R&D MANAGEMENT

An investigation of the personality traits of scientists versus nonscientists and their relationship with career satisfaction

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Drawing on Holland's vocational theory, Schneider's Attraction-Selection-Attrition model, and the Big Five/narrow traits model of personality, the present study identified key Big Five and narrow personality traits that both distinguish scientists from members of other occupations and related these to their career satisfaction. A sample of 2,015 scientists had significantly higher levels of openness, intrinsic motivation, and tough-mindedness, and significantly lower levels of assertiveness, conscientiousness, emotional stability, extraversion, optimism, and visionary style than a sample of nonscientists ($n = 78{,}753$). Seven traits were significantly correlated with the career satisfaction of scientists: agreeableness/teamwork, assertiveness, emotional stability, extraversion, openness, optimism, and work drive. Based on these results, a psychological profile of scientists was presented. Findings were discussed in terms of the functional value and person–occupation fit of these traits for the work of scientists. Implications were described for the recruitment, selection, management, and promotion of scientists, as well as their training, development, coaching, counseling, and mentoring.

1. Introduction

The present study was concerned with key personality traits of scientists, specified here as physical scientists or those working in the 'hard sciences' (Hedges, 1987) – including, physicists, chemists, geologists, and biologists. Our purpose was twofold: (1) identify traits which differentiate scientists from other occupations; and (2) determine whether these traits are related to the career satisfaction of scientists.

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We examined these issues through the lens of Holland's vocational theory and his model of person–occupation fit. Our study was intended to contribute a theoretically grounded, validated personality profile to the nascent knowledge base in the psychology of scientists.

There is, compared to other occupations, a relative dearth of research on the psychological attributes of scientists. With the exception of work by Feist (1998, 2006), research in this area has been piecemeal and fragmentary, characterized by a relatively small number of individual studies with little or no cross-referencing or accumulation of findings on the question of what are the distinguishing traits of scientists. For example, a study of 242 physicists (Wilson and Jackson, 1994) found them to be more introverted, careful, controlled, and inhibited compared to general, cross-occupation norms. Cattell et al. (1970) developed norms for scientists – defined as biologists, chemists, geologists, and physicists – which indicated that, compared to the general population, they were less outgoing, enthusiastic, and conscientious; as well as more stable, assertive, and tender-minded. Similarly, Bachtold and Werner (1972) examined the personality traits of 146 female biologists and chemists and found that, compared to general population norms, they were more serious, radical, confident, dominant, intelligent, and adventurous, although less sociable, group-dependent, and sensitive. In part, the earlier results are consistent with Roe's (1951) observation that physical scientists are less social as well as more autonomous, absorbed in their work, and intrinsically motivated compared to nonscientists.

In contrast to individual studies in this area, Feist (1998, 2006) conducted meta-analyses of the personality attributes of scientists. Before turning to a summary of his findings, it should be noted that Feist employed a much broader, although some might say looser, conceptualization of the term scientists than ours by defining scientists as: 'any sample from junior high school on through adulthood that showed special talent in science, majored in science, or that worked professionally' in science, where the field of science 'was not limited to the natural and biological science, but included the social sciences' (Feist, 1998, p. 294). Based on different normal personality inventories and comparison of scientists to nonscientists, Feist found that 'scientists' were generally higher on: introversion, confidence, conscientiousness, conventionality, assertiveness, openness, and skepticism.

In the present study, the conceptual framework we utilized to assess personality traits is the Big Five model. This model arose out of a concern that there were too many different terms employed by psychological researchers to describe human behavior. Indeed, early personality researchers were faced with a 'bewildering array' of terms used to characterize personality attributes. Allport and Odbert (1936) identified 17,953 human personality descriptors which they reduced to some 40,00 traits – still too many for the kind of common metric necessary for systematic research and theory building (John and Srivastava, 1999). Subsequently, personality researchers used factor analysis techniques to condense normal personality dimensions to the five basic traits of the 'Big Five' model (Costa and McCrae, 1992a). The Big Five traits, which are defined later in this paper, are agreeableness, conscientiousness, emotional stability, extraversion, and openness (De Raad, 2000). There is broad-based, consensual support for these five dimensions, which researchers have replicated across a wide range of cultures and different demographic groups, and which have been validated against many different criteria, including job performance (Salgado, 1997), job satisfaction (Judge et al., 2002), career success (Judge et al., 1999), life satisfaction (DeNeve and Cooper, 1998), and academic performance (Lounsbury et al., 2003c). More recently, other researchers have claimed that the Big Five taxonomy is too broad and that more narrow-scope personality constructs may augment the Big Five's ability to predict behavior. These claims have received verification in work and academic domains (Paunonen and Ashton, 2001; Lounsbury et al., 2003c), among others. Lounsbury et al. (2003b), found that the Big Five and five narrow personality traits (assertiveness, optimism, image management, intrinsic motivation, and work drive) were positively related to career satisfaction for individuals in various occupational fields.

In the present study, we drew on Holland's (1985, 1996) vocational theory to frame our research questions and interpret our results. Holland's central thesis is that 'people flourish in their work environment when there is a good fit between their personality type and the characteristics of the environment. Lack of congruence between personality and environment leads to dissatisfaction . . .' (p. 397). Two logical corollaries of Holland's model, which have been generally verified by subsequent research, are that: (1) There are differences in mean scores on personality characteristics associated with occupations which help determine fit; and (2) higher scores on these personality characteristics may be related to higher levels of satisfaction.

Although previous research has investigated job satisfaction among scientists (Jones, 1996; Keller, 1997), the present study utilized a measure of *career* *satisfaction* of scientists rather than job satisfaction for several reasons. First, career satisfaction is conceptually closer than job satisfaction to Holland's notion of satisfaction with an occupation. Additionally, career satisfaction represents a person's subjective attitudes about a lifetime of work – estimated to be about 100,000 hr for the typical American (Career Strategists, 2004) – rather than a singular job. It has also been shown that career satisfaction is a component of and is related to overall life satisfaction (Lounsbury et al., 2004b). Accordingly, for each of the personality traits examined in the present study, we also analyzed their correlations with career satisfaction.

1.1. Directional hypotheses

We present later a series of hypotheses for each personality trait which prior research has indicated as those that differentiate scientists from nonscientists, or for which a logical case can be made based on the meaning of the construct. Following these hypotheses, a corresponding set of research questions is presented which address the question of whether the trait is related to the career satisfaction of scientists.

Hypothesis 1: *Scientists will score lower on extraversion (i.e., are more introverted) than individuals in other occupations.*
One of the most consistent findings of research on the personality composition of scientists (e.g., Wilson and Jackson, 1994; Feist, 1998) is that they are less: sociable, outgoing, affiliative, gregarious, and expressive; in short, they are less extraverted. Much scientific work requires reflective althought, inductive and deductive reasoning, conceptual analysis, contemplation of competing ideas, and creative thinking – which are usually best done alone, without the distraction of having to interact with other people.

Hypothesis 2: *Scientists will score higher on openness than other occupations.*
In his meta-analysis of 26 studies using the five-factor model of personality traits to compare the personalities of scientists and nonscientists, Feist (1998, p. 294) concludes that openness 'is one of the clearest factors differentiating scientists from nonscientists'. Given the life span continuity of Big Five personality traits (Seifert et al., 2000) from adolescence into adulthood, the earlier results also align well with Feist's (ibid) finding that openness is related to the scientific interests of college students.

Hypothesis 3: *Scientists will score higher on tough-mindedness than other occupations.*
Tough-mindedness – which can be characterized as 'appraising information and making work decisions based on logic, facts, and data versus feelings, values and intuition' (Lounsbury and Gibson, 2011) – is clearly an important attribute for scientists, because the nature of their work is reliant on objective facts, impersonal logic, critical thinking skills, and rational decision making. Indeed, in Feist's (1998) meta-analysis using different personality instruments, scientists score higher than nonscientists on scales measuring tough-mindedness.

Hypothesis 4: *Scientists will score higher on intrinsic motivation than other occupations.*
*Intrinsic motivation reflects an interest or enjoyment in the work task itself which exists within the individual (Kooij et al., 2011) Intrinsic motivation has long been associated with scientific work (Hall and Mansfield, 1975; Jindal-Snape and Snape, 2006) and is a common characteristic of the various scientific occupations profiled in the US Department of Labor's Occupational Network (O*NET online,* 2011).

Hypothesis 5: *Scientists will score lower on conscientiousness than other occupations. As the subject matter analyses of the scientific occupations listed in O*NET show, scientific work typically requires adaptability, originality, creativity, flexibility, and the ability to work under conditions of uncertainty and ambiguity. Such conditions favor lower levels of the trait of conscientiousness. Indeed, Cattell and his colleagues* (1970) found that physical scientists displayed lower levels of conscientiousness than the general population.

1.2. Additional research questions

In addition, we evaluated a series of nondirectional research questions for the remaining Big Five and narrow traits. More specifically, we examined whether scientists differed from other occupations on agreeableness, emotional stability, assertiveness, optimism, visionary style, and work drive.

Regarding the relationship between the personality traits of scientists and their career satisfaction, in Holland's vocational theory, higher levels of satisfaction are realized when there are higher levels of traits which align with the occupation. When alignment or fit is associated with low levels of a trait, we would expect to see a negative correlation between that trait and career satisfaction. Accordingly, in line with the earlier five directional hypotheses, we predicted positive correlations between career satisfaction and: openness, tough-mindedness, and intrinsic motivation; and negative correlations between career satisfaction and extraversion and conscientiousness. For the other personality traits assessed in this study (agreeableness, emotional stability, assertiveness, optimism, visionary style, and work drive), we examined their correlations with career satisfaction as nondirectional research questions.

A final research question which we examined was whether the narrow traits, as a set, contributed significantly to the prediction of career satisfaction above and beyond the Big Five traits. Answering this question sheds further light on the issue addressed in other contexts as to whether the Big Five traits are sufficient, or whether narrow traits are also useful in accounting for variance in a criterion of interest such as career satisfaction (see, e.g., Paunonen and Ashton, 2001; Paunonen and Nicol, 2001; Lounsbury et al., 2003c).

2. Method

The data for this study came from an archival source representing a range of occupations as well as different personality, career, and job satisfaction measures. All data were originally collected via the Internet from employees of companies requesting career transition services from an international strategic human resources company. All cases in the data source between 2003 and 2010 were included in the present analysis.

2.1. Participants

The entire sample consisted of 80,768 individuals, of which 2,015 were physical scientists. Of the latter group, 60% were male and 40% were female. Participation rates by age group were as follows: under 30 – 8%; 30–39 – 26%; 40–49 – 38%, 50–59 – 24%, and 60 and over – 4%. Race/ethnic data were not available. While fewer than 10% of the scientists completed an open-ended question asking for their specific job title, of these, the most commonly listed occupations were physicist and chemist, most often working in a Federal research and development (R&D) laboratory.

The 78,753 individuals in the nonscientists sample came from a wide range of different occupations, including: managerial/executive (13%), accounting and finance (8%), sales (7%), engineering (6%), human resources (5%), clerical (4%), consulting (4%), customer service (3%), manufacturing (3%), operations (3%), information technology and computer-related (2%), education (2%), and over 80 individual occupations representing 1% or less of the sample. Additional information on the nature of this sample is provided in Lounsbury and Gibson (2011).

2.2. Personality factors

The personality instrument used in the current study was the Resource Associates' *Personal Style Inventory (PSI)*, a work-based personality measure comprising the Big Five as well as the narrow personality traits. The PSI has been used in a variety of organizational settings, mainly for career development and preemployment screening purposes and validated in relation to a variety of criteria and other psychological constructs (Lounsbury et al., 2003a; Lounsbury et al., 2003b; Lounsbury et al., 2004a; Lounsbury et al., 2004b; Williamson et al., 2005). All of the PSI items had five-point response scales with bipolar verbal anchors. Later is a sample item from the extraversion scale.

I prefer lively parties where there are lots of people.	__ __ __ __ __ 1 2 3 4 5	I prefer parties with just a few friends.

A brief description of each of the personality measures used in the present study is presented later along with the number of items in each scale and the coefficient alpha for the total sample. For each scale, an average score was obtained by taking the mean of the scores on the individual items, so that the minimum possible score in each case was 1.0, and the maximum possible score was 5.0.

2.3. Big Five personality traits

Agreeableness/Teamwork – propensity for working cooperatively with others and as part of a team (six items; coefficient alpha = 0.82).

Conscientiousness – dependability, reliability, trustworthiness, and inclination to adhere to company norms, rules, and values (eight items; coefficient alpha = 0.75).

Emotional Stability – overall level of adjustment and emotional resilience in the face of job stress and pressure (six items; coefficient alpha = 0.85).

Extraversion – tendency to be sociable, outgoing, gregarious, expressive, warmhearted, and talkative (seven items; coefficient alpha = 0.84).

Openness – receptivity/openness to change, innovation, novel experience, and new learning (nine items; coefficient alpha = 0.79).

2.4. Narrow personality traits

Assertiveness – a person's disposition to speak up on matters of importance, expressing ideas and opinions confidently, defending personal beliefs, seizing the initiative, and exerting influence in a forthright, but not in an aggressive manner (eight items; coefficient alpha = 0.81).

Intrinsic Motivation – a disposition to be motivated by intrinsic work factors, such as challenge, meaning, autonomy, variety, and significance (six items; coefficient alpha = 0.84).

Optimism – having an upbeat, hopeful outlook concerning situations, people, prospects, and the future, even in the face of difficulty and adversity; a tendency to minimize problems and persist in the face of setbacks (eight items; coefficient alpha = 0.88).

Tough-Mindedness – appraising information, drawing conclusions, and making decisions based on logic, facts, and data rather than feelings, values, and intuition; disposition to be analytical, realistic, objective, and unsentimental (seven items; coefficient alpha = 0.79).

Visionary Style – focusing on long-term planning, strategizing, and envisioning future possibilities and contingencies (eight items; coefficient alpha = 0.84).

Work drive – disposition to work for long hours (including overtime) and an irregular schedule; investing high levels of time and energy into job and career, and motivated to extend oneself, if necessary, to finish projects, meet deadlines, be productive, and achieve job success (eight items; coefficient alpha = 0.82).

2.5. *Career satisfaction*

A five-item scale was used to measure career satisfaction (Lounsbury et al., 2007), with items tapping satisfaction by way of career progress and trajectory, career advancement, future career prospects, and career as a whole. Career satisfaction items were framed on a five-point response scale with verbally opposing anchors at each end (e.g., 'I am very satisfied with the way my career has progressed so far' versus 'I am very dissatisfied with the way my career has progressed so far'). Coefficient alpha for the career satisfaction scale = 0.82. The career satisfaction scale was added to the inventory at a later stage than the personality traits; thus, the sample size for statistics involving scientists' career satisfaction was smaller (n = 315) than the sample size for personality traits (n = 2,015).

3. Results

Table 1 summarizes the results of t-tests comparing mean scores on the personality traits for scientists and all other occupations. As can be seen in Table 1, there were significant differences between the two groups on all traits except for agreeableness/teamwork and work drive. The mean score for scientists was significantly higher than the corresponding mean score for nonscientists on three traits – openness, intrinsic motivation, and tough-mindedness, but significantly lower on six traits – assertiveness, conscientiousness, emotional stability, extraversion, optimism, and visionary style. To assess whether there was an overall difference between scientists and nonscientists when all 11 traits were considered as a set, a MANOVA was performed using Wilk's criterion, and a significant multivariate F was obtained – F (1, 80755) = 20.35 ($P < 0.01$).

In Table 2 the correlations between each of the personality traits and career satisfaction are presented. Seven traits were significantly and positively correlated with career satisfaction, ranging from higher correlations for emotional stability ($r = 0.31$, $P < 0.01$) and optimism ($r = 0.39$, $P < 0.01$); more moderate correlations for extraversion ($r = 0.26$, $P < 0.01$) and agreeableness/teamwork ($r = 0.20$, $P < 0.01$); and lower magnitude correlations for work drive ($r = 0.17$, $P < 0.01$), openness ($r = 0.15$, $P < 0.01$), and assertiveness ($r = 0.15$, $P < 0.01$). The other four traits – conscientiousness, intrinsic motivation, tough-mindedness, and visionary style – were not significantly correlated with career satisfaction for scientists.

To examine the question of whether the narrow traits contributed significantly to the prediction of career satisfaction above and beyond the Big Five traits, a hierarchical multiple regression analysis was performed, with the Big Five traits entered as a set on the first step, followed by the narrow traits entered as a set on the second step. The results of this analysis indicate that the Big Five traits accounted for 7% of the variance in career satisfaction (R = 0.27, $R^2 = 0.07$, $P < 0.01$), with the five narrow traits accounting for an additional 7% of the variance in career satisfaction, producing an overall multiple correlation of R = 0.37, $R^2 = 0.14$, $P < 0.01$.

4. Discussion

The results of this study indicate that scientists differed from nonscientists in the predicted directions on five personality traits; in addition, they differed on four other traits. As indicated by the overall MANOVA, scientists can clearly be differentiated from nonscientists on the Big Five and narrow personality traits. We discuss later the findings for each

Table 1. Mean scores on personality traits for scientists versus all other occupations

Variable	Group	Mean	Standard.deviation	*t* test
Openness	Scientists	3.84	0.71	–6.40**
	All other occupations	3.73	0.74	
Conscientiousness	Scientists	3.27	0.72	4.10**
	All other occupations	3.34	0.73	
Emotional stability	Scientists	3.37	0.73	3.01**
	All other occupations	3.42	0.73	
Agreeableness/teamwork	Scientists	3.48	0.76	1.09 (n.s.)
	All other occupations	3.50	0.79	
Extraversion	Scientists	3.67	0.78	5.16**
	All other occupations	3.77	0.78	
Assertiveness	Scientists	3.48	0.83	2.45*
	All other occupations	3.52	0.84	
Intrinsic motivation	Scientists	3.62	0.79	–6.08**
	All other occupations	3.51	0.81	
Optimism	Scientists	3.74	0.80	3.69**
	All other occupations	3.81	0.78	
Tough-mindedness	Scientists	3.50	81	–14.28**
	All other occupations	3.16	0.84	
Work drive	Scientists	3.34	0.79	–0.55 (n.s.)
	All other occupations	3.33	0.79	
Customer service orientation	Scientists	4.11	0.67	5.96**
	All other occupations	4.21	0.70	
Visionary style	Scientists	2.94	0.78	–2.22*
	All other occupations	2.91	0.77	

Note: For scientists $n = 2015$; for all other occupations $n = 78{,}536$ (except for tough-mindedness, where $n = 1{,}164$ for scientists; for all other occupations, $n = 43{,}672$).
*$P < 0.05$.
**$P < 0.01$.
n.s, not significant.

of the five hypotheses followed by an analysis of the results for the other traits and research questions.

That scientists are more introverted than nonscientists is further corroboration of previous research findings (Albert and Runco, 1987; Wilson and Jackson, 1994). As noted by Feist (2006), ‘Scientists, relative to non-scientists, prefer to be alone and are somewhat less social and less affiliative.’ (p. 118). Because adult personality is fairly stable, (Costa and McCrae, 1997) and traits from, say, college age on, are unlikely to change as a person enters into an occupation and moves through a career, we can surmise that introverts are more likely to be attracted initially to scientific work than extraverts. This fulfills one criterion of the Holland vocational theory in that individuals are attracted to occupations that align with their personality. But are introverts also, as predicted by Holland’s theory, more satisfied with their careers than individuals who are more extraverted? Interestingly, the answer is ‘no’ – the reverse is true. The positive correlation between extraversion and career satisfaction indicates that more extraverted scientists have higher levels of career satisfaction. Such a pattern of results is inconsistent with Holland’s theory, although the finding of lower extraversion scores for scientists is consistent with a similar conceptual model called the Attraction-Selection-Attrition or ASA model (Schneider, 1987; Schneider et al., 1995). The ASA model posits that individuals are attracted to types of jobs or occupations which they perceive as fitting their personality, and that organizations select individuals for jobs and career paths whom they see as a good fit; and attrition occurs – either at the initiative of the individual or the organization (e.g., by voluntary or involuntary turnover, respectively) – when there is a lack of fit or a poor fit.

Consequently, even though it appears that introverted individuals are more likely to enter scientific occupations, more extraverted scientists are more

Table 2. Correlations of personality traits with career satisfaction for sales managers

Big five-related traits	Career satisfaction
Conscientiousness	11 (n.s.)
Emotional stability	0.31*
Extraversion	0.26*
Openness	0.15*
Agreeableness/teamwork	0.20*
Narrow traits	
Assertiveness	0.15*
Intrinsic motivation	0.07 (n.s.)
Optimism	0.39*
Tough-mindedness	0.02 (n.s.)
Work drive	0.17*
Visionary	0.08 (n.s.)

$n = 315$.
*$P < 0.01$ (one-tailed).
n.s., not significant.

satisfied with their careers as a whole. This may be a function of extraversion being associated with prosocial behaviors in the organization in which a scientist works leading to intrinsic and extrinsic rewards; those rewards, in turn, contribute to satisfaction with his or her job and, ultimately, career. Extraversion-related behaviors are important for some key facets of most scientists' jobs, including making presentations; interacting regularly with other members of work teams, projects, or technical areas; and having multiple, diverse contacts with vendors, suppliers, subcontractors, funding agencies, government officials, customers, and the general public (Wang and Yang, 2007; O*NET online, 2011). To the extent that such behaviors lead to recognition, reward, and job success for scientists (Sapienza, 2004), a positive relationship between extraversion and career satisfaction is a logical outcome.

The findings for openness are fully consistent with Holland's person–occupation fit model in that higher levels of openness both differentiate scientists from nonscientists and are associated with higher levels of career satisfaction for scientists. Given the life span continuity of openness (and the other traits), one explanation for the origins of this trait as an important individual differences variable for scientists might be what Albert and Runco (1987) have characterized as *canalization*. In this view, openness is a powerful early disposition which inclines individuals to seek out and engage in novel experiences, investigation, new learning, and experimentation which are often channeled in academic, research, and, in this case, scientific activities. These activities – through a process of selective reinforcement, shaping, and specialization – become actualized as a career choice and, later, a career path. Satisfaction with one's career is a natural outcome of these processes and a motivator for continued expressions of openness for scientists.

There are manifold practical implications of openness being a key trait for scientists. First, openness has relevance for career planning, both for students contemplating majoring in science in school, and for individuals who are thinking about becoming a scientist. Also, openness can play a role in the recruitment and preemployment assessment of individuals for jobs in science. Then, too, knowledge of an individual's level of openness can be useful for ongoing coaching, mentoring, and managing of scientists. For example, while opportunities for openness-related activities – such as working on new projects, continuing education, and attending conferences and symposia – should be afforded all scientists, especially in early career stages, managers may choose to allocate scarce organizational resources for such activities to those scientists with higher levels of openness.

Tough-mindedness is another characteristic and distinguishing trait of scientists (Feist, 2006) which aligns well with most types of scientific work and basic job activities (see, for example, O*NET online, 2011). Given that tough-mindedness is also a trait which can be observed in early childhood (Matheny and Dolan, 1980) and does not change much over time, it is likely that scientific occupations attract and select more tough-minded individuals. However, higher levels of tough-mindedness are unrelated to the career satisfaction of scientists. Therefore, from the perspective of, say, R&D managers, tough-mindedness may play a role in the recruitment and placement of individuals for science occupations, but not in their ongoing management, coaching, or development.

Similarly, a higher level of intrinsic motivation differentiates scientists from nonscientists, but is unrelated to their career satisfaction. Scientific work is imbued with intrinsic motivators such as task significance, challenge, autonomy, and skill variety (e.g., Lawler and Hall, 1970). As summarized by Jindal-Snape and Snape (2006), scientists are 'typically motivated by the ability to do high quality, curiosity-driven research and de-motivated by lack of feedback from management . . . Extrinsic motivators such as salaries, incentive schemes and prospects for promotion were not considered as motivating factors by most scientists.' (p. 1325). On the other hand, intrinsic motivation was not related to the career satisfaction of scientists in the present study, echoing a similar finding regarding the independence of satisfaction and intrinsic motivation of R&D scientists over 40 years ago by Lawler and Hall (1970). Thus, in the case of the intrinsic motivation of scientists, support for Holland's theory is mixed, although the higher mean scores of scientists versus nonscientists is consistent with the differential attraction and selection component of the ASA model. In terms of practical implications, intrinsic motivation is a factor which could be considered in the recruitment of candidates for scientific jobs, although it carries no implications for the ongoing management of scientists.

The results for conscientiousness present a special problem for both theoretical and practical implications. As predicted, scientists scored lower on conscientiousness than nonscientists. Why might this be? Both the Holland vocational theory and the ASA model would hold that less conscientious individuals are more likely to be attracted to scientist positions than more conscientious individuals. However, from a practical perspective, it would not be advisable to, say, recruit for scientific jobs from the ranks of individuals low on conscientiousness as this could include lawbreakers, rule violators, and people who are unreliable, undependable, or careless. In addition, from a conceptual standpoint, a low level of a trait does not have motivating potential (Costa and McCrae, 1992b), so it does not make sense for low conscientiousness to be invoked as an explanatory mechanism. A more appropriate theoretical approach might be to reframe lower levels of conscientiousness as indicative of a cognate trait-like nonconformity, originality, or creativity.

The results for emotional stability – with scientists scoring lower than individuals in other occupations, but emotional stability being positively related to career satisfaction – are only partially (the latter results) consistent with Holland's vocational theory. One possible explanation for the lower emotional stability of scientists in our study may lie in the different developmental processes characteristic of many scientists discussed by Albert and Runco (1987). These include weaker, insecure parental attachments in childhood which can lead in adulthood, to weaker interpersonal attachments, lower levels of emotional intimacy, and greater feelings of isolation – all of which may contribute to higher levels of neuroticism (Noftle and Shaver, 2006), i.e., lower levels of emotional stability, as well as the lower level of extraversion noted earlier. The different attachment styles of scientists described by Albert and Runco (*ibid*) can also lead to *compulsive self-reliance*, which arises from avoidance of having to depend on others for help or need satisfaction, habitually relying on one's own self, and placing such a high reliance on self-sufficiency that one cannot form close relationships with other people or seek assistance even when it is needed (West and Sheldon, 1988). These kinds of attachment styles can also contribute to lower levels of emotional stability.

However, in the present study, emotional stability was one of the stronger correlates of career satisfaction of scientists. Thus, from a human resources perspective, we are left with a paradoxical choice between trying to optimize person–occupation fit on the front end by attracting and recruiting individuals who are less emotionally stable or trying to optimize occupational satisfaction by selecting individuals with higher levels of emotional stability. Because emotional stability has been found in meta-analyses for a wide variety of jobs to be related to job performance (e.g., Salgado, 1997), selecting for high emotional stability will likely lead to higher levels of scientific achievement. Still, based on the present findings, employers of scientists might want to consider efforts aimed at helping less stable scientists deal with stress and their own individual mental health issues. In this regard, it is interesting to note a study by Stack (2001) which reported that among 32 occupational groups, scientists had one of the higher suicide rates. He found that scientists were 1.85 times more likely to die of suicide than the general working-age population, further underscoring a need to address the low emotional stability levels among scientists.

Optimism is another distinguishing personality trait of scientists, although in the present case, scientists scored lower on optimism than other occupations, meaning that they tend to be more pessimistic. This may be due, in part, to the skepticism inherent in the scientific method, which Sagan (1985) characterized as 'scientific skepticism', a crucial attribute of scientists. Higher levels of pessimism among scientists compared to other occupations may also be a function of the overarching importance of critical thinking to the scientific enterprise, as pessimism has been characterized as 'driven by critical thinking' (Mindsport, 2011).

On the other hand, optimism was the trait most highly correlated with the career satisfaction of scientists, which presents the same type of paradox noted earlier for emotional stability – namely, that while individuals with lower levels of optimism are differentially attracted to scientific jobs, individuals with higher levels of optimism achieve more career satisfaction than their more pessimistic counterparts. The challenge for the employer of scientists is how to reconcile the recruitment of individuals from more pessimistic candidate pools while trying to select and retain more optimistic individuals.

Finally, scientists were also distinguished by lower levels of assertiveness. There is no ready explanation of this result based on previous research or job analyses of scientific occupations. However, the introversion of many scientists goes hand in hand with shyness, reticence, and timidity (Watson and Clark, 1997) – traits which are the opposite of assertiveness. Also, assertiveness is regarded in some personality taxonomies as a component of extraversion [e.g., the NEO Personality Inventory-Revised (NEO-PI-R) – Costa and McCrae, 1992a], which is an additional factor that may help explain the lower level of assertiveness among scientists.

There are some broader implications of this study as well as some unresolved issues which merit discussion. First, in the present study, scientists display more 'discrepancies' from a Holland vocational theory perspective than other occupations we have studied using the same constructs and methodologies, including accountants, managers, librarians, health-care professionals, field sales representatives, human resource managers, marketing professionals, and computer scientists and information technologists. This may reflect a higher level of psychological complexity of scientists compared to other occupations, but it also presents unique challenges for employers of scientists such as high-tech corporations or Federal R&D labs. The personality traits which the organization looks for in attracting and recruiting scientists are, as discussed earlier, typically different from those which the organization attends to in selecting, training, and mentoring scientists. While such differences create opportunities for training and development, they can also lead to ongoing intraorganizational conflicts which must be continually negotiated by the employer of scientists, especially in the areas of recruitment versus management of scientists.

The unique constellation of personality traits of scientists also creates inherent difficulties for the manager of scientists. As one wag noted, 'Managing scientists is like herding cats. You can't get a scientist to work 9–5 and make breakthroughs at a given time.' (SciForums.com, 2011). At the heart of most of these difficulties is the tension created by dispositionally non-conscientious scientists working in conscientiousness-driven organizations which require compliance with rules and policies, proper organizational conduct, and good citizenship behavior, developing a well-funded program of mission-relevant research, and meeting ever-higher performance standards based on criteria like citation rates and the dollar value of grants. There are some other role conflicts facing many scientists, especially successful ones with heavily funded programs of research. They must develop management skills, particularly personnel management skills, as well as associated skills, in the areas of listening, negotiating, persuasion, and making presentations. This typically requires a radical departure from the skills the successful scientist initially relied upon to achieve recognition and eminence. As noted by Doms (in Hede, 2007), 'Science is odd in some ways. You spend all your time as a student and postdoctoral fellow learning how to be a good experimentalist. Then you become an independent scientist, and if you are successful, before long you are no longer doing experiments because you don't have any time, and personnel management becomes a major issue.' As a consequence of the difficulty of making these transitions, most employers of scientists have specific training and development programs in such areas as communication, leadership, management, people skills, 'soft skills', and even emotional intelligence.

Compared to other occupations, scientists are prone to be: pessimistic, gloomy, and cynical; less stable, anxious, and more emotionally reactive; less assertive, accommodating, and more easily swayed by dominant individuals; quieter, immersed with their own thoughts, and unaffiliative, with fewer connections to other people; nonconforming, independent-minded, less rule-following, and more comfortable with lack of structure; more open to new (and sometimes radical) ideas, willing to experiment, and inclined to seek out variety and novel experience. One concern in this context is that such individuals may eventually be in greater need of psychological help in the form of employee assistance programs, psychotherapy, or counseling. Another concern is that they may be more likely than other employees to become engaged in unethical, organizationally deviant, or antisocial behavior such as theft of intellectual property, sabotage, leaking classified information, espionage, and other activities which are inimical to the interests of the employer and to national security (Berry et al., 2007; Moore et al., 2011). In many cases, the gravity of such threats is magnified by the nature of the scientific work itself, which can encompass a wide range of consequential topics including: nuclear proliferation, advanced munitions and weaponry, cyberterrorism, genomic profiling, nanotechnology, biohazards, infrastructure protection, stem cell research, and all manner of technological innovations and advancements in basic and applied research.

Several limitations of the present study should be acknowledged. Although current data were based on relatively large samples – especially for the sample representing all other occupations – we did not have detailed information on the employing organization or on potentially important job characteristics – such as tenure, earnings, and scientific discipline – which might have moderated the findings observed in the present study. In addition, the individuals comprising our sample were participants in career transition services, which is of unknown generalizability to other employee groups. We conjecture that one effect of using such a sample compared to individuals not in career transition would be a lowering of career satisfaction, which could result in range restriction for our measure. In that case, our correlation and regression findings may be underestimates of effects compared to what might be found in comparable research on employees who are not in career transition. Also, we did not assess changes over time in the personality and satisfaction measures, nor we did look at the predictive validity of personality traits in relation to job and career satisfaction. Moreover, the field study nature of this investigation precludes inferences about causality or correlational directionality. One other limitation is that we did not assess some of the constructs assessed by other types of measures such as some of the traits assessed by the Myers-Briggs Type Indicator (MBTI) or Cattell's 16 Personality Factors (16PF) inventory (cf. John et al., 2008). However, we contend that the constructs we assessed represent a more comprehensive set of personality traits than the four measured by the MBTI; also, our emphasis on the Big Five and narrow traits is more in line with current, commonly used approaches to conceptualizing personality traits – most of which involve the Big Five model – than the 16 PF, which employs traits developed decades ago and which are seldom used in other personality inventories.

Looking ahead, we believe that, in the future, the role of personality traits will become more salient for the career satisfaction of scientists and more informative in the development of programs and activities designed to increase their interpersonal, communication, and leadership skills. In addition, there is growing concern about the future of 'careers' in our current era of massive sociocultural and technological change; in fact, some foresee the coming 'death of career' (Young and Valach, 2000), hastened by shorter job cycles, weaker employer–employee ties, and more fragmented career ladders. As work-related situational and environmental structures become more transitional and unstable, personality variables may be the one area of a person's work life in which there is relative stability and predictability (Judge et al., 1999). Then, too, as levels of stress continue to increase over time, the importance of emotional stability and optimism are likely to increase. By way of illustration for the measures we used here, the beta weight for emotional stability in predicting both career and life satisfaction has increased over a 10-year period (Lounsbury and Gibson, 2011).

In summary, the present results provide clear support for the proposition that scientists can be differentiated from nonscientists in terms of Big Five and narrow personality traits, typically in a manner indicative of good fit between the nature of scientific work and the meaning of the constructs specified by these traits. Hopefully, future research can extend the nomological network for constructs important for scientists, both in terms of other criteria, such as job performance and eminence, as well as other traits, such as locus of control, need for autonomy, achievement motivation, endurance, and curiosity, inter alia. From our vantage point, the future for empirical research and theory development in this area looks bright.

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