DO OPENNESS TO EXPERIENCE AND RECOGNIZING OPPORTUNITIES HAVE THE SAME GENETIC SOURCE?

SCOTT SHANE, NICOS NICOLAOU, LYNN CHERKAS, AND TIM D. SPECTOR

Recognizing opportunities for new businesses is an important part of the entrepreneurial process, one that researchers seek to explain and human resource managers seek to encourage. In this study, we examined whether the same genetic factors that affect openness to experience also influence recognizing opportunities. We applied bivariate genetics techniques to a sample of twins and found that a substantial part of the heritability of recognizing opportunities is mediated through genetic influences on openness to experience. Evidence of genetic effects on opportunity recognition has important implications for how companies might think about selection and training and raises important ethical issues in human resource management. © 2010 Wiley Periodicals, Inc.

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Introduction

Recognizing opportunities is of central importance to the field of entrepreneurship (Baron, 2004, 2007; Shane, 2003; Shane & Venkataraman, 2000). The decision to launch a new venture often arises from a person's belief that he or she has recognized an opportunity with profit potential. This suggests that variance in people's tendencies to start businesses can be explained by differences between them in their tendency to recognize entrepreneurial opportunities (Baron, 2007; Gaglio & Katz, 2001).

Because recognizing opportunities is at least partially a cognitive process, the psychological characteristic of openness to experience may influence it, perhaps by facilitating access to information useful in the opportunity recognition process. Openness to experience has a genetic component. Studies have shown that approximately half of the differences across people in openness to experience can be explained by our genes (Loehlin, 1992). In fact, a study by Comings et al. (1999) even identified specific genes associated with this personality trait, most notably the DRD4 gene.

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Other scholars have shown that genetic endowments also partly contribute to the variance between individuals in opportunity recognition (Nicolaou, Shane, Cherkas, & Spector, 2009). Genetic influences on both openness to experience and opportunity recognition raise an interesting question: Do the same genetic factors influence both the personality trait of openness to experience and the behavior of recognizing opportunities? A common genetic source for both of these characteristics is plausible because openness to experience influences how people gather and process information, an important aspect of opportunity recognition.

By correlating one twin's openness to experience score with the co-twin's opportunity recognition score, we can determine how much of the correlation between the two phenotypes comes from the same genetic factors.

This study seeks to answer the question "Are the same genetic factors influencing opportunity recognition and people's tendency to be open to experience?" It uses bivariate genetic techniques to determine the proportion of the covariance between openness to experience and opportunity recognition that is accounted for by genetic factors using a sample of 1,740 monozygotic and 1,714 same-sex dizygotic twins. Because identical twins share 100 percent of their genes and fraternal twins share 50 percent on average, we can identify the share of openness to experience and opportunity recognition attributable to genetic factors. By correlating one twin's openness to experience score with the co-twin's opportunity recognition score, we can determine how much of the correlation between the two phenotypes comes from the same genetic factors.

Investigating the genetic covariance between openness to experience and opportunity recognition is important to human resource management for two reasons: one theoretical and the other normative. On the theoretical side, seeking to explain why people become entrepreneurs is an important part of a scholarly exploration of this phenomenon. In recent years, scholars have begun to develop a biosocial foundation to explain entrepreneurship (Nicolaou, Shane, Cherkas, Hunkin, & Spector, 2008; White, Thornhill, & Hampson, 2007). This paper contributes to that endeavor by identifying one of the many pathways through which an important biological factor—genes—influences one important aspect of entrepreneurship—opportunity recognition.

Second, identifying the proportion of the covariance between openness to experience and opportunity recognition accounted for by shared genetic factors has several practical implications for human resource management. It will help evaluate to what degree HR can use teaching, public policy, and other interventions to increase entrepreneurship. For instance, can we make people more likely to recognize entrepreneurial opportunities by training them to be more open to experience? If so, then a good approach for entrepreneurship educators would be to train students in ways that make them more open to experience. If, however, the entire covariance between openness to experience and opportunity recognition was accounted for by genetic factors, then such teaching endeavors would be futile because we would not be able to influence recognizing opportunities by encouraging people to be more open to experience. Moreover, evidence of a common genetic source for openness to experience and opportunity recognition has important implications for how companies might think about selection and training, and raises important ethical issues in human resource management.

Theory Development

Recognizing the opportunity for a new business is an important dimension of the entrepreneurial process (Alvarez & Barney, 2007; Baron & Ensley, 2006; Casson & Wadeson, 2007; Shane, 2003; Shane and Venkataraman, 2000; Venkataraman, 1997) since the decision to launch a new venture often arises from a person's belief that he or she has recognized an opportunity with profit potential (Baron, 2007; Gaglio & Katz, 2001). As a result, scholars have given considerable attention to unraveling the antecedents of opportunity recognition. Factors that have been found to influence opportunity recognition include

social networks (Baron & Ozgen, 2007; Singh et al., 1999), prior information (McKelvie & Wiklund, 2004; Shane, 2000), pattern recognition (Baron, 2004; Baron & Ensley, 2006), and alertness (Gaglio & Katz, 2001; Kirzner, 1979). Psychological traits might also influence opportunity recognition.

Openness to experience is one dimension of the Five Factor Model of personality and describes the extent to which an individual is broad minded, imaginative, curious, and original (Barrick & Mount, 1991). People who score high on openness to experience are more amenable to new ideas, thoughts, and unconventional perspectives than people who score low on this trait (Costa & McCrae, 1992; George & Zhou, 2001). High-scorers are also more adaptable to changing circumstances and more likely to explore novel ideas. Moreover, the openness dimension reflects individual tendencies to consider external information (McCrae, 1987) and adjust one's beliefs (John, 1990).

Because recognizing opportunities is at least partially a cognitive process, the personality trait of openness to experience may be influential, perhaps by facilitating access to information useful in the opportunity recognition process. For example, Heinstrom (2003) showed that openness to experience is associated with broad information gathering, critical judgment, and preference for gathering nonconfirming information. Opportunity recognition might be facilitated by broad information acquisition, critical analysis, and a willingness to examine disconfirming data.

Moreover, research has shown that individuals who are open to experience are more creative (Feist, 1998, 1999; Scratchley & Hakstian, 2000) and, as a result, are more likely to identify and structure new solutions to existing problems (Harper, 1996; Shane, 2003). Also, openness is related to cognitive aspects of creativity such as divergent thinking (McCrae, 1987). Divergent thinkers are more likely to connect the dots between unrelated pieces of information and hence more likely to recognize entrepreneurial opportunities (Baron, 2004). It is not surprising that a recent meta-analysis showed that entrepreneurs scored higher than managers on openness to experience (Zhao & Siebert, 2006).

People might differ in openness to experience for a variety of reasons, including a host of individual life experiences. They may also differ in openness to experience, however, because of different genetic predispositions. Studies show that between 45 percent and 61 percent of the differences across people in their openness to experience is explained by difference in our genetic makeup (Comings et al., 1999; Loehlin, 1992), involving many genes of small effect, rather than a single gene.

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Recent research has also found that additive genetic factors account for 45 percent of the variance between people in opportunity recognition (Nicolaou, Shane, Cherkas, & Spector, 2009). The genetic component of opportunity recognition and openness to experience, coupled with the correlation between openness to experience and entrepreneurship, suggest that genetic factors might increase the likelihood of recognizing opportunities through the personality trait of openness to experience. Hence, we hypothesize:

Hypothesis 1: Genetic factors account for part of the covariance between openness to experience and opportunity recognition.

Methodology

Quantitative genetics studies are based on comparing monozygotic (MZ, identical) and dizygotic (DZ, nonidentical) twins. MZ twins derive from a single fertilized egg that splits and produces two genetically identical individuals. DZ twins derive from separately fertilized eggs and on average share 50 percent of their segregating genes, much like other siblings. If genetic factors exert a significant influence on a variable, then MZ twins must be more similar to each other than DZ twins on that variable (Plomin, DeFries, McClearn, & McGuffin, 2008). (Behavioral genetics studies

usually compare same-sex dizygotic twins to MZ twins [who are always of the *same sex*] because such a comparison removes the potentially confounding effect of gender differences [Plomin et al., 2008].) If MZ twins are therefore more similar than same-sex DZ twins for recognizing opportunities or being open to experience, this would imply that genetic factors contribute to the variance of the variable in question.

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Quantitative genetics studies can also be used to see if the same genetic factors influence two variables of interest, in our case openness to experience and opportunity recognition. If the same genetic factors did not influence the two variables, then there would be no difference in the cross-trait-cross-twin correlations between openness and opportunity recognition of MZ and DZ twins. As long as MZ and DZ twins experience similar environments to their cotwins, greater cross-trait-cross-twin correlations between openness to experience and opportunity recognition of MZ twins than DZ twins would mean that genetic factors contribute to the phenotypic correlation between the two variables.

A number of studies that have used different methodologies have generally confirmed the robustness of the equal environments assumption (Hettema, Neale, & Kendler, 1995; Kendler, 1983; Kendler et al., 1993; Kendler & Prescott, 2006; Scarr, 1968). We can therefore test whether the same genetic factors influence openness to experience and opportunity recognition by looking at the cross-trait-cross-twin correlations between openness to experience and opportunity recognition of MZ twins and DZ twins.

Sample

We examined a sample of 870 pairs of MZ and 857 pairs of same-sex DZ twins from the UK. The sample is drawn from the TwinsUK registry, which was initially recruited through a national media campaign (Spector, Cicuttini, Baker, Loughlin, & Hart, 2006 and www.twinsuk.ac.uk). All twins were healthy volunteers and were not selected based on the variables being studied. No significant differences have been found on a number of traits when this group was compared with adult singletons in the UK, suggesting that the sample is representative (Andrew et al., 2001). Twin zygosity was established using a standardized twin questionnaire (Peeters et al., 1998) and, in cases of uncertainty, through multiplex DNA fingerprinting using variable tandem repeats. To gather information about opportunity recognition and openness to experience, each twin was sent a self-report questionnaire in 2006 that included questions about these two variables. Because the relevant questions were included in different sections of the survey, and much of the survey concerned health-related activities, the respondents were unaware of this study's hypothesis when completing the questionnaire.

The sample included both entrepreneurs and nonentrepreneurs. Of the 3,454 people who participated in the study, 16 percent reported that they have been owner-operators of their own businesses, and 25 percent reported that they have engaged in the firm creation process in their working life. All of these are measures researchers use to identify entrepreneurs.

Opportunity Recognition

We measured opportunity recognition using a 5-item scale composed of the following questions drawn from the literature on opportunity recognition (Baron & Ozgen, 2007; Singh et al., 1999): (1) "I enjoy thinking about new ways of doing things"; (2) "I frequently identify opportunities to start-up new businesses (even though I may not pursue them)"; (3) "How many ideas for new businesses did you think of in the past month?" (4) "I frequently identify ideas that can be converted into new products or services (even though I may not pursue them)"; (5) "I generally lack ideas that may materialise into profitable enterprises" (reverse scored). This scale has a Cronbach's alpha of 0.72. (All five opportunity recognition questions used a 5-point scale

ranging from one to five. In questions 1, 2, 4, and 5, the answer categories ranged from "strongly disagree" to "strongly agree." In question 3, the answer categories were "none," "one," "two," "three," "four or more"; the respective answers were coded from one to five.)

Openness to Experience

We measured openness to experience using the Ten Item Personality Inventory (TIPI) scale (Gosling, Rentfrow, & Swann, 2003). As Gosling et al. (2003) argued, the instrument reaches "adequate levels in terms of: (1) convergence with widely used Big-Five measures in self-observer and peer reports, (2) test-retest reliability, (3) patterns of predicted external correlates, and (4) convergence between self and observer ratings" (Gosling et al., 2003, p. 504). The TIPI scale also achieves slightly better validity than other brief five-factor personality scales (Furnham, 2008) and has been used with success in many countries, having been translated into nine languages (Muck, Hell, & Gosling, 2007).

A factor analysis using all of the opportunity recognition and openness to experience questions yielded two distinct factors with eigenvalues greater than 1; the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.79; Bartlett's test of sphericity was highly significant ($p = 0.001$); and all factor loadings were higher than 0.50.

Bivariate Genetic Analysis

We used bivariate genetic analysis to partition the covariance between the two traits—openness to experience and opportunity recognition—into covariance due to additive genetic factors, common environmental factors, and unique environmental factors (Rice et al., 2004). Thus, in this analysis, we correlated one twin's openness to experience score with the co-twin's opportunity recognition score. As mentioned, if the cross-trait-cross-twin correlation for MZ twins is greater than the cross-trait-cross-twin correlation for DZ twins, this would imply that genetic factors account for part of the correlation between the two phenotypes (Kuntsi, Eley, Hughes, Asherson, Caspi, & Moffitt, 2004).

The path diagram underlying the analysis is illustrated in Figure 1. The boxes represent the observed variables—openness to experience and opportunity recognition—while the circles represent the latent variables that the model aims to estimate. **A** represents additive genetic effects; **C** represents shared environmental effects (i.e., those factors that are shared by family members); and **E** represents nonshared environmental factors (i.e., environmental factors unique to an individual and including measurement error).

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The correlation between the latent additive genetic factors is constrained at 1.00 for MZ twins and 0.5 for DZ twins to reflect the degree of genetic relatedness. The correlation between the latent shared environmental factors is also constrained at 1.00 for both types of twins, because all of the twin pairs were raised in the same family and therefore shared the same common environment. r_A, r_C, and r_E represent the genetic, shared environmental and nonshared environmental correlations, respectively. A genetic correlation of 1.00 would indicate that all genetic influences on openness to experience also influence opportunity recognition. A shared environmental correlation of 0 would indicate that the environmental influences that make the twins more similar on openness to experience would be entirely independent of the environmental influences that make the twins more similar on opportunity recognition (Plomin et al., 2008).

It is important to note that r_A, r_C, and r_E are independent of the individual heritabilities of each phenotype (Plomin et al., 2008). It is possible that openness to new experiences and opportunity recognition are each affected by genetic factors, but none of those genetic factors are the same. It is also possible

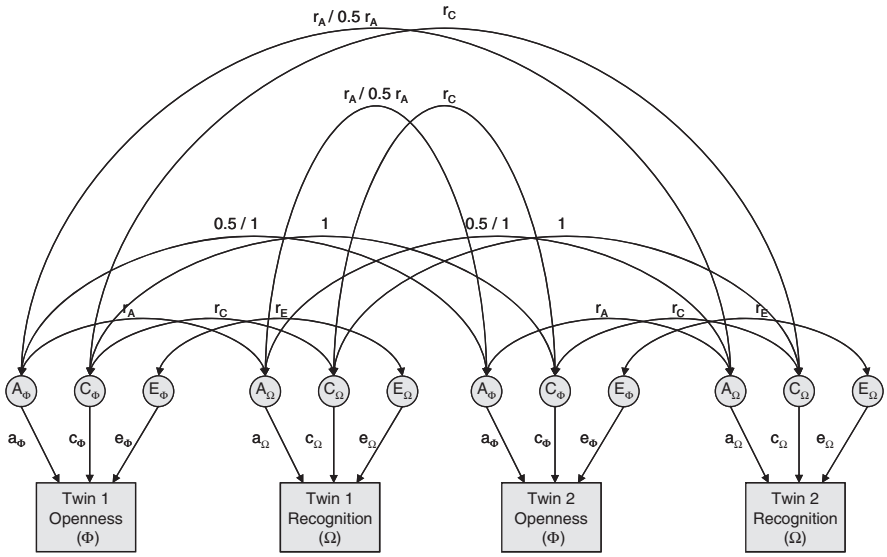

FIGURE 1. Path diagram illustrating the bivariate genetics analysis between openness to experience and opportunity recognition

that genetic factors have little influence on openness to experience and opportunity recognition, but that the same genetic factors influence both openness to experience and opportunity recognition.

Results

The correlation matrix and the descriptive statistics are presented in Table I. We did not find any statistically significant differences between the scores of MZ and DZ twins on openness to experience ($p = 0.40$) or opportunity recognition ($p = 0.39$). The MZ and DZ twins, therefore, are equally representative of the sample's openness to experience and opportunity recognition scores.

Table II shows the univariate heritability estimates for the two variables. For both variables, the best fitting model according to the chi-square statistic and the Akaike's Information Criterion (AIC; Akaike, 1987) was the model that included additive genetic and unique environmental effects (AE model). The heritability estimate for openness to experience was 0.40 (95% CI 0.33–0.46), while the heritability estimate for opportunity recognition was 0.45 (95% CI 0.40–0.50).

We also adjusted for potential confounders that could bias the results such as age, sex, marital status, and religion (Hakim et al., 2004). Specifically, we regressed the effect of the confounders from the measure of opportunity recognition and computed heritability estimates on the adjusted results (Hakim et al., 2004; Mohammed et al., 2003; Neale, 2004). After adjustment, the heritability of openness to experience fell marginally to 0.38 (95% CI 0.31–0.44) and the heritability of opportunity recognition dropped marginally to 0.41 (95% CI 0.34–0.47).

Table III shows the cross-trait-cross-twin correlations for both MZ and DZ twins for the two variables. Specifically, the cross-trait-cross-twin correlations for MZ twins are 0.26 and 0.28, while the cross-trait-cross-twin correlations for DZ twins are 0.08 and 0.03. In other words, the correlation between the opportunity recognition score for twin 1 and the openness to experience score for twin 2 is 0.26 for MZ twins and 0.08 for DZ twins. This indicates that genetic factors contribute to the covariance between openness to experience and opportunity recognition.

The overall (phenotypic) correlation between openness to experience and opportunity recognition was 0.37. The bivariate genetic analysis yielded a genetic correlation (r_A) of 0.57 and a nonshared environmental correlation (r_E) of 0.23. The correlation solely due to genetic factors, therefore, was 0.23,[1] indicating that more than half, or 62 percent, of the overall (phenotypic) correlation between openness to experience and opportu-

TABLE I Descriptive Statistics and Correlations

Variable	Mean	SD	1	2	3	4	5	6
1. Opportunity recognition	1.39	0.83	1					
2. Openness to experience	3.24	1.27	.37*	1				
3. Sex	0.91	0.29	.06*	–.02	1			
4. Age	55.6	13.2	–.17*	.09*	–.01	1		
5. Religious	.10	.31	–.05*	–.05*	–.03	–.08*	1	
6. Marital status	.69	.46	.02	.02	.01	.20*	–.11*	1

*$p < .05$.

TABLE II Univariate Heritability Estimates for Opportunity Recognition and Openness to Experience

Model	A (95% CI)	C (95% CI)	E (95% CI)	$\Delta\chi^2$	Δdf	ΔAIC
Opportunity Recognition						
ACE	0.45 (0.37 to 0.50)	0.00 (0.00 to 0.07)	0.55 (0.50 to 0.60)	—	—	—
CE	—	0.33 (0.28 to 0.37)	0.67 (0.63 to 0.72)	43.9	1	41.9
AE	*0.45 (0.40 to 0.50)*	—	0.55 (0.50 to 0.60)	0	1	–2.00
Openness to Experience						
ACE	0.40 (0.33 to 0.46)	0.00 (0.00 to 0.04)	0.60 (0.54 to 0.67)	—	—	—
CE	—	0.25 (0.20 to 0.30)	0.75 (0.70 to 0.80)	40.6	1	38.6
AE	*0.40 (0.33 to 0.46)*	—	*0.60 (0.54 to 0.67)*	0	1	–2.00

Note: The best fitting model is shown in italics. 95% confidence intervals in parentheses. A = additive genetic; C = common environment; E = unique environment.

nity recognition was accounted for by genetic factors (see Table IV).[2] The remainder was due to nonshared environmental factors.

Discussion

We have shown that genetic factors account for a large part of the variance in opportunity recognition by influencing the probability that people will be open to experiences. Our empirical investigation showed the heritabilities of opportunity recognition and openness to experience to be 0.45 and 0.40, respectively. We also found that the phenotypic correlation between openness to experience and opportunity recognition was 0.37. Our bivariate genetics models showed that genetic factors account for 62 percent of this overall (phenotypic) correlation between openness to experience and opportunity recognition.

Limitations

Our study has a number of limitations. First, more than 90 percent of our sample is female. While we controlled for the influence of sex in our models, the overwhelmingly female sample makes it difficult for us to generalize the results to males. Second, the Ten Item Personality Inventory (TIPI) used to measure openness to experience is less reliable than longer Big Five personality scales (Gosling et al., 2003), even though TIPI does very well compared to other brief Big Five measures (Furnham, 2008). Third, our measure of opportunity recognition relies on respondents to evaluate their own behavior. Self-reports of past approaches to opportunity recognition may not correlate well with actual opportunity recognition activity.

Implications

Before describing the implications of our study, we want to stress that the implications discussed here are speculative. Much additional research is needed before anyone can make concrete recommendations about the effects of genetic factors on human resource management, either from a research or a

TABLE III **Cross-Trait-Cross-Twin Correlations Between Openness to Experience and Opportunity Recognition**

	Twin 1 Openness to Experience	Twin 1 Opportunity Recognition	Twin 2 Openness to Experience	Twin 2 Opportunity Recognition
MZ Twins				
Twin 1 Openness to Experience	1			
Twin 1 Opportunity Recognition	.34*	1		
Twin 2 Openness to Experience	**.44***	.26*	1	
Twin 2 Opportunity Recognition	.28*	**.47***	.41*	1
DZ Twins				
Twin 1 Openness to Experience	1			
Twin 1 Opportunity Recognition	.37*	1		
Twin 2 Openness to Experience	**.08***	.08*	1	
Twin 2 Opportunity Recognition	.03	**.17***	.40	1

Note: The values in bold are the MZ and DZ cross-twin correlations for each variable, while the underlined values are the MZ and DZ cross-trait cross-twin correlations.
* $p < .05$.

TABLE IV **Bivariate Genetic Analysis**

AE Model	
Openness to Experience - Opportunity Recognition	
r_A	0.57
r_C	0
r_E	0.23
Correlation due to genetic factors	0.23
% of phenotypic r attributable to genetic influence	62

Note: A = additive genetic; C = common environment; E = unique environment.

practical perspective. The results of this study do, however, suggest some important, though tentative, implications.

Implications for Research

On the research side, our study has several implications. First, it shows that an important aspect of entrepreneurial behavior, opportunity recognition, has a genetic component. Researchers interested in explaining why people engage in entrepreneurship should consider this genetic component in developing theories to explain why some people and not others become entrepreneurs.

Second, our study shows that opportunity recognition and one of the Big Five personality traits, openness to experience,

have a common genetic source. This empirical pattern suggests researchers can benefit from considering a model of opportunity recognition that builds on personality differences between people. Perhaps genetic differences lead to variations in the tendency to develop certain personality traits, which, in turn, affect the odds of opportunity recognition.

Third, our study provides guidance for molecular genetics research. The genetic correlation between openness and opportunity recognition indicates that many of the same genetic factors influence both. Prior research (Comings et al., 1999) has shown that a variant of the DRD4 gene is associated with openness to experience. Our research suggests that the same gene would be a good candidate to consider when seeking to identify specific genes that influence the variance between people regarding opportunity recognition.

Implications for Practice

Our study also suggests some potential implications for practice (if future research confirms the results presented here). Genetic information about opportunity recognition might help human resource managers by pointing out how much of the difference in entrepreneurial behavior can be accounted for by situational factors and how much can be accounted for by innate forces. The proportion of behavior that results from each of these sources can tell us how efficient efforts will be when training people to recognize entrepreneurial opportunities. If genetics accounted for all of the differences between people in terms of opportunity recognition, then nothing else would affect this behavior. Companies could therefore neither train nor incentivize their employees to become better at recognizing opportunities. The only way to change employees' opportunity recognition would be to alter their DNA. The fact that only *part* of the variance in opportunity recognition is genetic means that companies can, indeed, influence their employees' level of opportunity recognition through training and incentives. This is an important fact to understand when deciding whether or not to invest in training tools for opportunity recognition.

Information on genetic covariation between openness to experience and opportunity recognition might also prove useful to human resource managers. Our results show that more than half of the difference between individuals in relation to opportunity recognition is explained by environmental factors. If this pattern remains after attempts to replicate it, we would have evidence that human resource managers could influence the likelihood that a person will recognize entrepreneurial opportunities by manipulating environmental factors associated with opportunity recognition. Moreover, efforts to alter these environmental factors might be more effective than efforts to increase an employee's openness to experience. This is because 62 percent of the covariance between openness to experience and opportunity recognition is accounted for by genetic factors, leaving 38 percent of the variance in opportunity recognition free to be influenced by efforts to change a person's openness to experience. This observation, of course, is consistent with the belief that personality traits, like openness to experience, are difficult to change.

Our study also showed that some people are better than others at opportunity recognition because of their genes. Assuming this empirical pattern could be replicated, could this suggest that companies might benefit from selecting genetically predisposed people to engage in jobs that demand recognizing opportunities? This possibility introduces a new ethical question into human resource management: Should companies be allowed to use genetic tests when selecting employees? Is it fair to allow companies to hire people on the basis of something over which they have no control and cannot easily change? We stress that we are definitely, unequivocally ***not*** arguing in favor of such a policy. Huge ethical issues remain involved in such policies, even if future genetic testing proved to be a better way to identify the "right" employees than other selection tools currently used. On the other hand, however, what if failing to allow companies to engage in ge-

netic testing put these companies at a competitive disadvantage vis-à-vis companies in countries that allow it? Clearly, evidence of genetic effects on aspects of organizational behavior brings new ethical dilemmas to the feet of human resource managers.

If our results remain supported after future efforts to replicate them, they might also have implications for job assignment. Matching people to appropriate positions and jobs on the basis of their personality traits and behaviors is important for work performance (Robbins & Judge, 2009). Because genes affect openness to experience and opportunity recognition, genetic information could help companies determine how to assign employees to different functions in the organization.

Take, for example, the case of creating a new business. If companies want to create more new businesses, they will need to identify opportunities for those businesses, which suggests the value of assigning employees who are good at recognizing opportunities to new business creation units. Because genes account for some of the difference between people in opportunity recognition, it might be possible for human resource managers to incorporate genetic predispositions to opportunity recognition when assigning employees to jobs in different parts of their organizations. Again, we would like to stress that we are ***not*** arguing in favor of such a policy. Nevertheless, the discussion above highlights some of the dilemmas that the genetic predisposition to opportunity recognition might bring to the human resource management profession.

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Notes

1. This estimate is obtained by multiplying the square root of the heritability estimate for opportunity recognition by the square root of the heritability estimate for openness to experience and by the genetic correlation (i.e., $\sqrt{0.41} \times 0.57 \times \sqrt{0.40}$).
2. 0.23 divided by 0.37.

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