Linearity of Personality–Performance Relationships: A large-scale examination

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This paper reviews theory and past research concerning nonlinear relationships between personality tests and job performance. We compare linear and nonlinear regression models for each of the 32 Occupational Personality Questionnaire (OPQ32i) scales using job performance as the criterion variable. We evaluate linear, quadratic, and cubic relationships between personality and job performance by calculating changes in R (ΔR) between the linear and nonlinear models. We use 3 decision rules of varying levels for ΔR and divide a large sample randomly into 2 samples to cross-validate any nonlinear effects found. Few scales exhibited nonlinearity and the magnitude of the departures from linearity were small.

1. Introduction

The validity of personality measures for predicting job performance continues to be a widely investigated topic in spite of continued pessimistic results over the last 30–40 years of research. Morgeson et al. (2007a, 2007b) noted that in high-stakes selection contexts, 'the observed validities of personality tests predicting job performance criteria are low and have not changed much over time' (2007b, p. 1029). Meta-analyses have shown that the only personality constructs in which the distributions of validities between personality and job performance generalized across jobs and situations were conscientiousness and emotional stability (Hurtz & Donovan, 2000) and the magnitude of these mean validities were low (.14 and .09, respectively).

Much research has attempted to understand why the validity is fairly low (compared with cognitive ability) and what might be done to improve it. One line of research involves the use of compound personality variables (cf. Hough & Ones, 2001; Hough & Oswald, 2000). Examples of compound personality scales include drug and alcohol, stress tolerance, and violence scales (Ones & Viswesvaran, 2001) and customer satisfaction scales (Frei & McDaniel, 1998). Ones, Viswesvaran, and Dilchert (2005) conducted a meta-analysis of compound personality scales and found uncorrected validities ranging from .19

to .42 for supervisor ratings of performance. As opposed to combining across multiple constructs, another line of research involves investigating personality at the facet level. Ones, Dilchert, Viswesvaran, and Judge (2007) investigated facets of conscientiousness (i.e., achievement and dependability) and found comparable validities for the overall and task performance criteria. Conscientiousness predicted overall performance ($\rho = .22$) and task performance ($\rho = .15$). Achievement predicted overall and task performance ($\rho = .18$ and .22, respectively). Uncorrected validities for dependability were .22 and .15, for overall and task performance, respectively. These results suggest that either by combining personality variables or by splitting them into facets, personality may be more valid than previously believed. Of course, to the extent that these validities are based on concurrent designs conducted with employees, the validity of personality measures may change when used with applicants.

Another line of research expands theory and practice by examining potential moderators of the relationship between personality and job performance. These include investigations of the effects of agreeableness (Witt, Burke, Barrick, & Mount, 2002), social skill (Witt & Ferris, 2003), and the nature of job characteristics (Witt et al., 2002) on conscientiousness. For example, Witt et al. (2002) found that the conscientiousness-job performance relationships were stronger among workers around the mean or at high

levels of agreeableness than among workers low in agreeableness. For workers who are low in conscientiousness, agreeableness was unrelated to ratings of job performance. Among the highly conscientious workers, those who were low in agreeableness received lower ratings of job performance than those high in agreeableness. Witt *et al.* (2002) also found that the interaction effects were not found in all samples, especially for those jobs that may not require interaction with others (e.g., cross-county truck drivers).

Still another line of research, which we pursue in this paper, examines whether theory and practice can be enhanced by investigating nonlinear relationships. Personality researchers have typically focused on linear relationships, which are described by the following equation:

$$y = a + b_1 x \qquad (1)$$

where *a* is an intercept, and b_1 is the slope of the linear relationship between the personality predictor (*x*), and the job performance measure (*y*). All linear relationships look similar varying only in the intercept and the slope. In contrast, nonlinear relationships can assume an infinite number of shapes. Nonlinear relationships can be classified as to how many times the line bends. As noted by Guion (1998), there are several different kinds of nonlinear relationships including curves with one bend, such as a U (or inverted U) curve, or an asymptotic J-shaped (or inverted J) curve in which scores after a certain point do not increase substantially, or a curve with two bends. Lines that approximate the letters U and J, whether inverted or not, bend only once and are modeled using the quadratic regression equation:

$$y = a + b_1 x + b_2 x^2 \qquad (2)$$

where b_2 is the beta weight of the personality score squared (x^2). Curves with two bends are modeled using the cubic regression equation:

$$y = a + b_1 x + b_2 x^2 + b_3 x^3 \qquad (3)$$

where b_3 is the beta weight of the personality score cubed (x^3).

Although one might describe potential nonlinear relationships as U shaped or J shaped, the nonlinear relationship may not be dramatic and reflect only a slight departure from linearity. Thus, a quadratic term may signify a relationship that is mostly linear but has a slight concave shape. Also, one should not assume the nonlinear relationships are primarily symmetrical, such as a concave or U-shaped relationship. In addition to non-symmetrical relationships, such as those that are J shaped, quadratic relationships may be asymptotic where the relationship between personality and job performance may be largely linear at lower levels of the personality trait, but after some point increases in personality scores are not associated with increases in job performance. As an example, asymptotic curves have explained the rela-

tionship between job experience and job performance (McDaniel, Schmidt, & Hunter, 1988).

Nonlinear relationships can be intuitively appealing and it is easy to generate reasonable speculations concerning their use. For example, when selecting employees for customer service positions, candidates with low scores on agreeableness may tend to anger or upset customers, and candidates with very high scores on agreeableness may be characterized as 'giving away the store.' That is, people with extremely high agreeableness scores may attempt to be so pleasing that they do not enforce procedures for fear of angering the customer (e.g., accepting the return of a product that is counter to store procedures). In this case, candidates with moderate scores on agreeableness may be the best employees and the relationship between agreeableness and job performance may be an inverted U or a concave shape. Concerning conscientiousness, Murphy (1996, p. 2) noted that an individual who is very high on conscientiousness, 'might be so conventional and rule-bound that he or she cannot function in anything but the most bureaucratic setting.' In these cases, more is not necessarily better.

Although the assumption of linearity is well supported for the relationship between cognitive ability and job performance (Coward & Sackett, 1990; Hawk, 1970; Schmidt, Hunter, McKenzie, & Muldrow, 1979), there is relatively little evidence exploring the shape of the relationship between other predictors and job performance (Society for Industrial and Organizational Psychology, 2003). The studies that investigated nonlinear relationships between personality and job performance are described below. First, we describe a study with five samples that found only linear relationships between personality and job performance; then we describe studies in which nonlinear relationships were identified. We then describe the use of profile assessments that rely on assumptions of nonlinearity.

1.1. Linear relationships between personality and criterion variables

Robie and Ryan (1999) addressed the possibility of nonlinear relationships between conscientiousness and performance using five samples: (a) Federal government employees ($N = 999$); concurrent design, (b) Multi-organizational private sector employees ($N = 200$); concurrent design, (c) Department of Defense managers ($N = 146$); concurrent design, (d) Wholesale Sales Representatives ($N = 206$); concurrent design, and (d) Long-Haul Semi-truck Drivers ($N = 256$); predictive design. They found significant linear relationships in three of the four concurrent samples and in the predictive sample. Regarding nonlinear relationships, they found no evidence of significant quadratic or cubic relations between conscientiousness and job performance. This

study suggests that, to the extent that there is a relationship between personality and performance, it is linear. We now turn to a discussion of studies showing the existence of nonlinear relationships among personality and criterion variables.

1.2. Nonlinear relationships between personality and criterion variables

LaHuis, Martin, and Avis (2005) reported results from two studies of clerical employees that showed nonlinear effects ($N = 192$ and 203, respectively). In the first study, using a situational judgment test and biodata items as a measure of conscientiousness, they found a significant quadratic trend in the form of an inverted U shape between conscientiousness and job performance. Adding the quadratic term resulted in a $\Delta R^2 = .02$. In the second study, they used a traditional self-report measure of conscientiousness and a measure of cognitive ability to control for ability level. After controlling for ability, they found a nonlinear relationship. The curve was asymptotic at the upper end of the conscientiousness distribution, suggesting that past a certain point higher scores on conscientiousness did not result in higher levels of job performance.

Manley and Mobbs (2004) investigated the linearity of the relationship between biographical data and training performance for 4,559 Federal Aviation Administration Air Traffic Controller Specialists. Analyses showed that most rationally developed scales had no significant relationship with Academy training performance, except for the conscientiousness and mental processes scales, which did exhibit slight nonlinearity. At the high and low ends of the distribution of test scores, there was greater prediction of training performance than scores in the middle of the distribution.

Cucina and Vasilopoulos (2005) investigated the relationship between Big 5 personality variables and grade point average. In a sample of 262 undergraduates, they computed the linear and quadratic relationships and found a ΔR^2 of .023 for openness and .022 for conscientiousness. The ΔR^2 for the remaining three personality variables indicated that the relationship was linear.

Vasilopoulos, Cucina, and Hunter (2007) investigated linear and curvilinear relationships between cognitive and personality variables and performance at a US law enforcement training academy ($N = 1,010$). The personality scales were conscientiousness (and its subfactors dependability and achievement) and emotional stability (and its subfactors stress resistance and frustration tolerance). For both conscientiousness and emotional stability, the use of separate factor scores increased the level of prediction of training grades using both linear and nonlinear models. Specifically, when the quadratic term was added for the consciousness construct (over the linear combination of cognitive ability and conscientiousness), the ΔR^2 was .019. When the quadratic term was added for the dependability and achievement facets (over the linear combinations of cognitive ability, dependability, and achievement), the ΔR^2 was .016. Similarly, when the quadratic term was added for the emotional stability construct (over the linear combination of cognitive ability and emotional stability), the ΔR^2 was .011. When the quadratic term was added for the stress resistance and frustration tolerance facets (over the linear combinations of cognitive ability, stress resistance, and frustration tolerance), the ΔR^2 was .027. Thus, in all cases, although the ΔR^2 were fairly small, the quadratic terms increased the prediction beyond the linear models alone. The higher level of prediction at the lower end of the scales provides evidence of the nonlinear relationship between these personality constructs and training performance.

Benson and Campbell (2007) tested for nonlinear relationships among 'derailing' personality characteristics and leadership performance using two independent samples of managers/leaders ($N = 1,306$ and 290). Derailing/dark side personality characteristics included insensitivity to others; aloof, cold, and arrogant; betrayal of trust; overly ambitious; burn out; and various skill deficiencies (McCall & Lombardo, 1983). In their first study, they found that the relationships between performance in an assessment center and the derailing composite was nonlinear and was represented by a negative, concave curve, which was asymptotic at the low end (i.e., the distribution was nearly flat at the low end). Thus, for low derailment scores, there was little differentiation among various levels of leadership, but the greater the presence of derailers, the more negative the relationship between derailers and leadership performance. In a second study, they correlated a set of dysfunctional dispositions (Hogan Development Survey, Hogan & Hogan, 1997) with ratings on a multirater feedback tool. In this study, the curves were better described by an inverted U shape, rather than the asymptotic curves in the first study. They concluded that some level of risk-taking, egocentricity, ambition, and rule-breaking behavior are beneficial (up to a point) for leadership performance.

These studies suggest that when using measures of personality, some nonlinearity was observed, although the magnitude of the ΔR^2 was small (Cucina & Vasilopoulos, 2005; LaHuis et al., 2005; Manley & Mobbs, 2004; Vasilopoulos et al., 2007). When derailing personality characteristics were investigated, the nonlinear relationships suggested that the greater the presence of negative characteristics, the lower the levels of perceived leadership, resulting in a J-shaped curve (Benson & Campbell, 2007). When correlated with a multirater feedback tool, the derailers revealed a U-shaped curve.

In sum, the current literature is sparse and the results are contradictory. In spite of the paucity of evidence, there is an applied practice, profile assessment, which is based on the assumption of nonlinearity. The practice is described below.

1.3. Profile assessments

Profile assessments use job analysis or scores of incumbents to identify an assumed optimal score or range of scores on a scale for new hires. To the extent that the purported optimal score or score range does not include the lowest and highest possible scores, the assessments incorporate assumptions of nonlinear relationships (i.e., inverted U relationships) between the scale and outcome measures, such as job performance. For example, if the mean incumbent score is 6.5 on a 10-point scale, the optimal score range may be set at 6 to 7 and those who score below 6 or above 7 are considered less qualified than those who receive a score of 6 or 7. Samples of illustrative profile assessment reports are readily available on the internet (e.g., Brainbench's Prehire Personality Profile, 2005; Profile International Inc.'s Job Profile Summary Report, 1999–2003). Although such assessments are plentiful, the authors have located no profile assessment vendor who offers empirical research supporting the assumed nonlinear relationships used in scoring these assessments. One notable exception to the paucity of validity research on profile assessments is Dilchert (2007) in which he investigated the relationship between personality and leadership and managerial interests (e.g., influencing/enterprising interests). The personality profile pattern predictive of influencing and leadership interests was stable across different managerial domains. Dilchert (2007) concluded that personality profile patterns explained a larger portion of the variance in leadership interests compared with individuals' absolute trait levels. A remaining question is the extent to which these relationships apply to job performance criteria and such research is clearly needed.

1.4. Contributions of the current study

In this study, we use a large sample study to evaluate nonlinear relationships in a broad range of personality scales. Our evaluation of nonlinearity is restricted to calculating whether quadratic and cubic polynomial relationships have incremental validity over linear relationships. We note that one could also define nonlinearity as interactions among the personality scales. This latter approach is outside the scope of this paper. This study makes important scientific and practical contributions to the literature. First, as seen in our literature review, the conclusions concerning linearity are mixed. Because there are relatively few studies on this topic, there is likely greater second-order sampling error associated with a small number of studies (i.e., the located studies are not representative of all studies) and, thus, the possibility that results are a function of publication bias. Concerning the latter point, nonlinear relationships between personality and job performance may have more intuitive appeal than linear relationships. This may increase the chances of publishing nonlinear results such

that their presence in the available literature may over-represent their presence in the population. On the other hand, it may be that unsuccessful attempts to find nonlinearity are among the unpublished studies in researchers' file drawers. Second, our sample is large and can help identify nonlinear relationships, even when the effects are of relatively small magnitude. Thus, we can estimate the magnitude of the relationships with substantial precision. Because we have a large sample size ($N = 1,152$), we cross-validated the results to permit firm conclusions concerning the presence or absence of nonlinear effects. Third, we examine nonlinearity in a very wide range of personality constructs. Previous examinations of nonlinear relationships have focused on only one or a few personality scales. Fourth, from a practical perspective, many profile assessments used for applicant screening are scored in manner that assumes nonlinear relationships between personality and job performance. These testing vendors offer little empirical evidence to support these assumptions. An analysis of nonlinear relationships provides much needed information on whether the scoring approach of these measures results in useful prediction.

Because of the mixed conclusions concerning nonlinear relationships and the scant theorizing in this area, there is little basis on which to offer strong empirical or theoretical arguments for the presence of nonlinear relationships. Thus, we offer the following hypothesis:

H: Relationships between personality scales and job performance will be linear.

We tested this hypothesis using a large sample data set from a financial services firm to examine empirically the linear and nonlinear relationships between 32 scales of the Occupational Personality Questionnaire (OPQ32i) and job performance.

2. Method

2.1. Respondents and data set

Respondents were 1,152 professionals in a financial services firm who were part of a concurrent validity study investigating a large number of predictors. The heterogeneous sample included incumbents from a broad array of functions in the company, including information technology, human resources, legal, finance, marketing, operations, and sales. The data set was provided to the researchers as an archival data set with no personal identifiers.

2.2. Measures

The ipsative version of the Occupational Personality Questionnaire (OPQ) served as the measure of personality. Like the original OPQ, the ipsative version (OPQ32i) yields 32 scales. The reliability of the OPQ32i has been established

Table 1. Correlation matrix (samples 1 and 2 combined)

Scale	Job perf.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Job performance																	
1. Achieving	.22																
2. Adaptable	-.02	-.12															
3. Affiliative	-.09	-.13	.10														
4. Behavioral	.00	-.04	-.01	.15													
5. Caring	-.16	-.23	.06	.25	.33												
6. Conceptual	.00	-.02	-.10	-.18	.20	-.10											
7. Conscientious	-.02	.10	-.02	-.13	-.19	-.03	-.11										
8. Competitive	.11	.37	-.07	-.12	-.15	-.30	-.03	-.11									
9. Controlling	.28	.30	-.05	-.07	-.07	-.26	-.15	-.03	.25								
10. Conventional	-.15	-.32	.01	-.09	-.26	.07	-.20	.28	-.17	-.22							
11. Data rational	.07	.03	-.07	-.25	-.18	-.13	.07	.01	.12	-.15	.09						
12. Decisive	.18	.06	-.03	-.13	-.12	-.30	-.01	-.07	.16	.26	-.13	-.07					
13. Democratic	-.01	-.12	.09	.30	.22	.33	-.02	-.05	-.27	-.11	-.11	-.20	-.27				
14. Detail conscious	-.15	-.16	.03	-.13	-.16	.11	-.23	.47	-.26	-.18	.40	.10	-.26	-.02			
15. Emotionally controlled	-.15	-.29	.09	-.18	-.12	.06	-.10	.03	-.10	-.29	.32	.10	-.14	-.12	.19		
16. Evaluative	.11	.06	-.08	-.30	.03	-.20	.31	.01	.04	-.02	-.02	.30	.03	-.11	.10	-.06	
17. Forward thinking	.14	.19	-.21	-.27	.02	-.13	.18	.03	-.01	-.03	-.04	.11	-.03	-.12	.08	-.01	.14
18. Independent minded	-.09	-.13	.01	-.08	.00	-.10	.16	-.14	.10	-.08	.01	-.03	.13	-.25	-.12	.14	-.06
19. Innovative	.06	.13	-.11	-.13	.03	-.13	.37	-.31	-.01	.06	-.41	-.03	.10	-.04	-.35	-.22	.06
20. Modest	-.09	-.32	-.03	-.14	-.06	.17	-.06	.04	-.21	-.37	.26	.07	-.14	-.02	.18	.48	-.03
21. Optimisitic	.06	-.04	-.13	-.02	-.04	-.02	-.02	-.16	-.10	-.07	-.06	-.05	-.05	.02	-.18	-.03	-.23
22. Outgoing	-.04	.04	.03	.45	-.01	-.06	-.16	-.15	-.01	.26	-.27	-.35	.05	.17	-.25	-.42	-.27
23. Outspoken	.10	.04	-.08	-.06	-.06	-.29	.02	-.06	.10	.30	-.15	-.17	.22	-.10	-.17	-.36	.19
24. Persuasive	.06	.14	-.11	.00	.02	-.10	-.04	-.16	.09	.28	-.28	-.25	.02	.02	-.23	-.20	-.07
25. Relaxed	-.12	-.14	-.18	-.11	-.08	-.06	.00	-.11	-.02	-.19	-.01	.04	.02	-.16	-.04	.13	-.09
26. Rule following	-.17	-.19	.00	-.15	-.19	.14	-.21	.31	-.17	-.23	.62	.14	-.25	-.02	.51	.26	.03
27. Socially confident	-.11	-.04	-.10	.27	.02	.02	-.10	-.09	-.17	.10	-.16	-.24	-.11	.14	-.13	-.26	-.18
28. Tough minded	-.08	-.14	-.13	-.16	-.05	-.04	.06	-.10	-.15	-.14	-.03	.01	-.04	-.08	-.04	.09	-.10
29. Trusting	.06	-.21	-.03	.14	-.06	.20	-.15	-.03	-.15	-.12	.11	-.02	-.04	.13	-.06	.02	-.19
30. Variety seeking	.03	.13	.02	.07	.03	-.11	.09	-.16	.08	.00	-.36	-.17	.12	-.09	-.33	-.10	-.12
31. Vigorous	.02	.22	-.04	.11	-.10	-.07	-.26	.22	-.02	.07	-.03	-.13	.00	-.05	.09	-.14	-.19
32. Worrying	-.09	-.21	.27	.12	.00	.16	-.08	.11	-.08	-.27	.27	.01	-.12	.10	.12	.27	-.06

OPQ scale	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
18. Independent minded	.00														
19. Innovative	.16	.06													
20. Modest	.02	.05	-.14												
21. Optimisitic	.16	-.09	.08	-.05											
22. Outgoing	-.34	-.11	.00	-.38	-.03										
23. Outspoken	-.17	.15	.01	-.26	-.17	.31									
24. Persuasive	-.10	-.12	.23	-.24	.02	.25	.11								
25. Relaxed	-.08	-.01	.01	.03	.29	-.14	-.06	.00							
26. Rule following	.00	-.15	-.41	.24	-.11	-.25	-.23	-.26	-.08						
27. Socially confident	-.16	-.22	-.01	-.19	.10	.48	.11	.26	.09	-.19					
28. Tough minded	-.06	-.11	.06	.14	.10	-.09	.01	.01	.34	-.07	.12				
29. Trusting	-.11	-.17	-.09	.09	.28	-.03	-.16	-.10	.02	.07	.01	-.05			
30. Variety seeking	-.02	.17	.26	-.07	-.02	.11	.08	-.05	.03	-.40	.02	.01	-.13		
31. Vigorous	-.06	-.19	-.11	-.08	-.12	.18	.00	-.05	-.13	.03	.03	-.06	.00	.10	
32. Worrying	-.09	.15	-.29	.19	-.20	-.11	-.15	-.26	-.34	.24	-.37	-.27	.01	-.08	-.01

using large, international samples. For example, using data from 12 European countries ($N = 40,922$), cross-scale country median reliabilities ranged from .76 to .81, and cross-country scale median reliabilities ranged from .66 to .87, with an overall median reliability of .77 (Bartram, Brown, Fleck, Inceoglu, & Ward, 2006). The intercorrelations among the 32 scales are provided in Table 1.

Ipsative measures, particularly those with few scales, may create problems such as negative correlations among scales and low reliabilities. However, Baron (1996) reviewed the psychometric properties of ipsative measures and concluded that these issues are less of a concern when an ipsative measure has 30 or more scales. As noted above, the OPQ32i has 32 scales. In addition, the manual for the OPQ32i (Bartram *et al.*, 2006) presented evidence that the ipsative versions of the 32 scales are reasonably equivalent to the normative version of the scales.

Ninety-six percent of the sample had complete data for the 32 scales. Two percent of the sample had missing data on one of the 32 scales. The remaining 2% of the sample had missing data on more than 1 scale, but no observation had missing data on more than 9 of the 32 scales.

The criterion measure was the mean of 15 items on a supervisory performance appraisal instrument whose content reflected task performance. The criterion measure was developed by the organization for the purpose of the validation study and was not used for administrative purposes. All respondents had criterion data.

2.3. Analyses

Because of our relatively large sample size, we could obtain statistically significant nonlinear effects of trivial magnitude. Also, because we were analyzing 32 separate personality scales, reliance on statistical significance testing could result in a high Type I error rate. To avoid these problems, we defined meaningful nonlinear relationships with respect to the magnitude of the change in the multiple R (ΔR) between the linear model and the nonlinear model using three criteria. The first criterion required the quadratic model to yield a multiple R that was at least .05 larger than the r from the linear model. Thus, if the linear analysis yielded a correlation of .10, the quadratic relationship would need to yield a multiple R of at least .15 ($\Delta R \geq .05$). We believe that most researchers and practitioners would consider an increment in validity of .05 to be meaningful. The second criterion required a ΔR that was $\geq .025$. Some, but not all, researchers and practitioners would find a validity increment of .025 to be meaningful. The third criterion required a ΔR that was $\geq .01$. Although some would find an increase in validity of .01 (multiple R .10 vs. 11) to be meaningful, many would not. To assess the cubic models, the same ΔR decision rules were applied except that the multiple R of the cubic model was compared with the multiple R of the quadratic model.

Because replication is a primary principle of the scientific method and because our sample size was large, the sample was randomly divided in half, yielding two separate samples each with 576 observations. To conclude that a personality scale was nonlinear, we required that the scale meet the ΔR criterion in both samples. To estimate the multiple R for each model, we used regression to evaluate a linear, a quadratic, and a cubic relationship between the personality scale and job performance. Thus, for a given personality scale, the relationship could be concluded to be linear, nonlinear with one bend in the fitted line (i.e., a quadratic model), or nonlinear with two bends in the fitted line (i.e., a cubic model).

3. Results

Table 2 presents the linear and nonlinear relationships for 32 scales of the OPQ32i. Column 1 presents the scale name. The next three columns are the analysis for Sample 1 including the absolute value of the correlation[1] between the OPQ32i scale and job performance (r linear), the multiple R for a quadratic model, and the multiple R for a cubic model. The same information is repeated for the second sample in the next three columns.

We examined the results by comparing the ΔRs of Samples 1 and 2 to determine if there is evidence of a nonlinear relationship between the scale and job performance. If the scale met the ΔR quadratic criterion in both samples, we concluded that the scale has a nonlinear relationship with the job performance criterion. Likewise, if the scale met the ΔR cubic criterion in both samples, we concluded that the scale has a nonlinear relationship with the job performance criterion.

For the first criterion ($\Delta R \geq .05$), we found evidence for a nonlinear quadratic relationship solely for conscientiousness. The linear relationship is near zero (.017 and .015 for the two samples). The ΔR for the quadratic equation raises the validity (.089 and .056 for the two samples) although the magnitude of the validity is still quite low. Figure 1 shows the quadratic fitted line for conscientiousness. The quadratic relationship between the conscientiousness personality scales and job performance is described by a concave line. The line's smoothness should not be interpreted as reflecting a large magnitude relationship (the figure is not a scatter plot). The multiple R for the quadratic relationship is only .088 (it is .106 for Sample 1 and .071 for Sample 2). Although the multiple R of .088 is a substantial improvement over the linear correlation of $-.016$ (the correlation for Samples 1 and 2 combined), it still represents a weak level of prediction. In sum, conscientiousness was the sole predictor that showed a nonlinear relationship that met the $\Delta R \geq .05$ decision rule. Thus, for the $\Delta R \geq .05$ decision rule, our hypothesis of linear relationships is supported for 31 of the 32 personality scales.

Table 2. Linear, quadratic, and cubic relationships between 32 OPQ32i scales and job performance

| Scale names	Sample 1			Sample 2		
	r linear	R quadratic	R cubic	r linear	R quadratic	R cubic
Achieving	.200	.204	.204	.240	.240	.240
Adaptable	.012	.072	.073	.052	.075	.077
Affiliative	.124	.124	.131	.060	.064	.065
Behavioral	.088	.095	.097	.089	.089	.090
Caring	.227	.227	.229	.096	.098	.100
Conceptual	.054	.059	.129	.051	.073	.082
Conscientiousness	.017	.106	.109	.015	.071	.083
Competitiveness	.144	.152	.156	.075	.123	.130
Controlling	.286	.287	.289	.283	.313	.315
Conventional	.169	.172	.174	.134	.151	.154
Data rational	.108	.111	.112	.035	.060	.060
Decisive	.212	.215	.218	.151	.179	.180
Democratic	.040	.054	.064	.010	.030	.031
Detail conscious	.144	.147	.157	.153	.162	.165
Emotionally controlled	.149	.150	.158	.143	.164	.164
Evaluative	.127	.127	.127	.084	.094	.094
Forward thinking	.178	.179	.179	.104	.106	.116
Independent minded	.043	.080	.080	.131	.139	.148
Innovative	.073	.107	.127	.046	.059	.090
Modest	.072	.078	.093	.110	.118	.119
Optimistic	.049	.073	.106	.069	.080	.083
Outgoing	.083	.087	.092	.005	.019	.044
Outspoken	.110	.110	.110	.084	.147	.150
Persuasive	.023	.089	.101	.091	.092	.093
Relaxed	.155	.161	.162	.091	.092	.095
Rule following	.190	.201	.201	.157	.157	.168
Socially confident	.138	.153	.153	.078	.079	.079
Tough minded	.052	.054	.058	.113	.113	.129
Trusting	.077	.093	.093	.040	.041	.041
Variety seeking	.003	.014	.133	.047	.074	.116
Vigorous	.031	.031	.067	.009	.032	.034
Worrying	.074	.074	.080	.100	.129	.136
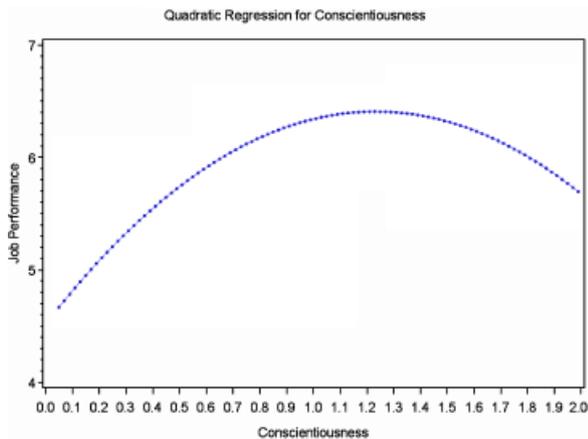
Figure 1. Graphic display of quadratic relationship between conscientiousness and job performance. Graph is based on all data (the two cross-validation samples combined).

The second and third ΔR rules permitted more relationships to be considered nonlinear. For quadratic relationships, conscientiousness was the sole scale showing a nonlinear relationship for the $\Delta R \geq .025$ decision rule. For the $\Delta R \geq .01$ decision rule, there were quad-ratic relationships for six scales: adaptability, conscientiousness, democratic, innovative, optimistic, and variety seeking. Cubic relationships were less frequent than quadratic relationships. For the $\Delta R \geq .025$ decision rule, one cubic relationship was found (variety seeking). For the $\Delta R \geq .01$, two cubic relationships were found (innovative and variety seeking). Thus, for the $\Delta R \geq .025$ decision rule, the hypothesis was supported for 30 of the 32 personality scales (quadratic: conscientiousness; cubic: variety seeking). Finally, for the $\Delta R \geq .01$ decision rule, the hypothesis was supported for 25 of the 32 personality scales (quadratic: adaptability, conscientiousness, democratic, innovative, optimistic, and variety seeking; cubic: innovative and variety seeking).

4. Discussion

Our analysis of the OPQ32i showed that nonlinear relationships between personality scales and job performance were uncommon and, when found, the effects were modest. The only OPQ32i scale that had a nonlinear relationship using the $\Delta R \geq .05$ decision rule was

conscientiousness and that raised the validity of the scale to only .088. A small number of scales showed nonlinear relationships for the $\Delta R \geq .025$ and $\Delta R \geq .01$ decision rules. Although one could generate post hoc explanations for the few nonlinear relationships we observed, we avoid post hoc explanations in this paper because the bulk of the findings are consistent with our hypothesis. However, it may be premature to generalize from this finding to all personality measures without considering limitations of the current study.

4.1. Limitations

One limitation of our study is that the OPQ32i is an ipsative measure. Although there is evidence that the ipsative version of the OPQ yields similar results to the normative version of the OPQ, greater confidence may be placed in the results when these findings are replicated with a nonipsative measure.

Another limitation applies to our study as well as any other study that uses personality scales. Unless a personality scale specifically taps 'derailers,' many personality scales used for selection may yield linear relationships because the items selected are only from the linear portion of a nonlinear curve. That is, statements reflecting the very high or very low ends of conscientiousness may not be included because they would show little variance in a personnel selection situation (e.g., when applying for a job, few would admit to being slothful, careless, or sluggish [on one hand], or micromanaging, compulsive, and obsessive [on the other hand]).

4.2. Future research

Although this research found little evidence for nonlinear relationships between personality scales and job performance, we encourage additional research on this topic for several reasons. First, the analyses in this paper are limited to one ipsative test, the OPQ32i. There may be factors associated with this measure, which limit the generalizability of these findings to other personality measures. Thus, future research should examine nonlinearity in other measures. Still, the OPQ has 32 scales that cover a very wide range of personality constructs. If one cannot find nonlinearity in this large set of personality constructs, it may be difficult to find replicable nonlinear relationships in other personality constructs.

Second, we encourage additional research because we located relatively few studies examining nonlinear relationships involving personality measures. Perhaps the studies we found were anomalies that do not reflect linear population relationships and were published because of the statistical significance of their findings. On the other hand, few researchers may look for nonlinear relationships and thus some nonlinear relationships may have yet to be uncovered. This uncertainty can be reduced if more researchers look for nonlinear relationships and report the findings regardless of their magnitude or statistical significance.

Third, this study examined job performance and did not examine job satisfaction or turnover. One may infer that overqualified employees will become dissatisfied with their jobs and this may harm productivity and increase the likelihood of turnover. Thus, future research should explore nonlinear relationships between personality constructs and both job satisfaction and turnover. On the other hand, Judge, Thoresen, and Bono (2001) have reported the typical correlation between job satisfaction and job performance to be positive ($\rho = .30$). Given that the current large sample research showed few nonlinear relationships with performance, some might question the likelihood that other research will find nonlinear relationships with satisfaction and turnover. As a related issue, our criterion was task performance. Future research might consider contextual measures of performance that might have nonlinear relationships with personality predictors.

Fourth, nonlinear relationships between personality and work-related criteria (e.g., performance, satisfaction, and turnover) should be examined with jobs of varying complexity. The sample members in this study were professionals in a financial services company. Many had graduate degrees. The work placed substantial cognitive demands on the incumbents. In high complexity jobs such as these, the correlation between job satisfaction and job performance can be expected to be much higher than in jobs of lower complexity (Judge *et al.*, 2001). Thus, although the relative lack of nonlinear relationships in our analysis for performance might generalize to a lack of nonlinear relationships in job satisfaction in this sample, this may be less true for lower complexity jobs.

Fifth, research on nonlinear relationships between personality and job performance might be conducted in the context of profile assessments. To the extent that there are nonlinear relationships, research should be directed to identifying the best approaches to incorporating these relationships when scoring profile assessments. To the extent that there are not nonlinear relationships between personality and job performance, one might question the appropriateness of profile assessments for applicant screening. We note that the OPQ32i test used in this research is not a profile assessment and thus our cautions concerning the use of profile assessments do not apply to the OPQ32i.

Sixth, large sample sizes should be used. The magnitudes of the nonlinear relationships found in this study were not large. Large sample sizes will be needed to estimate the magnitude and shape of the relationships accurately. Note that to the extent that nonlinear relationships vary by job content, job demands, or the situations in which the jobs are found, one should have adequate samples sizes within levels of such variables.

Seventh, theory should guide hypotheses concerning nonlinear relationships between personality and job performance. Theory development is needed to identify what combinations of predictors and jobs would make nonlinearity plausible. Theory is needed to help classify jobs according to their demands on personality-related attributes (e.g., interpersonal demands or need for attention to detail) and determine under which conditions (up to what point) is a personality characteristic related to performance. Currently, there is little personality theory that can inform hypotheses concerning nonlinearity.

5. Conclusion

There is little literature examining nonlinear relationships between personality and job performance. This study contributes to this literature with a large sample and extensive analyses. We find little support for nonlinear relationships between personality scales and job performance. When relationships were found, they did not dramatically improve prediction. Large sample studies and theory-based hypotheses concerning nonlinear relationships will be required to advance our knowledge in this area.

Note

1. The correlation is presented as an absolute value (i.e., negative correlations are presented as positive) because multiple *R* are always positive. To compute an incremental *R* over the zero order correlation, the zero-order correlation should be an absolute value. Signed zero-order correlations for the two samples combined are in Table 1.

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