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Nature vs nurture: Are leaders born or made? A behavior genetic investigation of leadership style

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With the recent resurgence in popularity of trait theories of leadership, it is timely to consider the genetic determination of the multiple factors comprising the leadership construct. Individual differences in personality traits have been found to be moderately to highly heritable, and so it follows that if there are reliable personality trait differences between leaders and non-leaders, then there may be a heritable component to these individual differences. Despite this connection between leadership and personality traits, however, there are no studies of the genetic basis of leadership using modern behavior genetic methodology. The present study proposes to address the lack of research in this area by examining the heritability of leadership style, as measured by self-report psychometric inventories. The Multifactor Leadership Questionnaire (MLQ), the Leadership Ability Evaluation, and the Adjective Checklist were completed by 247 adult twin pairs (183 monozygotic and 64 same-sex dizygotic). Results indicated that most of the leadership dimensions examined in this study are heritable, as are two higher level factors (resembling transactional and transformational leadership) derived from an obliquely rotated principal components factors analysis of the MLQ. Univariate analyses suggested that 48% of the variance in transactional leadership may be explained by additive heritability, and 59% of the variance in transformational leadership may be explained by non-additive (dominance) heritability. Multivariate analyses indicated that most of the variables studied shared substantial genetic covariance, suggesting a large overlap in the underlying genes responsible for the leadership dimensions.

Keywords: leadership style, behavior genetics, transformational leadership, transactional leadership, heritability

A great deal of behavioral genetic research has been conducted into various personality traits, resulting in the consensus that personality is dependent on both genetic and environmental influences. The majority of twin studies has demonstrated moderate to large genetic contributions to many personality dimensions.[1,2] On average, individual differences in personality have been found to be approximately 40% heritable.[2]

Current scientific thought on leadership may be traced to Galton,[3] who conducted the first study of the genetic basis of leadership. The main thesis of Galton's work was not, however, leadership, nor did he address the heritability of leadership in a modern sense, owing to the underdeveloped genetic methodology of his time. Galton's subjects were 100 individuals whom he considered to be 'great men', insofar as they had attained eminence in their field to an extent realized by only 1 in 4000 individuals. He then undertook to examine the pedigree of these men, concluding that, since 'greatness' appeared to be more prevalent within the family history of these subjects than would be expected in the public at large, 'greatness' is wholly due to the action of genes. It was a small leap from this to trait theories, and the 'great man' theory of William James.[4] James believed that individuals are chosen by the situation, due to some intrinsic quality that makes them suitable to lead or to 'initiate movement'.

Scientists began to research leadership with the intention of discovering which personality traits distinguish those with this ability from those without. To this end, researchers compiled lists of traits that had been associated with leadership, typically through observations of the characteristics of publicly visible leaders. Stogdill[5] surveyed hundreds of articles, and concluded that the most important traits were (in order of importance): originality,

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popularity, sociability, judgement, aggressiveness, desire to excel, humor, cooperativeness, liveliness, and athletic ability. To simplify classification further, he proposed a rough taxonomy of leadership, with six dimensions, five of which were personality traits (capacity, achievement, responsibility, participation, and status). The sixth dimension was the situation.

It was Stogdill's[5] reference to the importance of the situation that prompted the greatest reaction from the scientific community. As a consequence of this article, there arose an increased level of research activity into the situation as the primary determinant of emergent leadership ability.[6] Trait theories are, however, seeing a resurgence in popularity among researchers. As is often the case when theoretical models swing from one extreme to another, the best available answer may be a compromise between the two. Although it is becoming increasingly clear that there are systematic trait differences between leaders and non-leaders,[6,7] there are situational, organizational, and motivational characteristics that affect the success of the individual within the leadership role.[8] One widely accepted model of leadership style is the transactional–transformational model proposed by Burns.[9] Transactional leadership refers to a leadership style in which the leader offers promises of rewards and benefits in exchange for fealty. Transformational leadership, on the other hand, involves the use of inspirational techniques, to inspire followers to suppress their own interests in favor of the long-term benefit of the group.[9]

If individual differences in the personality characteristics of leaders may be determined, it seems logical to determine the extent to which these characteristics, and the overall construct of leadership, are heritable. This notwithstanding, in over 2000 citations since 1990 involving a leadership construct taken from Psychological Abstracts, none has employed a modern behavior genetic approach. This study was designed to address this issue, applying a twin study paradigm to several psychometric measures of leadership.

Examination of the heritability of leadership is an important contribution to leadership research for a number of reasons. The most immediate benefit of such an analysis is to provide some initial answers to the question of whether leaders are 'born or made'. Another important feature of genetic analyses, however, is the examination of contributions due to an individual's unique experiences, a component of environmental variance that can only be properly identified with data collected in a twin (or similarly genetically informative) sample. When considering a personality construct such as leadership style, the magnitude of this environmental component may give some indication of the degree to which training would be effective for any given dimension.

Method

Participants were part of a large behavior genetic investigation spanning multiple personality constructs.[10] The subjects were 247 adult twin pairs: 183 pairs of monozygotic (MZ) twins (149 female pairs, mean age = 45.1 years, SD = 16.5; 34 male pairs, mean age = 45.1 years, SD = 15.8), and 64 same-sex dizygotic (DZ) twin pairs (55 female pairs, mean age = 42.8 years, SD = 17.6; 9 male pairs, mean age = 33.9 years, SD = 8.9). The subjects represent a wide variety of backgrounds and levels of education.

Subjects completed three self-report questionnaires assessing different facets of leadership behavior: the Multifactor Leadership Questionnaire (MLQ),[11] the Leadership Ability Evaluation (LAE),[12] and the Adjective Checklist (ACL).[13] These questionnaires were mailed to subjects, along with instructions for their completion and the promise of a chance to win one of 10 cash prizes of $100 in return for filling in the questionnaires. Completed questionnaires were returned in stamped, preaddressed envelopes. Subsequently, 10 subjects were randomly selected from among those who had returned their completed questionnaires and these subjects were sent the prize money.

The MLQ is an 80-item measure requiring subjects to rate the applicability of items to their own behavior, using a 5-point scale. The test consists of nine measures of leadership behavior: attributed charisma, idealized influence, inspirational motivation, intellectual stimulation, individualized consideration, contingent reward, active management-by-exception, passive management-by-exception, and laissez-faire leadership. Attributed charisma refers to an individual's perceived charisma in nonbehavioral situations, and may be thought of as a physical charisma. Idealized influence refers to the individual's charisma in behavioral situations. The inspirational motivation scale measures the leader's tendency to cause followers to respond to their task on an emotional level. Scores on the intellectual stimulation variable reflect the degree to which the leader provides tasks or subtasks that represent an appropriate level of mental challenge to their followers. The individualized consideration scale is a measure of how well the leader provides personal attention to each member of the target group. Contingent reward represents the exchange of value for performance. The two forms of management-by-exception (active and passive) are quite similar, with both forms involving a laissez-faire leadership style until the situation commands their attention (in other words, until the situation demands correction). To remedy a problem situation, however, an active leader will set performance standards and monitor

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subordinates carefully, whilst the passive leader will suggest that the situation must be remedied, but provide no concrete method for the amelioration of the problem. Finally, individuals who are completely non-involved with the follower group (except in an advisory capacity) typify the laissez-faire leadership style. The MLQ also contains the criterion scale 'extra effort', which measures the degree to which the individual inspires others to work beyond the immediate requirements of the task at hand, and perform 'above and beyond' the call of the situation. Although subordinate ratings of leader performance are preferable, the extra effort scale provides a useful comparison variable for the other leadership variables.[11] Bass[14] provides a good description of the construction methods and assumptions underlying the MLQ.

The LAE is a 50-item questionnaire designed to measure the decision pattern or social climate in which the leadership behavior is likely to take place. The individual is presented with 50 hypothetical situations and is required to identify with the leader, choosing the decision mode that he or she believes is best for the described situation. Each situation describes four types of decision: laissez-faire, democratic–cooperative, autocratic–submissive, and autocratic–aggressive. Laissez-faire leadership is typified by a lack of involvement with group members beyond the role of advisor or mentor, whilst democratic–cooperative leadership emphasizes attention to the group dynamic among followers, with decisions being made through the consensus of the follower group. Both autocratic–submissive and autocratic–aggressive leadership styles involves the direction of the group according to the leader's plan, and allow little deviation from the leader's preconceived notion of what should be done. Autocratic–submissive leaders, however, allow followers to determine how they wish to achieve the objective, whilst autocratic–aggressive leaders define the process as well as the objective.[12] One can also calculate a total leadership score by weighting the decision mode scores to discriminate optimally between leaders and non-leaders. Cassel and Stancik[12] recommend that an individual's total leadership score on the LAE be one tenth of the sum of their laissez-faire score (multiplied by seven), their democratic–cooperative score, and their autocratic–submissive score (multiplied by four). The autocratic–aggressive score does not enter into calculations of the total leadership score.

The ACL is a list of 300 descriptive adjectives, 47 of which were judged by the present authors to be relevant to leadership behavior (see Table 1). Subjects were to respond to the full adjective checklist on a 5-point Likert scale. It was hoped (and subsequently confirmed) that this modification to the original format of the ACL would yield a more reliable measure than having subjects simply tick any adjectives they felt were descriptive of them. The 47 adjectives judged to be relevant to leadership behavior were aggregated to form an adjectival leadership measure.

In total, 16 measures of leadership were obtained, the reliabilities of which ranged from moderate (LAE Autocratic–Aggressive, $\alpha = 0.55$), to high (ACL Leadership, $\alpha = 0.91$); median $\alpha = 0.78$. Reliabilities for all personality scales may be found in Table 2. Subjects also completed a zygosity questionnaire,[15] which has a reported accuracy of 93% in comparison with the results of blood-typing.[16]

Table 1 Adjectives contained in the ACL leadership scale

Aggressive	Frank
Alert	Hard-working
Appreciative	Having initiative
Authoritative	Honest
Business-oriented	Independent
Capable	Industrious
Caring	Inspiring
Charismatic	Leaderlike
Civilized	Likeable
Conscientious	Methodical
Co-operative	Moderate
Decisive	Motivated to achieve
Deliberate	Persevering
Demanding	Powerful
Dependable	Responsible
Driven	Self accepting
Dynamic	Self monitoring
Efficient	Strong
Empathic	Thoughtful
Enterprising	Tolerant
Enthusiastic	Trustworthy
Entrepreneurial	Versatile
Extraverted	Well adjusted
Farsighted	

Table 2 Reliabilities of the MLQ, LAE, and ACL-r leadership scales

Scale	α
LAE Autocratic–aggressive	0.55[a]
LAE Autocratic–submissive	0.59[a]
LAE Laissez-faire	0.58[a]
LAE Democratic–cooperative	0.91[a]
LAE Total	0.90[a]
MLQ Attributed charisma	0.74
MLQ Idealized influence	0.82
MLQ Inspirational motivation	0.84
MLQ Intellectual stimulation	0.82
MLQ Individualized consideration	0.87
MLQ Contingent reward	0.83
MLQ Management-by-exception, active	0.65
MLQ Management-by-exception, passive	0.69
MLQ Laissez-faire	0.71
MLQ Extra effort	0.81
ACL Leadership	0.91

[a]From Cassel R, Stancik E.[12]

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Results

Preliminary analyses

Means were computed for each raw scale score based on the whole sample and within each kinship group. A one-way analysis of variance was performed on each variable to compare the means between kinship groups, using each member of each twin dyad as an independent replication. None of the variables demonstrated a significant mean difference between MZ and DZ twins, and tests for heterogeneity of variance indicated that there were no significant differences in variances between kinships.

As was demonstrated by McGue and Bouchard,[17] the presence of age and sex effects on a trait score can seriously bias estimates of genetic and environmental components. To avoid these confounds, corrections for age and sex effects were made by computing completely standardized residual scores from the multiple regression of each score on age and sex. All further analyses are based on these transformed scores.

Factor analyses

Because the MLQ was designed to tap multiple facets of a two-dimensional factor space (ie transformational and transactional leadership), higher order factors were extracted from a principal components factor analysis of the MLQ, and the resulting factors were obliquely rotated to facilitate interpretation. The resulting factor matrix is presented in Table 3. Two factors were extracted, based on an examination of the scree plot. The first rotated factor of the solution obtained in this fashion accounts for 50.9% of the total variance in the sample space, and is identifiable as transformational leadership, as it has high positive loadings from attributed charisma (0.84), idealized influence (0.88), inspirational motivation (0.88), intellectual stimulation (0.82), and individualized consideration (0.87), all of which are considered to be the scales of the MLQ that designate transformational leadership.[11] Factor one also has a high positive loading from contingent reward (0.80), but this does not necessarily pose a problem for interpretation, given that transformational and transactional leadership are not mutually exclusive leadership styles, and the use of contingent rewards is a valid extension of transformational leadership behavior.[18] The second rotated factor of the solution accounts for 20.9% of the variance, and is identifiable as transactional leadership, possessing high positive loadings from active management-by-exception (0.73), passive management-by-exception (0.84), and laissez-faire leadership (0.72). This factor analysis is similar to analyses that have been undertaken in previous analyses, and the factors arrived at in this fashion may be seen to be representative of the higher-level leadership factors of transactional and transformational leadership.[11,18]

Because the LAE was not designed to tap higher level factors, it was not reduced beyond the scale scores, nor was it included in a factor analysis with the MLQ scale scores.

Table 3 Varimax rotation of principal components solution for the MLQ

	I	II
Attributed charisma	0.84	–0.08
Idealized influence	0.88	–0.01
Inspirational motivation	0.88	–0.17
Intellectual stimulation	0.82	0.05
Individualized consideration	0.87	–0.11
Contingent reward	0.80	0.22
Management-by-exception, active	0.35	0.73
Management-by-exception, passive	–0.13	0.84
Laissez-faire	–0.36	0.72
Eigenvalues	4.58	1.88
Percentage of variance	50.90	20.90

Univariate genetic analyses

Using LISREL 8,[19] univariate genetic analyses were conducted to assess the relative contributions of genetic and environmental effects to individual differences on the 16 leadership variables and the two MLQ factor scores (transformational and transactional leadership). For all variables, a full ACE model was fit first, to determine the proportion of variance that is attributable to additive genetic effects (A), common environmental effects (C), and specific environmental effects (E). If the presence of non-additive genetic effects was indicated (ie when the MZ correlation was more than twice the DZ correlation), then an ADE model was applied to the data, examining the proportion of variance attributable to additive genetic effects, non-additive (dominance) genetic effects (D), and specific environmental effects. These full models were then systematically decomposed into three models, AE, CE, and DE, comprising only two sources of variation each. The final model fit to the data was an E model, comprising only one source of variation, namely specific environmental variance. To determine which model afforded the 'best fit' to the data, the χ^2 obtained from each model was divided by its degree of freedom, and the model with the lowest χ^2:df ratio was considered to be the best fit to the data. Maximum likelihood estimates resulting from this analysis were squared to produce estimates of the variance due to each of the effects specified by the model.[20] The best fitting model for each variable may be found in Table 4. The best-fit model for each of the variables demonstrated a good fit to the data.

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As is apparent from Table 4, virtually every leadership scale demonstrated evidence of heritability, with the exceptions of MLQ contingent reward, MLQ passive management-by-exception, and MLQ laissez-faire. Among the scales that evidence genetic determinism, there is roughly an even split between additive and non-additive sources of variance, with effects ranging from 0.30 to 0.59. Because contingent reward, passive management-by-exception, and laissez-faire leadership (the only univariate models not displaying heritable components) represent two thirds of the transactional leadership dimension, as proposed by Avolio, Bass, and Jung,[21] this might indicate that individual differences in this form of leadership are predominantly environmentally determined. Indeed, the other component of transactional leadership, active management-by-exception, possesses the smallest amount of additive genetic variance, at 0.30.

The heritability of the MLQ factor scores was examined with univariate genetic models by analyzing the factor scores in a fashion similar to the analyses conducted on the scale scores. The results of these analyses are also contained in Table 4. The best fitting model for both transactional and transformational leadership indicated the presence of genetic effects, with additive effects for transactional leadership, and non-additive effects for transformational leadership.

Multivariate genetic analyses

Table 5 contains phenotypic correlations between the scales of the LAE, the ACL leadership scale, the two MLQ leadership factors (transformational and transactional leadership), and MLQ extra effort. Correlations in bold are significant at $P < 0.01$. As one would expect, given that these variables are purported to measure the same general construct, most are highly intercorrelated. Within the LAE, it would appear that the overall scale score for the LAE (LAE total) is predominantly measuring a laissez-faire leadership style. Democratic–cooperative leadership might be considered to be the best LAE

Table 4 MZ and DZ correlations and genetic analyses for LAE, ACL, and MLQ scales

Variable	MZ	DZ	a^2 (SE)	d^2 (SE)	c^2 (SE)	e^2 (SE)	χ^2(df)
LAE Autocratic–aggressive	0.32	0.09	—	0.33 (0.062)	—	0.67 (0.040)	3.59 (4)
LAE Autocratic–submissive	0.31	0.05	—	0.31 (0.066)	—	0.69 (0.042)	0.99 (4)
LAE Laissez-faire	0.41	0.29	0.42 (0.057)	—	—	0.58 (0.038)	1.25 (4)
LAE Democratic–co-operative	0.35	0.15	0.36 (0.061)	—	—	0.64 (0.040)	0.44 (4)
LAE Total	0.36	0.28	0.38 (0.060)	—	—	0.62 (0.040)	2.58 (4)
ACL Leadership	0.50	0.16	—	0.49 (0.054)	—	0.51 (0.037)	1.95 (4)
MLQ Attributed charisma	0.50	0.13	—	0.49 (0.053)	—	0.51 (0.037)	0.84 (4)
MLQ Idealized influence	0.50	0.18	0.48 (0.054)	—	—	0.52 (0.036)	2.92 (4)
MLQ Inspirational motivation	0.54	0.20	—	0.55 (0.051)	—	0.45 (0.034)	2.49 (4)
MLQ Individualized consideration	0.50	0.20	—	0.52 (0.053)	—	0.48 (0.036)	1.71 (4)
MLQ Intellectual stimulation	0.47	0.20	—	0.47 (0.054)	—	0.53 (0.037)	1.16 (4)
MLQ Contingent reward	0.25	0.27	—	—	0.25 (0.067)	0.75 (0.040)	0.11 (4)
MLQ Management-by-exception, active	0.31	0.11	0.30 (0.068)	—	—	0.70 (0.042)	3.52 (4)
MLQ Management-by-exception, passive	0.31	0.31	—	—	0.31 (0.060)	0.69 (0.038)	2.86 (4)
MLQ Laissez-faire	0.28	0.33	—	—	0.29 (0.061)	0.71 (0.037)	3.60 (4)
MLQ Extra effort	0.48	0.05	—	0.48 (0.056)	—	0.52 (0.038)	0.66 (4)
MLQ Factor I Transformational leadership	0.58	0.21	—	0.59 (0.051)	—	0.41 (0.035)	1.16 (4)
MLQ Factor II Transactional leadership	0.47	0.33	0.48 (0.055)	—	—	0.52 (0.037)	4.09 (4)

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exemplar of transformational leadership, whilst laissez-faire leadership is probably the best LAE indicator of transactional leadership. The ACL leadership scale is also likely to be a good indicator of transformational leadership, as it is highly positively correlated with MLQ factor 1.

Having noted that the putative model of transformational/transactional leadership appears to cut across the three psychometric measures used in the study, it is interesting to note the extent to which the scales share common genetic variance. Using Mx,[22] bivariate Cholesky decompositions were performed on all possible pairs of LAE subscales, the MLQ factors, the ACL leadership scale, and the MLQ extra effort scale. Tables 6 and 7 contain estimates of the genetic and environmental correlations (respectively) between the LAE scales, MLQ factors, ACL leadership scale, and the MLQ extra effort scale, with correlations significant at $P < 0.05$ in bold. (In the interest of brevity, only reduced scores are reported at a multivariate level. The complete matrix of phenotypic and genetic correlations is available

Table 5 Phenotypic correlations between transformational/transactional leadership, MLQ extra effort scale, leadership ability evaluation scales, and adjective checklist leadership scale

	LAE Autocratic–aggressive	LAE Autocratic–submissive	LAE Democratic—co-operative	LAE Laissez-faire	LAE Total	MLQ Extra effort	ACL Leadership	MLQ Factor 1
LAE Autocratic–aggressive								
LAE Autocratic–submissive	0.02							
LAE Democratic–co-operative	–0.40	–0.29						
LAE Laissez-faire	–0.14	–0.28	–0.65					
LAE Total	–0.22	0.03	–0.73	0.92				
MLQ Extra effort	0.00	–0.06	0.27	–0.24	–0.27			
ACL Leadership	–0.04	–0.06	0.22	–0.18	–0.21	0.50		
MLQ Factor 1	–0.04	–0.08	0.32	–0.26	–0.29	0.76	0.60	
MLQ Factor 2	0.07	0.08	–0.33	0.28	0.28	–0.18	–0.27	–0.09

Correlations in bold are significant at p<0.01; MLQ Factor 1 = Transformational Leadership; MLQ Factor 2 = Transactional Leadership

Table 6 Genetic correlations between transformational/transactional leadership, MLQ extra effort scale, leadership ability evaluation scales, and adjective checklist leadership scale

	LAE Autocratic–aggressive	LAE Autocratic–submissive	LAE Democratic—co-operative	LAE Laissez-faire	LAE Total	MLQ Extra effort	ACL Leadership	MLQ Factor 1
LAE Autocratic–aggressive								
LAE Autocratic–submissive	0.34							
LAE Democratic–co-operative	–0.38	–0.20						
LAE Laissez-faire	–0.25	–0.45	–0.72					
LAE Total	–0.23	–0.21	–0.78	0.97				
MLQ Extra effort	0.06	–0.22	0.39	–0.29	–0.34			
ACL Leadership	–0.05	–0.13	0.38	–0.27	–0.33	0.85		
MLQ Factor 1	–0.04	–0.25	0.47	–0.30	–0.35	0.90	0.88	
MLQ Factor 2	–0.36	0.08	–0.42	0.48	0.56	–0.31	–0.33	–0.21

Correlations in bold are significant at p<0.05; MLQ Factor 1 = Transformational Leadership; MLQ Factor 2 = Transactional Leadership

Table 7 Environmental correlations between transformational/transactional leadership, MLQ extra effort scale, leadership ability evaluation scales, and adjective checklist leadership scale

	LAE Autocratic–aggressive	LAE Autocratic–submissive	LAE Democratic—co-operative	LAE Laissez-faire	LAE Total	MLQ Extra effort	ACL Leadership	MLQ Factor 1
LAE Autocratic–aggressive								
LAE Autocratic–submissive	0.10							
LAE Democratic–co-operative	–0.38	–0.35						
LAE Laissez-faire	0.09	–0.20	–0.62					
LAE Total	–0.21	0.14	–0.72	0.89				
MLQ Extra effort	–0.08	0.07	0.21	–0.20	–0.19			
ACL Leadership	–0.02	0.02	0.10	–0.10	–0.11	0.18		
MLQ Factor 1	–0.04	0.06	0.23	–0.23	–0.23	0.61	0.29	
MLQ Factor 2	0.26	0.08	–0.22	0.09	0.06	–0.05	–0.20	0.05

Correlations in bold are significant at p<0.05; MLQ Factor 1 = Transformational Leadership; MLQ Factor 2 = Transactional Leadership

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on request.) Most of the phenotypic correlations may be decomposed to find a significant genetic component, indicating that there is a strong common source of genetic variation underlying the different dimensions of leadership.

Discussion

Univariate genetic analyses revealed that psychometric measures of leadership demonstrate moderate to large heritabilities in most dimensions of the construct. Although transformational leadership demonstrated a clearly genetic determination, further examination of the transactional leadership domain is warranted, given that several of the transactional leadership scales yielded models that did not include additive or non-additive genetic effects.

Higher level leadership factors, constructed from the MLQ, represent transformational and transactional leadership. Univariate genetic analyses indicated that both of these factors were heritable, with transformational leadership demonstrating non-additive heritability, and transactional leadership demonstrating additive heritability. This is an interesting finding in itself, because it suggests that transformational leadership might be of greater evolutionary significance, as it has been proposed that traits expressing dominance heritability patterns may be more adaptive to the organism.[23] In comparing these factors to the scales from the LAE and the ACL, through multivariate genetic analyses, it becomes clear that a great deal of the variance shared by these variables is attributable to common genes, because the correlations among the majority of the variables contain significant common genetic influences.

One limitation of the present study lies in the nature of the leadership measures: they are exclusively self-report questionnaires. It would be interesting to examine a sample of behavioral measures of leadership within a twin sample, or perhaps to send an evaluation version of leadership batteries to someone in a subordinate position to the twins, so that this individual might evaluate the twins' leadership performance. In a similar vein, it would be interesting to examine individual perceptions of an ideal leader within a sample of twins. Bass[14] addresses the idea that people tend to think of their ideal leader in similar terms, and that this ideal leader is typically a transformational leader. Although this question has been approached from a psychometric standpoint, it has yet to be examined from a behavior genetic stance, and there is substantial information to be had from such an analysis, as is illustrated by the present study. Finally, it should be noted that due to an imbalance in sex composition within the sample, all effects of sex were removed from the analysis. Future research may be directed at examining leadership in a sample of adult twins containing a more substantial number of male subjects, to allow for the study of sex effects.

This study represents the first behavior genetic study to examine psychometric indices of leadership and, as such, the results are exploratory and require replication. Despite this fact, it is encouraging to note that the results appear to be generalizable, insofar as they are consistent across multiple measures of leadership. It is unlikely that this study will end all debate on the topic of whether leaders are born or made. It does, however, provide preliminary empirical data regarding the contributions of both genetic and environmental factors to individual differences in leadership style.

References

1 Loehlin JC. Genes and Environment in Personality Development. Sage Publications: London, 1992.
2 Plomin R, DeFries JC, McClearn GE. Behavioral Genetics: A Primer, 2nd edn. WH Freeman: New York, 1990.
3 Galton F. Hereditary Genius. Appleton: New York, 1869.
4 James W. Great men, great thoughts, and their environment. Atlantic Monthly 1880; 46: 441–459.
5 Stogdill R. Personal factors associated with leadership: A survey of the literature. J Psychol 1948; 25: 35–71.
6 Bass B. Bass and Stogdill's Handbook of Leadership, 3rd edn. Free Press: New York, 1990.
7 Lord RG, DeVader CL, Alliger GM. A meta-analysis of the relation between personality traits and leadership perceptions: An application of validity generalization procedures. J Appl Psychol 1986; 61: 402–410.
8 Kirkpatrick S, Locke E. Leadership: Do traits matter? In: Steers RM, Porter LW, Bigley GA (eds). Motivation and Leadership at Work, 6th edn. McGraw-Hill: New York, 1996, pp 186–199.
9 Burns JH. Leadership. Harper & Row: New York, 1978.
10 Vernon PA, McCarthy JM, Johnson AM, Jang KL, Harris JA. Individual differences in multiple dimensions of aggression: A univariate and multivariate genetic analysis. (Twin Research, in press).
11 Bass B, Avolio B. Multifactor Leadership Questionnaire (Form 5X – Self). Consulting Psychologists Press: Palo Alto, CA, 1991.
12 Cassel R, Stancik E. The Leadership Ability Evaluation – Revised. Western Psychological Services: Los Angeles, CA, 1982.
13 Gough H, Heilbrun A. The Adjective Checklist Manual. Consulting Psychologists Press: Palo Alto, CA, 1983.
14 Bass B. Does the transactional-transformational leadership paradigm transcend organizational and national boundaries? Am Psychologist 1997; 52(2): 130–139.
15 Nichols R, Bilbro W. The diagnosis of twin zygosity. Acta Genet Stat Med 1966; 16: 265–275.
16 Kasriel J, Eaves L. The zygosity of twins: Further evidence on the agreement between diagnosis by blood groups and written questionnaires. J Biosoc Sci 1976; 8: 263–266.

https://doi.org/10.1375/twin.1.4.216 Published online by Cambridge University Press

17 McGue M, Bouchard TJ Jr. Adjustment of twin data for the effects of age and sex. Behav Genet 1984; 14: 325–343.
18 Bass B. Leadership: Good, better, best. Organiz Dynam 1985; 13(3): 26–40.
19 Jöreskog K, Sörbom D. LISREL 8: A Guide to Program and Applications, 3rd edn. Scientific Software: Mooresville, IN, 1993.
20 Neale MC, Cardon LR. Methodology for Genetic Studies of Twins and Families. Kluwer Academic: Dordrecht, 1992.
21 Avolio B, Bass B, Jung D. Construct validation and norms for the Multifactor Leadership Questionnaire (MLQ – Form 5X). CLS Report 95-4. Binghamton University: Center for Leadership Studies, 1995.
22 Neale MC. Mx: Statistical Modeling (4th ed.). Box 126 MCV, Richmond, VA 23298. Department of Psychiatry, 1997.
23 Jensen AR. The g Factor: The Science of Mental Ability. Praeger: Westport, CT, 1998.

https://doi.org/10.1375/twin.1.4.216 Published online by Cambridge University Press