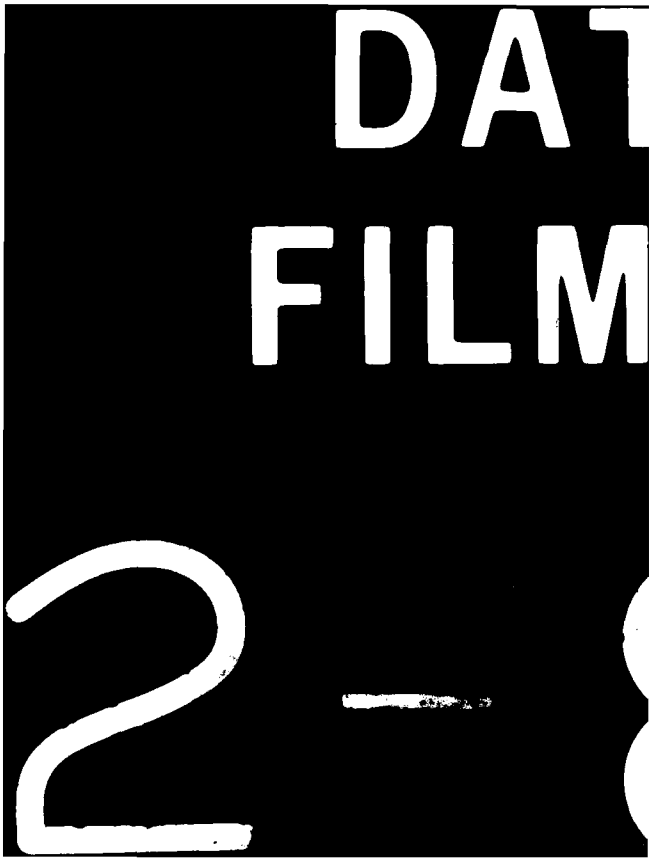
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