

# Myopia and Personality: The Genes in Myopia (GEM) Personality Study

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**PURPOSE.** A long-held view among the medical and broader community is that people who are short-sighted (myopic persons) have distinctive personality characteristics such as introversion and conscientiousness. However, existing research on this question is flawed, and its findings are inconsistent. The authors therefore aimed to determine whether myopia and personality are associated.

**METHODS.** The authors examined twins recruited through the Australian Twin Registry and a clinical-based family sample through a proband from a Melbourne Excimer Laser Clinic. There was no relation between family members and twins recruited in our study. Each individual underwent a full eye examination, completed a standard medical and general questionnaire, and was administered a five-factor model International Personality Item Pool (IPIP) inventory (Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism). Myopia was defined as worse than or equal to  $-0.50$  (DS) spherical equivalent in the eye with the least refractive error.

**RESULTS.** Data from 633 individual twins aged 18 to 83 years (mean, 53.04 years) and 278 family members aged 11 to 90 years (mean, 49.84 years) were analyzed. Prevalence of myopia was 35.7% for twins and 47.6% for family members. Mean spherical equivalent was  $+0.13$  DS (95% CI,  $\pm 0.16$ ) for twins and  $-1.13$  DS (95% CI,  $\pm 0.25$ ) for family members. Correlation and regression results for personality for both sample cohorts after multivariate analysis did not support the view that myopic persons are introverted or conscientious; however, there was a significant but small association between myopia and Agreeableness ( $r = 0.08$ ,  $P < 0.05$ ). In multivariate analysis with age, sex, education, and the five personality factors entered as predictors, Openness was the only significant personality predictor of myopia in both samples.

**CONCLUSIONS.** This is the first multivariate study to assess links between personality and myopia using the IPIP. The long-held view that myopic persons are introverted and conscientious may reflect intelligence-related stereotypes rather than real correlations. Furthermore, the predictive characteristic of in-

telligence, subsumed in Openness, appeared to be representative of a previously reported link between intellectual abilities (IQ) and myopia rather than personality and myopia. (*Invest Ophthalmol Vis Sci.* 2008;49:882-886) DOI:10.1167/iovs.07-0930

Myopia, or short-sightedness, affects approximately 20% to 25% of individuals in Western populations, with a much higher prevalence (80%) in certain urbanized regions of South-east Asia, such as Singapore.<sup>1,2</sup> It manifests as a complex disease with environmental and genetic aspects implicated in its etiology. Evidence arising from twin and family studies has suggested a role for genetic factors, with monozygotic (MZ) twins having a significantly higher concordance ( $>0.80$  DS) for myopia ( $\leq 0.50$  DS) than dizygotic (DZ) twins ( $<0.40$  DS). Heritability estimates range from 50% to as high as 90%.<sup>3</sup> Family studies have also shown approximately a four times greater risk of myopia in offspring of two myopic parents than in those of two nonmyopic parents.<sup>4</sup> Heritability estimates derived from family studies have typically ranged from 40% to 73%. Moreover, a recent review<sup>5</sup> reported a number of candidate loci (14 MYP regions) for nonsyndromic myopia in its low ( $-0.50$  DS to  $-2.99$  DS), moderate ( $-3.00$  DS to  $-5.99$  DS), and high ( $\leq -6.00$  DS) clinical classifications through family and twin studies. It should be noted that most loci so far reported have been for high myopia. However, a recent family-based study by Chen et al.<sup>6</sup> found replication to the MYP12 locus using a lower limit definition of common myopia of  $\leq -0.50$  DS. Overall these findings suggest a significant genetic component in myopia, though no genes have yet been identified.

Environmental factors that have a behavioral component, such as near work (reading/studying), academic achievement, and educational attainment, have also been reported to play a role in the development of myopia, explaining 11.6% of the total variance.<sup>7</sup> However, it can be argued that these environmental risk factors are interrelated rather than independent.

Personality is defined as the system of enduring characteristics that contribute to consistency in an individual's thoughts, feelings, and behavior. It is widely accepted that personality is influenced by genetic and environmental factors.<sup>8</sup> However, the literature is inconclusive with respect to links between personality and myopia. Numerous studies report that myopic persons tend to differ from nonmyopic persons along personality dimensions such as introversion/extroversion, passivity/anxiety, and abstractness/practicality. In a review of the literature, Lanyon and Giddings<sup>9</sup> concluded that myopic persons tend to be more introverted, tolerant to anxiety, and overcontrolled than nonmyopic persons. Beedle and Young<sup>10</sup> agreed with these findings after sampling 782 introductory psychology students; however, their ocular classification was based on self-report rather than an objective measure. In a more comprehensive review, Baldwin<sup>11</sup> also concluded that there appears to be a relation between myopia and introversion, self-confidence, and reflexivity as opposed to a relation between hypermetropia and extroversion, self-effacement, and a preference for overt activity.

In contrast to these reviews and studies, other studies have suggested that no differences in personality characteristics

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between myopic persons and nonmyopic persons exist.<sup>12-15</sup> Bullimore et al.<sup>15</sup> recruited 189 optometry students who self-reported their refractive classification and completed the Eysenck Personality Inventory (EPI). No differences on the three EPI factors (Extroversion, Neuroticism, and Social Desirability) between myopic persons (55.6%), emmetropic persons (38.1%), and hypermetropic persons (6.3%) were reported.

Generally, most studies have recruited undergraduates, optometry students, or military recruits or have used clinical samples, with personality assessed by clinical observation and later by self-report using the EPI or Catells 16 Personality Factor questionnaire. In addition, sample size has generally been modest (apart from Beedle and Young<sup>10</sup>), and the use of postal surveys rather than clinical measurements (subjective or objective refraction) of refraction can be problematic because the surveys do not account for individuals with uncorrected refractive error.

A more recent study into myopia and personality by Lauriola<sup>16</sup> assessed five factors of personality (Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism) using a correlational approach. A five-factor model is now widely accepted as a description of the primary dimensions of personality.<sup>17</sup> Eighty-eight patients (3.5% with emmetropia, 46.9% with myopia, 24.5% with hypermetropia, 24.5% with astigmatism) between 12 and 35 years of age and attending optometry centers completed the Short Adjectives Checklist (SACBIF) to measure the five personality factors and a near-work questionnaire. Significant but low correlations were found between refractive error and the personality factors Extroversion ( $r = 0.15$ ), Openness ( $r = 0.12$ ), and Conscientiousness ( $r = -0.24$ ). These correlations further supported an association between refractive error and introversion and indicated that myopic persons are also less open and more conscientious than nonmyopic persons.

Although the use in Lauriola<sup>16</sup> of the five-factor model represents an advance on previous work, it was unclear whether subjective refraction or dilated/undilated objective refraction was used to assess refractive error. In addition, the modest sample size limits the generalizability of the study's findings. The proposal that Conscientiousness, Introversion, and near work have a cumulative effect on myopia was not directly tested using multivariate analyses, and the associations between personality and myopia might have been confounded by associations between personality and near work (Conscientiousness,  $r = 0.40$ ; Extroversion,  $r = -0.25$ ). Assessing past near work or current educational attainment would have been more informative than the measure of current near work. No other studies have been published on relationships among the five personality factors and myopia, near work, and educational attainment (EA).

In summary, several studies investigating personality-myopia links have failed to yield consistent correlations. This may reflect a number of limitations, including small and selective samples, inconsistent categories for refractive error, differences in personality assessment, or influence of confounding factors. To address these issues and to clarify the role of personality and myopia, we undertook analysis using a widely accepted summary measure of the five personality factors, multivariate analysis (which included currently known risk factors for myopia), and two different samples, a population based sample of twins and a clinically based family member sample.

## METHODS

### Recruitment

All participants had previously been recruited and examined for the Genes in Myopia (GEM) study, which is an Australian-based myopia

study that holds a large database of twins and family members recruited from the Australian Twin Registry (ATR) and the Melbourne Excimer Laser Group (MELG; for a full report of the GEM study methodology for family members, see Garoufalidis et al.<sup>18</sup>). The ATR is a national registry of twin pairs (more than 31,000 registered twin pairs 0-95 years of age) who, or whose guardians, are willing to consider participation in twin studies. Approximately one third of all twins registered at the ATR reside in the state of Victoria. All Victorian-registered twins recruited into the twin component of the GEM study received a letter of invitation from the ATR, consisting of an information sheet, invitation letter, and consent form. After recruitment of twins and families in the GEM study, each family member and twin received a separate invitation letter to consider participating in the personality component of the GEM study and the International Personality Item Pool (IPIP) Five Factor inventory.

### Ethics

The consent procedure adhered to the tenets of the Declaration of Helsinki, and ethical approval for the personality component of the GEM study was provided by the Royal Victorian Eye and Ear Hospital Human Research and Ethics Committee, the ATR, and the School of Behavioral Science Departmental Human Ethics Advisory Group at the University of Melbourne.

### Materials

In brief, dilated autorefractometry was measured in GEM participants with the use of an autorefractor (KR 8100; Device Technologies, Melbourne, Australia). For all twins (18 years or older) and only family members younger than 21, a single drop of tropicamide 1% (mydriatic) was instilled approximately 20 minutes before autorefractometry. Three readings were taken for each eye, and the average value was recorded. Results were converted to their spherical equivalent (SE; sphere + half the cylinder). Given that there were no significant difference in the SE between right and left eyes ( $P > 0.05$ ), we presented the findings only for right eyes. Age, sex, and EA were recorded. The EA of twins was self-assessed on an ordinal scale (0, no formal education; 5, completion of at least one national or internationally recognized university degree), and that of family members was self-assessed on an interval scale (years in education).

For the personality component of the GEM study, participants were mailed an invitation letter, an information sheet, a personality questionnaire, and a postage paid envelope for reply. Completed and returned questionnaires implied formal consent. The short version (120 items) IPIP Five Factor Inventory was used as the personality questionnaire. The IPIP is a widely used and accepted self-report inventory that assesses individual differences in the five personality factors. Participants self-rate the accuracy of statements (23-25 per factor) on a five-point Likert-type scale (1 = very inaccurate; 2 = moderately inaccurate; 3 = neither inaccurate nor accurate; 4 = moderately accurate; 5 = very accurate). Examples include "I am the life of the party," "I am always prepared," and "I get stressed out easily." Standard scoring instructions were used. Some statements were negatively framed and required reverse scoring, after which the items in each scale were summed.

### Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 14.0 (Chicago, IL) was used for all analyses. A critical  $P = 0.05$  was adopted. Analysis of variance was used to test for significant group differences among those classified as hypermetropic persons ( $\geq +0.5$  DS), emmetropic persons ( $\leq +0.49$  DS to  $\leq -0.49$  DS), low myopic persons ( $\leq -0.5$  DS to  $\leq -2.99$  DS), moderate myopic persons ( $\leq -2.99$  DS to  $\leq -5.99$  DS), and high myopic persons ( $\leq -6.0$  DS) on each of the mean scores for each of the five personality factors. Pearson correlations were used as measures of association except when EA was correlated with SE for twins, in which case Spearman  $\rho$  correlations were used. To examine the dimensional structure of the personality measure, confirmatory

**TABLE 1.** Correlations between Spherical Equivalent and the Big Five Factors for Twins

	SE	O	C	E	A
Openness	-0.07	—	—	—	—
Conscientiousness	0.00	0.04	—	—	—
Extroversion	0.01	0.35†	0.26†	—	—
Agreeableness	0.08*	0.19†	0.38†	0.15†	—
Neuroticism	0.00	0.14†	-0.39†	-0.37†	-0.27†

O, Openness; C, Conscientiousness; E, Extroversion; A, Agreeableness.

\*  $P < 0.05$  (two-tailed).

†  $P < 0.01$  (two-tailed).

factor analyses were conducted on the twin and family data sets and were checked against requirements for factor analyses.<sup>19</sup> When regression analyses were conducted, age was entered into the models to statistically control for the hypermetropic shift in older age. Logistic regression analyses were used to predict membership in either the myopia or the no myopia categories, with myopia defined as SE less than or equal to  $-0.50$  DS. Age, EA, sex, and the five personality factors were entered simultaneously as predictors. For the twin analyses, EA was entered as a ranked categorical variable and was analyzed using dummy variables.

## RESULTS

### Descriptive Statistics

Of the 2128 (1224 individual twins from twin pairs and 904 family members) persons approached, 708 (57.8%) twins (female = 496 [70%]; male = 212 [30%]) and 303 (33.5%) family members (female = 186 [61.4%]; male = 117 [38.6%]) completed and returned the personality questionnaire. Complete data across all variables were obtained from 633 (89%) twins, consisting of 235 people with hypermetropia (37.1%), 172 people with emmetropia (27.2%), 159 people with low myopia (25.1%), 51 people with moderate myopia (8.1%), and 16 people with high myopia (2.5%) and from 278 (90%) family members, consisting of 45 people with hypermetropia (16.2%), 101 people with emmetropia (36.2%), 95 people with low myopia (34.3%), 26 people with moderate myopia (9.2%), and 11 people with high myopia (4.1%) and were used for correlation and regression analyses.

### Baseline Measures

Tests of independent group effects revealed significant differences between family members and twins for SE ( $t(909) = 8.30$ ;  $P < 0.01$ ). Twins had significantly higher means for SE ( $+0.13$  DS;  $SD = 2.08$ ) than family members ( $-1.13$  DS;  $SD = 2.15$ ), confirming the clinical nature of the family sample and the more general population nature of the twin sample. The mean EA value for family members was 15.5 years ( $SD = 3.98$ ) and a rating of 4.79 (approximately 14 years;  $SD = 1.76$ ) for twins. An equal proportion (approximately 60%) of twins and family members had begun or completed university. Confirmatory factor analyses supported the five-factor structure for the IPIP in twin and family member samples. Reliabilities of the five personality factor scales were uniformly high ( $\alpha = 0.78-0.85$ ) in both samples. SE and EA were significantly negatively correlated for twins ( $r = -0.22$ ;  $P < 0.01$ ) and for family members ( $r = -0.17$ ;  $P < 0.01$ ). Participants with higher educational attainment were more likely to have myopia than their counterparts with lower EA.

### Spherical Equivalent and the Five-Factor Model for Twins

We found no significant differences between any of the refractive error groups on mean scores for each of the five personality factors. Table 1 presents correlations between SE and the five personality factors for twins. There were trivially small positive correlations between Agreeableness and spherical equivalent ( $r = 0.08$ ) for twins. However, there were significant correlations among the five personality factors with moderate correlations existing between Openness and Extroversion ( $r = 0.35$ ), Conscientiousness and Neuroticism ( $r = -0.35$ ), Conscientiousness and Agreeableness ( $r = 0.39$ ), and Extroversion and Neuroticism ( $r = -0.37$ ).

Logistic regression analysis was conducted to determine whether the personality factors predicted myopia independently of the potentially confounding variables of EA, sex, and age in the twin sample (Table 2). The Hosmer and Lemeshow test for model fit indicated a good fit:  $\chi^2(8, n = 633) = 6.30$ ,  $P = 0.61$ . Odds ratios for predicting myopia were calculated after accounting for the influence of all the other predictors. Nagelkerke's<sup>20</sup> adjustments of Cox approximation of  $R^2$  indicated that the model explained only a small amount of the variance in myopia (8%). The overall classification rate for the model was unimpressive. Knowing their status on each of the

**TABLE 2.** Logistic Regression Analysis of Myopia Status as a Function of Age, Sex, Educational Attainment, and the Big Five Factors for Twins

	B	SE	Wald	df	Significance	Odds Ratio
Age (years)	-0.022	0.007	9.564	1	0.00*	0.97
Sex	0.322	0.213	2.282	1	0.13	1.38
Education						
(1)	-0.435	0.241	3.255	1	0.07	0.65
(2)	-0.038	0.276	0.019	1	0.89	0.96
(3)	0.076	0.351	0.047	1	0.83	1.08
(4)	-0.744	0.471	2.490	1	0.12	0.48
Openness	0.022	0.009	5.586	1	0.02†	1.02
Conscientiousness	0.007	0.010	0.469	1	0.49	1.01
Extroversion	-0.022	0.010	5.100	1	0.02†	0.98
Agreeableness	-0.008	0.012	0.456	1	0.50	0.99
Neuroticism	0.003	0.008	0.100	1	0.75	1.00
Constant	0.330	1.770	0.035	1	0.85	1.39

B, logistic coefficient. Education with (1) completion of primary, (2) completion of secondary, (3) completion of trade school, (4) completion of university.

\*  $P < 0.01$  (two-tailed).

†  $P < 0.05$  (two-tailed).

**TABLE 3.** Correlations between Spherical Equivalent and the Big Five Factors for Family Members

	SE	O	C	E	A
Openness	-0.14	—	—	—	—
Conscientiousness	-0.13	0.04	—	—	—
Extroversion	-0.05	0.30*	0.20*	—	—
Agreeableness	-0.03	0.30*	0.34*	0.02	—
Neuroticism	0.14	-0.14†	-0.35*	-0.42*	-0.16†

O, Openness; C, Conscientiousness; E, Extroversion; A, Agreeableness.

\*  $P < 0.01$  (two-tailed).

†  $P < 0.05$  (two-tailed).

predictor variables improved the rate for correctly classifying twins as having myopia or not having myopia by 1.6% when the five personality factors, age, sex, and EA were predictors. For twins, the odds of having myopia were increased by 1.02 for every unit increase in Openness and decreased by 0.98 for every unit increase in Extroversion and by 0.97 for every unit increase in age (Table 2).

### Spherical Equivalent and the Five-Factor Model for Family Members

We hypothesized that if we generalized the lack of meaningful correlations between SE and personality factors to the population, we might mask an effect in those with myopia. As a consequence, we undertook the IPIP in a clinic-based family sample, in which there was a higher ascertainment of individuals with myopia (56.8% vs. 28.5%). Again, we could clearly identify significant correlations among the five personality factors (Table 3), but we were unable to detect any significant correlations between myopia, represented as SE, and the five personality factors for family members (Table 3).

Logistic regression analysis was conducted for family members to determine whether the personality factors predicted myopia independently of the potentially confounding variables EA, sex, and age. Model fit using the Hosmer and Lemeshow test was good:  $\chi^2(8, n = 273) = 4.57, P = 0.80$ .  $R^2$  approximations indicated that the model explained only 9% of the variance in myopia. Knowing their status on each of the predictor variables improved rates for correctly classifying family members as having myopia or not having myopia by 5.7%. Again, odds ratios were calculated after accounting for the influence of all the other predictors. The odds of having myopia were increased by 1.03 and 1.07 for every unit increase in openness and EA respectively, and decreased by 0.98 for every unit increase in age (Table 4).

## DISCUSSION

### Myopia and the Five-Factor Model

There was a significant correlation between one personality factor and myopia in the twin sample, but it was trivially small and not evident in the family sample. Therefore, this lack of consistent and meaningful associations between personality and myopia in both samples was consistent with the results from previous studies<sup>12,13,15</sup> but did not support those of Lanyon and Giddings,<sup>9</sup> Beedle and Young,<sup>10</sup> or Baldwin.<sup>11</sup> Similarly, they did not support the negative correlations between SE and Conscientiousness and the positive correlations between SE and Openness found by Lauriola.<sup>16</sup> Instead, results of the regression analyses in the present study pointed to Openness as a very weak predictor of myopia rather than no myopia for both samples. Extroversion was a predictor of no myopia in the twin sample, and this was in line with the results of Lauriola,<sup>16</sup> who found a positive correlation between Extroversion and SE. However, as a predictor, it was very weak, and the minuscule odds ratio and its absence as a predictor in the family sample suggests that its effect on no myopia was trivial.

There are numerous possible explanations for the lack of support for previous studies, such as their small and selective samples, inconsistent categories for refractive error, differences in personality assessment, and failure to account for confounding factors. Another possible, and more probable, explanation is that the trends in the literature are similar to the perceived associations held by health professionals of a distinctive so-called myopic personality and therefore taken as meaningful. If the latter explanation is the case, a question remains as to how these perceived associations can exist when the strength of associations are well below what could be observed anecdotally. It could be argued that these observations are of those with high myopia; however, the results suggest that personality does not differ for any of the ocular groups, making observational distinctions unlikely. Another possibility is that they represent mistaken intelligence-based stereotypes. Myopic persons do indeed score relatively high on measures of IQ and educational attainment (Saw et al.<sup>7</sup>), and intelligent people are commonly stereotyped as introverted, reserved, and bookish. By this argument, myopic persons may be inaccurately inferred to have these traits because they are accurately seen as intelligent. Further support for this can be seen in regression analyses. As a predictor of myopia, Openness and the characteristics of being open are also characteristics of those with higher IQ.

### Limitations of the Personality Component of the GEM Study

The personality component of the GEM study is an improvement on previous attempts at determining whether myopic

**TABLE 4.** Logistic Regression Analysis of Myopia Status as a Function of Educational Attainment, Age, Sex, and the Big Five Factors for Family Members

	B	SE	Waldman	df	Significance	Odds Ratio
Age (years)	-0.020	0.008	5.849	1	0.02*	0.98
Sex	0.046	0.264	0.030	1	0.86	1.05
Education	0.070	0.035	4.085	1	0.04*	1.07
Openness	0.027	0.013	4.153	1	0.05*	1.03
Conscientiousness	-0.003	0.012	0.070	1	0.79	1.00
Extroversion	-0.003	0.013	0.070	1	0.79	1.00
Agreeableness	0.004	0.014	0.081	1	0.78	1.00
Neuroticism	0.002	0.012	0.037	1	0.85	1.00
Constant	-1.892	2.350	0.648	1	0.42	0.15

B, logistic coefficient.

\*  $P < 0.05$  (two-tailed).

persons have distinctive personality characteristics. Two large samples were used to detect small effects. We also collected clinical measures of refractive error, rather than participant subjective self-report measures, and administered the widely used IPIP to successfully tap the primary dimensions of personality. In addition, the two samples were independent of each other; one was normative for myopia, and the other was clinical in nature. However, the personality component of the GEM study was not free of limitations, and sample ascertainment bias may place limits on the generalizability of the studies. By virtue of their current ATR membership, twins have demonstrated their willingness to participate in research. Although prevalence rates for myopia in twins are similar to those in the general population, their status as twins means their personality trait levels may not be representative of the general population. Similarly, family members have previously volunteered to participate in the GEM study and have a vested interest in research into myopia by virtue of their genetic vulnerability to the condition. In addition, the low participation rate (33.5%) of family members in our study may be considered less generalizable to the total sample population used in the family component of the GEM study and to the general population. Furthermore, another potential limitation in our study was the lack of dilation in family members 21 years of age and older, which might have led to an overestimation of myopia and an underestimation of hypermetropia.

## CONCLUSIONS

The focus of the personality component of the GEM study was on whether personality and myopia are linked. Methods used to test this hypothesis were rigorous and advanced. The results do not support the view that there is a myopic personality. However, we cannot discount a causal link between personality and myopia development or an impact of myopia on personality and behavior. Beliefs about a link between personality and myopia may reflect intelligence-related stereotypes rather than real correlations. This should bring to a close the long-held belief that myopic persons have distinctive personality characteristics.

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