Openness to experience, plasticity, and creativity: Exploring lower-order, high-order, and interactive effects*

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Abstract:
What are creative people like? Openness to experience is important to creativity, but little is known about plasticity, the higher-order factor that subsumes openness. College students (n = 189) completed measures of the Big Five and measures of creative cognition (fluency and quality of divergent thinking), everyday creative behaviors, creative achievement, and self-rated creativity. Latent variable models found broad effects of openness to experience and few effects of the other four domains. At the higher-order level, plasticity predicted higher scores on nearly all of the facets of creativity, and stability had several significant effects. For some creativity measures, plasticity and stability had opposing effects. Tests of latent interactions found no significant effects: plasticity and stability predict creatively independently, not jointly.
Keywords: Creativity; Openness to experience; Personality; Big Five; Plasticity

Abstract:

1. Introduction

If some people are more creative than other people, then what are creative people like? The study of personality is one of the oldest areas in the science of creativity (Batey & Furnham, 2006). In recent research, the Big Five model of personality structure has focused and organized this complex body of work (Feist, 1998). Openness to experience, one of the Big Five factors, is fundamental to creativity: it predicts creativity in a wide range of domains (e.g., arts, sciences, and humanities; Feist, 1998) and levels of analysis (e.g., creative thinking styles, goals, hobbies, and accomplishments; [Feist and Barron, 2003], [King et al., 1996], [Silvia et al., 2008] and [Wolfradt and Pretz, 2001]). The other four domains predict creativity less consistently, although some domains often appear as positive (e.g., extraversion) or negative (e.g., conscientiousness) correlates (Batey & Furnham, 2006).

The Big Five, however, are not the Biggest Five. Several researchers have argued that two traits—known as higher-order factors, meta-traits, or the Huge Two (Silvia et al., 2008)—subsume the five factors ([DeYoung, 2006] and [Digman, 1997]). *Plasticity*, composed of openness to experience and extraversion, reflects a tendency "to explore and engage flexibly with novelty, in both behavior and cognition" (DeYoung, 2006, p. 1138); *stability*, composed of agreeableness, conscientiousness, and emotional stability (neuroticism's lower pole), reflects a tendency "to maintain stability and avoid disruption in emotional, social, and motivational domains" (p. 1138).

Consistent with their interpretation, the Huge Two factors predict outcomes associated with behavioral variability, impulsiveness, and control. For example, people high in stability are lower in externalizing behaviors (DeYoung, Peterson, Séguin, & Tremblay, 2008), higher in conformity (DeYoung, Peterson, & Higgins, 2002), higher in morningness (DeYoung, Hasher, Djikic, Criger, & Peterson, 2007), and lower in divergent thinking (Silvia et al., 2008). People high in plasticity, in contrast, are higher in externalizing

* Researchers interested in reanalyzing the data can obtain the input and data files from the first author.

behaviors (DeYoung et al., 2008), lower in conformity (DeYoung et al., 2002), lower in morningness (DeYoung et al., 2007), and higher in divergent thinking (Silvia et al., 2008).

Plasticity and stability often have opposite effects, so an intriguing question is whether they interact. For creativity, it seems likely that plasticity and stability jointly predict some creative outcomes. Feist's (1998) meta-analysis found that creative people were characterized by high levels of plasticity traits (e.g., higher openness, impulsiveness, and novelty seeking) and by low levels of stability traits (e.g., lower conscientiousness and agreeableness). It is possible that different combinations of plasticity and stability predict different levels, kinds, or patterns of creativity.

Researchers rarely consider interactions between latent predictors—not because the interactions are uninteresting, but because common software and methods make it hard to do so. Nevertheless, interactions between latent variables—even higher-order variables in a hierarchical model—can be estimated using maximum likelihood and finite mixture extensions of standard latent variable models. The latent moderated structural equations (LMS) approach (Klein & Moosbrugger, 2000) directly estimates an interaction effect; it does not require researchers to compute residual terms, apply nonlinear weights, or multiply indicators. The LMS method has fared well in simulations ([Little et al., 2006] and [Marsh et al., 2004]), and it is easy to implement with advanced software.

In the present research, we explored lower-order, higher-order, and interactive effects of personality on creativity. At the lower-order level, we appraised the role of the Big Five in predicting creativity. At the higher-order level, we appraised the role of plasticity and stability in predicting creativity. Finally, we examined latent interactions between plasticity and stability, an issue that has not been examined thus far in the Huge Two literature.

We assessed creativity using a broad range of constructs. There is no single sense in which people are creative, so it is important for creativity researchers to capture some of the breadth of creativity. First, we measured divergent thinking, which can be viewed as a creative cognitive style, creative potential, or the ability to generate original ideas (Silvia et al., 2008). Second, we measured everyday creative behaviors, which reflect how often people choose everyday activities that afford creativity (Richards, 2007). Third, we measured lifetime creative achievements (Carson et al., 2005), which captures people's observable, high-level accomplishments in diverse domains. Finally, we measured self-ratings of creativity in different areas (Kaufman & Baer, 2004). People's beliefs about their creativity are clearly different from their creative traits, abilities, and accomplishments, but people's theories of what they are like are interesting in their own right (Furnham, Zhang, & Chamorro-Premuzic, 2006).

2. Method

2.1. Participants

Our sample consisted of 189 students—150 women and 39 men—enrolled in General Psychology at the University of North Carolina at Greensboro. (A total of 202 people participated, but some people were excluded due to extensive missing data and limited language proficiency.) The sample was primarily Caucasian (69%) and African–American (26%), based on self-reported ethnicity.

2.2. Procedure

People participated in groups of 2–10. After completing three divergent thinking tasks, people completed a questionnaire that assessed demographics and individual differences.

2.2.1. Big Five scales

The five domains were measured with four scales: the 60-item Five Factor Inventory (FFI; Costa & McCrae, 1992), a 50-item scale taken from the International Personality Item Pool, and two 10-item scales ([Gosling et al., 2003] and [Rammstedt and John, 2007]). People responded using a 1–5 response format.

2.2.2. Divergent thinking

People completed three divergent thinking tasks: they were asked to generate unusual uses for a brick, a knife, and a box. We instructed them to try to come up with "unusual, creative, and uncommon" uses. The tasks were timed at 3 min each. After the task, people were asked to read their responses and to circle the two that they thought were the most creative ones. Divergent thinking tasks provide two scores: fluency (the number of responses) and creativity (the quality of the responses). A fluency score was gained by simply counting the number of responses. A creativity score was gained by having four raters independently score each response for creativity, using a 1–5 scale. The responses were first entered into a spreadsheet and sorted alphabetically within each task, so raters were unaware of who generated the response, whether the response was picked as a "top two" response, the person's other responses, and the person's questionnaire data. The creativity score is based on the ratings for people's "top two" responses, the two that people saw as their best. The full rationale, details, instructions, and scoring methods are described by Silvia et al. (2008).

2.2.3. Everyday creativity

We measured everyday creativity with the 28-item Creative Behavior Inventory (CBI; Dollinger, 2007). People rate how often, in their "adolescent and adult life," they have done common creative activities, such as *wrote a short story*, *designed and made a costume*, *wrote the lyrics to a song*, and *built a hanging mobile*. People use a four-point scale: A = *Never did this*, B = *Did this once or twice*, C = *Did this 3–5 times*, and D = *More than five times*. The items capture common domains of creative action, such as the arts, crafts, music, and creative writing. For most of the items, people are instructed not to count behaviors done to meet a course requirement.

2.2.4. Creative achievement

We measured creative achievement with the Creative Achievement Questionnaire (CAQ), a 10-domain self-report scale (Carson et al., 2005). For each creative domain, people respond to items that emphasize objective and observable accomplishments. Because the scale captures a broad range of achievement, most people have low scores (Silvia, Kaufman, & Pretz, in press). Following Hirsh and Peterson (2008), we analyzed a log-transformed CAQ total score.

2.2.5. Creative self-concepts

We measured people's creative self-concepts—their views of themselves as creative people—with the nine-item Creativity Scale for Different Domains (CSDD; Kaufman & Baer, 2004). People report their level of creativity in eight areas, such as "How creative are you in the area of art?" and "How creative are you in the area of interpersonal communication?" People respond to each item on a 1–5 scale (endpoints: *Not at all creative*, *Very creative*). This scale yields four scores. There are three domains—a math–science factor, an empathy–interpersonal factor, and a hands-on creativity factor—and a global self-concept question ("How creative would you say you are in general?"). This scale is analyzed as a multivariate model with four outcomes.

3. Results

3.1. Model specification and analytic method

We used Mplus 5.2 for all models, which were estimated with full-information maximum likelihood with robust standard errors (MLR). Very few observations were missing; most analyses had complete cases. Given the many effects, we focus on effect sizes, which are reported in Table 1. Readers interested in the dirty details or in running alternate models can obtain the raw data and input files from the first author.

Table 1.
Relationships between the Big Five, the Huge Two, and creativity.

	N	**E**	**O**	**A**	**C**	**Stability**	**Plasticity**
Divergent thinking: fluency	.108	−.020	.246 *	−.061	.145	−.072	.281 *
Divergent thinking: creativity	.093	−.113	.268 *	.213	−.201	−.112	.217

	N	E	O	A	C	Stability	Plasticity
Everyday creative behaviors (CBI scale)	.108	−.023	.624 *	−.023	−.017	−.233 *	.756 *
Creative achievement (CAQ scale)	.021	−.024	.481 *	−.009	−.084	−.210	.617 *
Global creativity (CSDD)	−.016	−.067	.655 *	.116	.013	.039	.741 *
Hands-on creativity (CSDD)	−.014	−.053	.528 *	.072	.029	.034	.586 *
Empathic–interpersonal creativity (CSDD)	−.166 *	.113	.422 *	−.082	.267 *	.295 *	.548 *
Math–science creativity (CSDD)	−.291 *	−.012	.059	−.015	.072	.309 *	.052

Note: n = 189. The coefficients are standardized regression weights, which represent effect sizes.
* Coefficients with an asterisk are significant at the 5% level.

We modeled divergent-thinking creativity scores as a higher-order creativity factor, which had a variance fixed to 1 and was indicated by lower-order brick, knife, and box factors. These, in turn, had four indicators, which were the raters' scores; the paths to the second rater were fixed to 1. This model fit well (CFI = .97, RMSEA = .049, SRMR = .045). Divergent thinking fluency scores were modeled as a latent variable with three indicators; the variance was fixed to 1.

We modeled the Big Five factors by specifying the four scale scores as indicators; for each factor, the path to the NEO-FFI scores was fixed to 1. A CFA model in which the five factors covaried freely with each other fit acceptably but somewhat weakly (CFI = .90, RMSEA = .086, SRMR = .083). The higher-order plasticity factor was specified by the latent openness and extraversion factors. These two paths were constrained to be equal. (This constraint reduces model fit somewhat—the indicators are not tau-equivalent—but it is necessary for empirical identification.) The stability factor was specified by the latent agreeableness, conscientiousness, and neuroticism factors. The variances of plasticity and stability were fixed to 1, and the two variables were allowed to covary freely. Model fit was again somewhat weak (CFI = .90, RMSEA = .084, SRMR = .093).[1]

3.2. Big Five and creativity

How did the Big Five domains predict creativity? We estimated a series of models that evaluated the effects of the Big Five on the markers of creativity. Table 1 reports the effects; except for the CSDD scales, which were estimated in a multivariate model, each outcome was analyzed separately.[2]

Openness to experience emerged as the strongest and most consistent predictor: it significantly predicted divergent thinking (both quantity and quality), everyday creativity, creative achievement, and all of the creative self-concept domains (except for the math–science domain). Most of the effect sizes were large (see Table 1). The other personality factors had modest and scattered effects, mostly for the creative self-concept measures.

3.3. Huge Two and creativity

How did the higher-order factors predict creativity? Did plasticity and stability exert stronger or weaker effects than the lower-order Big Five? Table 1 shows the effects; as before, each outcome (except for the CSDD scales) was analyzed separately.

Plasticity had broad relations with creativity: it predicted nearly all of the facets of creativity. Apart from a marginal effect for divergent-thinking creativity and no effect for the math–science self-concept domain, plasticity's effects were all statistically significant and at least moderate in size. Stability, too, had several significant and notable effects. Stability's lower-order domains—agreeableness, conscientiousness, and neuroticism—generally did not predict creativity, but stability had larger effects and several significant effects.

For everyday creativity and creative achievement, stability and plasticity had opposing effects. The higher-order factors thus had some relationships that were not apparent at the lower-order level.

3.4. Exploring latent interactions

Our final set of analyses explored interactions between plasticity and stability. As noted earlier, the LMS method directly estimates interactions between latent variables (Klein & Moosbrugger, 2000), including higher-order latent variables. Our analyses found no evidence for latent interactions: stability and flexibility did not significantly interact for any of the outcomes. (Standardized effects are unavailable for these models.) It thus appears that the Huge Two factors exert independent main effects, but not joint effects, on creativity.

4. General discussion

The present research explored relations between personality and creativity at two levels: the widely-studied Big Five domains and the relatively new Huge Two factors. At the level of the Big Five, openness to experience was the clear leader: as in past work, it had broad effects across essentially all of the facets of creativity, and its effect sizes were mostly moderate or large in size. Openness deserves its reputation as the factor most related to creativity, but researchers have speculated about what lies beyond openness. Batey and Furnham (2006), for example, note that many studies have found positive effects of extraversion and negative effects of conscientiousness. In this study, openness swamped the other factors: extraversion and conscientiousness had small effects. Their few significant ones were primarily for self-rated creativity—people's self-concepts as creative people in different areas. For creative thinking and behavior—divergent thinking and the CBI and CAQ scales—openness was essentially the only predictor of the five factors.

Only one marker of creativity—describing oneself as creative in the math–science domain—was not predicted by openness. Kaufman and Baer (2004) found that this domain stuck out from the other domains they measured, and later work found that the math–science domain was the only one that failed to load on a global creative self-concept factor (Kaufman et al., in press). This consistent pattern likely comes from people's stereotypes of math–science fields as unrelated to creativity, which is a barrier to fostering interest in these occupations (Charyton, Jagacinski, & Merrill, 2008).

At the level of the Huge Two, both plasticity and stability explained variance in creativity. Like its lower-order openness factor, plasticity predicted essentially every facet of creativity, although the effect sizes were lower for divergent thinking than for the other measures. Stability, too, predicted several facets of creativity. Some of its relationships were positive, such as self-ratings of creativity in some domains; other relationships were negative, such as everyday creative behavior and creative achievement (a marginal effect). These latter effects are particularly intriguing: they represent instances where plasticity and stability have opposing effects. Finally, we explored whether the Huge Two factors interactively predict creativity. Given their patterns of main effects—such as opposing effects on everyday creative behaviors—it seems likely that the two factors could interact. For example, people high in plasticity but low in stability may have especially high levels of creativity, a pattern consistent with Feist's (1998) meta-analysis. Nevertheless, no evidence for latent interactions appeared—none of the interaction models found a significant effect, so it appears that plasticity and stability exert independent effects on these facets of creativity.

Because openness is the dominant personality factor in creativity, it would be worth expanding and clarifying the meaning of openness to experience. Our study measured openness with four scales, some of which come from different traditions and propose different meanings of openness. The latent variable thus pools these meanings, losing any facets that might be worth preserving. In particular, DeYoung, Quilty, and Peterson (2007) have proposed that openness to experience has two primary aspects—openness (an imaginative, creative, and aesthetic aspect) and intellect (a thinking and reasoning aspect)—and they have developed scales to separate them. Just as the present research looked at the abstract factors above openness to experience, future research should look at the specific factors below it.

A more fine-grained analysis would also clarify the roles of the other factors in creativity. Extraversion, for example, plays a complex role. Batey and Furnham (2006) argued that extraversion predicts only the quantity, not the quality, of ideas. In his meta-analysis, Feist (1998) found that the confident, assertive facet of extraversion predicted creative accomplishment but the gregarious, sociable facet did not. In our study, we found few effects of extraversion but widespread effects of plasticity, its higher-order factor. As with openness, looking both above and below extraversion would illuminate which components of the trait predict creativity.

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1 Although model fit was weak, we decided against model tinkering. Common patches—such as correlating residuals or adding cross-loadings—add latent variables to the model and shift the substantive factors' meanings in unknown ways (Skrondal & Rabe-Hesketh, 2004). Both the Big Five and the Huge Two are *a priori* models, so it is worth testing these *a priori* predictions. Exploring the source of misfit revealed that removing either or both of the brief scales did not appreciably enhance model fit. According to modification indices, the largest source of misfit concerned a possible cross-loading of the NEO-FFI's extraversion score on the latent agreeableness factor. Because this cross-loading would cross the higher-order variables, specifying it would have complex influences on the estimation of interactions between stability and plasticity. We thus retained the simpler, original CFA.

[2] The regression coefficients were similar to the simple correlations between the latent Big Five traits and the outcomes. The most salient difference involved extraversion: its correlations were slightly positive with each outcome, but its regression effects were slightly negative. This pattern, taken together with the positive correlation between extraversion and openness, is consistent with the strong effects of plasticity, which pools extraversion and openness.