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Opening up Openness to Experience: A Four-Factor Model and Relations to Creative Achievement in the Arts and Sciences

ABSTRACT

Openness to experience is the broadest personality domain of the Big Five, including a mix of traits relating to intellectual curiosity, intellectual interests, perceived intelligence, imagination, creativity, artistic and aesthetic interests, emotional and fantasy richness, and unconventionality. Likewise, creative achievement is a broad construct, comprising creativity across the arts and sciences. The aim of this study was to clarify the relationship between openness to experience and creative achievement. Toward this aim, I factor analyzed a battery of tests of cognitive ability, working memory, Intellect, Openness, affect, and intuition among a sample of English Sixth Form students (N = 146). Four factors were revealed: explicit cognitive ability, intellectual engagement, affective engagement, and aesthetic engagement. In line with dual-process theory, each of these four factors showed differential relations with personality, impulsivity, and creative achievement. Affective engagement and aesthetic engagement were associated with creative achievement in the arts, whereas explicit cognitive ability and intellectual engagement were associated with creative achievement in the sciences. The results suggest that the Intellectual and Openness aspects of the broader openness to experience personality domain are related to different modes of information processing and predict different forms of creative achievement.

Keywords: openness to experience, openness, intellect, intelligence, implicit cognition, arts, sciences, creative achievement, dual-process theory.

Within the Five-Factor taxonomy of personality traits, openness to experience is the broadest domain, including a mix of traits relating to intellectual curiosity, intellectual interests, perceived intelligence, imagination, creativity, artistic and aesthetic interests, emotional and fantasy richness, and unconventionality (Batey & Furnham, 2006; Carson, Peterson, & Higgins, 2003; DeYoung, Peterson, & Higgins, 2001; Feist, 1998; Feist & Barron, 2003; Hirsh, DeYoung, & Peterson, 2009; King, Walker, & Broyles, 1996; McCrae, 1987, Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009; Silvia et al., 2008). While the unifying theme of this broad personality domain is cognitive exploration (DeYoung, in press), recent converging evidence suggests that cognitive engagement with abstract and semantic information primarily through reasoning (Intellect) can be

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separated from cognitive engagement with sensory and perceptual information, at the psychometric, neurological, and genetic levels of analysis (DeYoung, Grazioplene, & Peterson, 2012; DeYoung, Peterson, & Higgins, 2005; DeYoung, Quilty, & Peterson, 2007; DeYoung, Shamosh, Green, Braver, & Gray, 2009; DeYoung et al., 2010; Jang, Livesley, Angleitner, Riemann, & Vernon, 2002; Johnson, 1994; Mussel, Carolin, Gelleri, & Schuler, 2011; Wainwright, Wright, Luciano, Geffen, & Martin, 2008).

Distinguishing Openness from Intellect may help clarify the nature of the association of personality with creativity. While studies show medium and large effects of openness to experience on measures of divergent thinking and creative achievement (Carson, Peterson, & Higgins, 2005; King, Walker, & Broyles, 1996; McCrae, 1987; Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009), Nusbaum and Silvia (2011) found that Openness significantly predicted creative achievement but not fluid reasoning, whereas Intellect predicted fluid reasoning but not creative achievement. They did not, however, differentiate different domains of creative achievement. It is quite likely that both Openness and Intellect show different relations to creative achievement in the arts and sciences. The aim of this study was to break down the openness to experience domain into its various factors and investigate relations with creative achievement across various scientific and artistic domains. Predictions are informed by dual-process theory.

DUAL-PROCESS THEORY

In recent years, dual-process theories of cognition have become increasingly required for explaining cognitive, personality, and social processes (e.g., Allen & Thomas, 2011; Epstein, 1994, 2003; Evans, 2008, 2010; Evans & Frankish, 2009; Gilhooly & Murphy, 2005; Gilhooly & Fioratou, 2009; Kahneman, 2011; Kahneman & Frederick, 2002, 2005; Lieberman, 2003, 2007; Lin & Lien, 2013; Stanovich, 2004, 2009, 2011; Stanovich & West, 2000; Strack & Deutsch, 2004; Kaufman, 2009a, 2011—but also see Keren and Schul (2009), Kruglanski and Gigerenzer (2011), and Osman (2004)). Although the precise specifications of the theories differ, there are some unifying themes (Evans, 2008; Stanovich & Toplak, 2012).

"Type 1" processes (Evans, 2008) consist of a "grab-bag" of different (and not necessarily correlated) processes, including affect, intuition, evolutionary evolved modules, implicit learning, latent inhibition, and the firing of learned associations (Stanovich & Toplak, 2012). According to Stanovich and Toplak (2012), the defining feature of Type 1 processing is *autonomy:* "the execution of Type 1 processes is mandatory when their triggering stimuli are encountered, and they are not dependent on input from high-level control systems" (p. 7). In contrast, Stanovich argues that the defining feature of "Type 2" processes is the ability to sustain decoupled representations—in other words, to sustain thinking while keeping real-world representations separate from cognitive representations. According to Stanovich and Toplak (2012), "decoupling processes enable one to distance oneself from representations of the world so that they can be reflected upon and potentially improved (p. 10)." What Stanovich refers to as cognitive decoupling is heavily tapped into by traditional psychometric measures of intelligence and working memory (Conway, Cowan, Bunting, Therriault,

& Minkoff, 2002; Conway, Jarrold, Kane, Miyake, & Towse, 2008; Engle, 2002; Kane & Engle, 2002; Kaufman, DeYoung, Gray, Brown, & Mackintosh, 2009).

Although scores on traditional measures of intelligence correlate with openness to experience around .3 (Ackerman & Heggestad, 1997; DeYoung, 2011), psychometric intelligence and working memory are more strongly related to Intellect than Openness (DeYoung, Quilty, Peterson, & Gray, 2013; DeYoung et al., 2005; Moutafi, Furnham, & Crump, 2006). In fact, when Intellect and Openness are used as simultaneous predictors, only Intellect is related to psychometric intelligence (DeYoung, 2011; DeYoung et al., in press). In one sample of 104 healthy adults, Intellect but not Openness was related to the ability to update working memory representations and the brain areas associated with that activity in the left lateral anterior prefrontal cortex and posterior medial frontal cortex (DeYoung et al., 2009). Therefore, Type 2 processes are more strongly related to Intellect than Openness.

What cognitive mechanisms are associated with Openness? While both Peterson, Smith, and Carson (2002) and Peterson and Carson (2000) found a significant relationship between reduced latent inhibition (Lubow, 1989; Lubow & Weiner, 2009) and openness to experience, Kaufman (2009a,b) found that reduced latent inhibition was only significantly correlated with the affective/experiential aspects of the domain. In addition, using structural equation modeling, Kaufman (2009a) and Kaufman et al. (2010) found a double dissociation between implicit learning and working memory: Implicit learning was related to Openness but not Intellect, whereas working memory was related to Intellect but not Openness. Taken together, these results suggest that openness to experience can be situated within dual-process theory, with Intellect being more strongly associated with Type 2 cognitive processing relative to Type 1 cognitive processing and Openness being more strongly associated with Type 1 cognitive processing relative to Type 2 cognitive processing.

CREATIVE ACHIEVEMENT

Carson, Peterson, and Higgins (2003) found that eminent creative achievers among a high-IQ sample of college students were seven times more likely to have a reduced rather than enhanced latent inhibition (LI). The researchers did not, however, differentiate different domains of creative achievement. Kaufman (2009a) found that reduced latent inhibition was significantly correlated with creative achievement in the arts, but not the sciences. Therefore, it is expected that creative achievement in the arts will show stronger relations to Openness than Intellect, whereas creative achievement in the sciences will show stronger relations to Openness than Intellect. Furthermore, Openness is expected to relate to personality traits associated with Type 1 processing, whereas Intellect is expected to relate to personality traits associated with Type 2 processing. I test these predictions in a sample of English schoolchildren using a large battery of tests of cognitive ability, working memory, personality, affect, and intuition.

PARTICIPANTS

One hundred forty-six participants (44 male adolescents, 102 female adolescents) were included in the analyses presented here. These participants were part of a larger

study that involved 177 participants and formed the core of the author's doctoral dissertation (Kaufman, 2009a).[1] Out of the total sample of 177, the 146 participants included in this analysis had no missing scores on tests that loaded on Openness or Intellect (see Results section for a list of the tests that were entered into the Openness/Intellect factor analysis). All participants were aged 16–18 years, and attended a selective Sixth Form College (which takes high-achieving students who are in their last 2 years of secondary education) in Cambridge, England. Participants engaged in three separate 1.5-h testing sessions in groups at PC desktop terminals. To minimize confounding factors, whenever possible, all participants received all tests in the same order. Each participant earned £20 (about $31.44) for their participation in the three testing sessions (which were part of a larger study).

MEASURES

COGNITIVE ABILITY

Fluid reasoning. The Raven's Advanced Progressive Matrices Test, Set II (RAPM; Raven, Raven, & Court, 1998) was used as a measure of fluid reasoning (α = .81, N = 177). Each item consists of a 3 × 3 matrix of geometric patterns with the bottom right pattern missing. The participants' task is to select the option that correctly completes the matrix. Descriptive statistics of the RAPM (M = 21.7, SD = 5.4, *Range* = 7–33) suggests the current sample is comparable in IQ to the average undergraduate student (Raven et al., 1998).

Verbal reasoning. The verbal reasoning section of the Differential Aptitudes Test (The Psychological Corporation, 1995) was administered to each participant as a measure of verbal reasoning ability (M = 24.5, SD = 5.9, *Range* = 9–38, α = .78 based on N = 177). Each problem consisted of a sentence with two words missing, and participants chose a pair of words from the answer options that were related to the words in the sentence in some way. After two practice items, participants had 15 min to complete 40 problems.

Mental rotation ability. The Mental Rotations Test, Set A (MRT-A; Vandenberg & Kruse, 1978) contains 24 problems and measures mental rotation ability (M = 13.1, SD = 5.3, *Range* = 2–24, α = .85 based on N = 177). Each problem in the MRT-A shows a three-dimensional target figure paired with four choice figures, two of which are rotated versions of the target figure. To score a point, both rotated versions must be identified.

Working memory. An automated version of The Operation Span task (Ospan; Turner & Engle, 1989) was used as a measure of working memory (M = 44, SD = 5.3, *Range* = 2–24, α across all set sizes = .73 based on N = 177). The task requires participants to store a series of unrelated words in memory while simultaneously solving a series of simple math operations, such as "Is (9/3) − 1 = 1?" After participants selected the answer, they were presented with a word (e.g., DOG) to

[1] Although three other papers have already been published using this dataset (Kaufman, 2009b; Kaufman et al., 2009, 2010), this paper is the only one that (a) focuses on the Openness/Intellect domain, (b) includes measures of creative achievement, (c) includes analysis of all Big Five aspects, and (d) includes this precise combination of variables.

recall. Then participants moved onto the next operation word string. This procedure was repeated until the end of a set, which varied from two to six items in length. Participants were then prompted to recall all the words from the past set in the same order in which they were presented by typing each word into a box, and using the up and down arrow keys to cycle through the boxes. Total Ospan score is the sum of all correctly recalled words in their correct positions. The number of operation word pairs in a set was varied between two, three, four, five, and six with three sets of each. Scores therefore ranged from 0 to 60. Prior research has demonstrated significant correlations between Operation Span and *g* (e.g., Unsworth & Engle, 2005) and a high loading of Operation Span on a general working memory factor (Kane et al., 2004).

PERSONALITY

The Big Five Aspect Scales (BFAS). The Big Five Aspect Scales assess the personality traits of the Five-Factor model or Big Five taxonomy (DeYoung et al., 2007). In the BFAS, each of the five major domains is broken down into two sub-traits that capture key aspects of the domain. Reliability of the BFAS scales can be found in Tables 4 and 5.

NEO-PI-R. The Openness to Experience scale of the NEO-PI-R was administered. The Openness to Experience scale is divided into six subscales or "facets" [descriptions according to Piedmont (1998)]: Openness to Aesthetics (deep appreciation for art and beauty), Openness to Action (preference for novelty and variety), Openness to Fantasy (vivid imagination and active fantasy life), Openness to Feelings (receptivity to one's own inner feelings and emotions), Openness to Ideas (active pursuit of intellectual interests for their own sake and a willingness to consider new, perhaps unconventional ideas), and Openness to Values (readiness to reexamine social, political, and religious values). The Aesthetics ($\alpha = .81$, $N = 177$), Fantasy ($\alpha = .78$, $N = 177$), Feelings ($\alpha = .78$, $N = 177$), and Actions ($\alpha = .61$, $N = 177$) facets are good markers of the Openness aspect of the domain, whereas the Ideas facet ($\alpha = .80$, $N = 177$) is a good marker of Intellect (DeYoung et al., 2007). Therefore, only these five facets were included in the analysis presented here.

Rational–Experiential Inventory (REI). The Rational–Experiential Inventory was used to measure both an intuitive and a rational cognitive style, which consist of the two different aspects of Epstein's Rational–Experiential model of personality (Epstein, Pacini, & Norris, 1998; Pacini & Epstein, 1999). The REI is a 20-item questionnaire consisting two subscales—the rational and experiential inventories. The rational inventory attempts to quantify an individual's ability and preference for relying on logic and analysis in making decisions and solving problems. This scale is based on the Need for Cognition Scale, which correlates very highly with the Ideas facet of the NEO-PI-R ($r = .78$; Cacioppo, Petty, Feinstein, & Jarvis, 1996). The REI rational favorability subscale ($\alpha = .82$, $N = 177$) was used to provide another marker of Intellect. The experiential scale measures faith in intuition and a preference for using gut feelings, intuitions, and emotions to make decisions (Kaufman, 2009b; Pretz & Totz, 2007), and was used as a marker of Openness ($\alpha = .88$, $N = 177$).

Myers-Briggs Type Indicator (MBTI). The intuition/sensation (α = .86, N = 177) and thinking/feeling scales (α = .88, N = 177) of the MBTI (Myers, McCaulley, Quenk, & Hammer, 1998) were administered as measures of an affective and intuitive cognitive style. In recent years, researchers have found that the MBTI Intuition scale measures a holistic form of intuition and is related to implicit cognitive processing (Kaufman, 2009b; Pretz & Totz, 2007). On the MBTI, "Intuitive" individuals are described as concentrating on patterns and possibilities rather than concrete details, whereas a "sensing" person is more concerned with details and facts than an intuitive person. "Feeling" individuals are described as making decisions based on feelings and compassion whereas "Thinking" individuals tend to rely more on logic and rules in interacting with people and making decisions, being more concerned with the truth than social sensitivity. For the purposes of this study, the Intuition scale was scored as a continuous dimension ranging from low (sensation) to high (intuition). Likewise the Feeling scale was scored from low (thinking) to high (feeling).

The UPPS impulsivity scale. The UPPS Impulsivity Scale (α = .77, N = 177) was derived from factor analysis of a large number of scales commonly used to measure impulsivity-related constructs (Whiteside & Lynam, 2001). The UPPS consists of four subscales: Urgency, (lack of) Premeditation, (lack of) Perseverance, and Sensation Seeking. According to Whiteside, Lynam, Miller and Reynolds (2005, p. 561), urgency "refers to the tendency to engage in impulsive behaviors under conditions of negative affect despite the potentially harmful longer-term consequences", (lack of) Premeditation "refers to a difficulty in thinking and reflecting on the consequences of an act before engaging in that act", (lack of) Perseverance refers to both "an individual's inability to remain focused on a task that may be boring or difficult", and "difficulty completing projects and working under conditions that require resistance to distracting stimuli", and Sensation Seeking is described as reflecting "a tendency to enjoy and pursue activities that are exciting and an openness to trying new experiences that may be dangerous." Reliability of each UPPS subscale can be found in Table 6.

CREATIVE ACHIEVEMENT

Creative Achievement Questionnaire (CAQ; Carson et al., 2005). The CAQ is a measure of self-reported lifetime creative accomplishment in the arts and sciences. The CAQ has demonstrated good test-retest reliability, as well as good convergent, discriminant, and predictive validity (Carson et al., 2003). Participants received a computerized version of the CAQ, where they indicated their achievements in the following 10 separate domains of creative accomplishment: Architecture, Domestic Arts, Visual Art, Music, Theater/Film, Dance, Inventions, Scientific Discovery, and Humor. Participants received a sum of the weighted scores for each domain, and all of the domain scores were summed to yield a total creative achievement score. The mean CAQ score of all participants who took the CAQ (N = 177) is 16.4 (*SD* = 13.2, minimum = 0, maximum = 74), which is close to the mean scores found among a sample of Harvard undergraduate students (Carson et al., 2005).

This number makes sense considering the current sample also consists of high-achieving students. Consistent with prior theory and research (Carson et al., 2005; Eysenck, 1995; Simonton, 1999, 2005, 2010), CAQ scores were not normally distributed, but were skewed to the right, with 87% of the participants obtaining a total CAQ score of less than 29 (Figure 1). Indeed, this finding relates to one of Carson et al.'s (2005) underlying assumptions about the nature of creative achievement: "Fewer individuals attain higher levels of achievement. The CAQ was therefore designed so that the levels of achievement acknowledged by the fewest individuals received the most weight (p. 39)". Reliability is not reported as CAQ does not get scored in a way that allows for a sensible internal reliability measure (Silvia, Wigert, Reiter-Palmon, & Kaufman, 2012).

MISSING VALUES

Due to computer error, values were missing for 11 participants for the test of abstract perceptual reasoning, for which data from the other two markers of explicit cognitive ability were used to impute the missing scores using expectation-maximization.

RESULTS

TWO-FACTOR SOLUTION

Table 1 shows the two-factor solution using Principal Axis Factoring with Oblimin rotation. I included in the factor analysis all measures of cognitive ability, working memory, and self-report measures of Openness, Intellect, intuition, and affect. The first factor is clearly "Intellect", with loadings from self-report measures of Intellect, cognitive ability, and working memory. The second factor is clearly "Openness", with loadings from self-report measures of Openness, intuition, and affect. In addition, the correlation between the Intellect factor and the Openness factor was only .16, further supporting the distinction between the two factors.

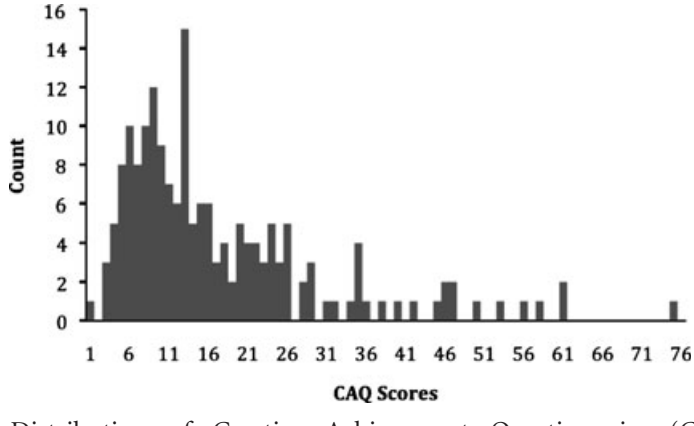

FIGURE 1. Distribution of Creative Achievement Questionnaire (CAQ) scores (N = 177).

TABLE 1. Two-factor Model of Openness to Experience (N = 146) using Principal Axis Factoring with Direct Oblimin Rotation

Measure	Intellect	Openness
NEO ideas	**.76**	**.42**
REI rational	**.76**	.26
BFAS intellect	**.74**	.22
Fluid reasoning	**.63**	.04
Verbal reasoning	**.60**	.20
Mental rotation ability	**.54**	−.05
Working memory	**.41**	.20
BFAS openness	.23	**.79**
NEO aesthetics	.24	**.76**
NEO feeling	.15	**.68**
NEO fantasy	.25	**.52**
NEO action	.16	**.47**
MBTI intuition	.28	**.46**
MBTI feeling	−.36	**.45**
REI experiential	−.23	**.40**

Note. Factor loadings over .4 are given in bold. λ1 (Intellect) = 4.6 (30.41% Variance), λ2 (Openness) = 2.75 (18.33% Variance). Total variance explained: 48.8%. The structure matrix is presented in this table.

FOUR-FACTOR SOLUTION

To get a better grasp on the structure of the correlation matrix I followed Goldberg's (2006) "Bass-Ackwards" methodology and developed the hierarchical factor structure from the top down. This technique involves calculating the factor scores of multiple rotated factor solutions, starting with a one-factor solution, proceeding to two- and three-factor solutions, etc., and ending with a solution where the factors are still interpretable. Then the correlations among the factor scores from adjoining levels are graphically represented as path coefficients in a hierarchical structure. Research has found that this technique is useful in clarifying the relationship among self-described personality-related adjectives, self-reported dissociative experiences, eating habits and food preferences, musical behaviors and experiences, and musical preferences (Dunn, de Ruyter, & Bouwhuis, 2011; Goldberg, 2006).

This technique has a number of advantages for the purpose of this study. First, it allows for a visual representation of factors that are independent of all factors at other levels. Second, the technique helps clarify the core components of each factor at each level. Third, this technique allows for a top-down exploration of the structure of the Openness/Intellect domain without the need to commit in advance to the optimal number of factors to extract and rotate. I can simply go down the hierarchy until I reach a level at which no new interesting factors emerge (Goldberg, 2006). This has

advantages over a confirmatory factor analysis as the number of expected cross-loadings would make it difficult to specify an adequate a priori model.

The Bass-Ackwards analysis suggested that four levels were sufficient to meaningfully account for the covariance among all the tests (Figure 2). Therefore, I present analyses in this article using factor scores generated from the Four-Factor solutions.

Table 2 shows the loadings of all the tests on the four factors. Altogether, the four factors explained 64.24% of the total variance among all the tests. Loading on the first factor are the three tests of intellectual engagement: REI Rational Favorability, NEO Ideas, and BFAS Intellect. Therefore, I labeled this factor "Intellectual Engagement", to distinguish itself from the ability aspect of Intellect. The second factor had high loadings from NEO Feeling, MBTI Feeling, and REI Experiential. I labeled this factor "Affective Engagement" due to the affect-laden nature of the tests that loaded the highest on this factor. Loading on the third factor were all of the measures of cognitive ability and to a lesser extent the measures of Intellectual Engagement. The measure with the highest loading on this factor is the Ravens Advanced Progressive Matrices, which prior research has shown to be one of the best markers of *g* (Lohman, 2001). As all the tests that have their primary loading on this factor relate to explicit, goal-directed, intentional forms of cognition, I labeled this factor "Explicit Cognitive Ability". Finally, the three highest loadings on the fourth factor were BFAS Openness, NEO Aesthetics, and MBTI Intuition. I labeled this factor "Aesthetic Engagement", because the tests that loaded the highest on this factor relate an appreciation of fantasy, imagination, aesthetics, and sensations.

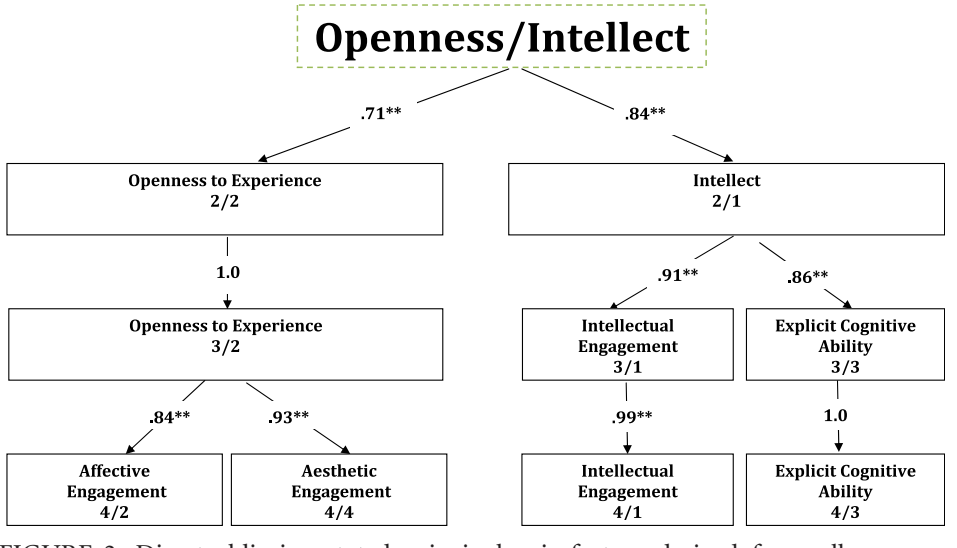

FIGURE 2. Direct-oblimin-rotated principal axis factors derived from all measures of cognitive ability, working memory, and self-reported measures of Intellect, Openness, intuition, and affect (N = 146) (Openness/Intellect, first unrotated principal axis factor).

TABLE 2. Four-Factor Model of Openness to Experience (N = 146) Using Principal Axis Factoring with Direct Oblimin Rotation

Measure	Intellect		Openness	
	Intellectual engagement	Explicit cognitive ability	Affective engagement	Aesthetic engagement
REI rational favorability	**.88**	**.44**	−.03	.31
NEO ideas	**.87**	**.47**	.12	**.46**
BFAS intellect	**.81**	**.43**	−.09	.30
MBTI feeling	−.29	−.14	**.67**	.29
NEO feeling	.31	.12	**.65**	**.55**
REI experiential	−.05	−.19	**.59**	.21
Fluid reasoning	.37	**.76**	−.16	.16
Verbal reasoning	.36	**.70**	−.06	.34
Mental rotation ability	.28	**.69**	−.19	.06
Working memory	.27	**.48**	.06	.27
BFAS openness	.26	.23	.45	**.91**
NEO aesthetics	.38	.11	.46	**.79**
MBTI intuition	.25	.27	.21	**.52**
NEO fantasy	.25	.27	.35	**.52**
NEO action	.28	.08	.36	**.41**

Note. Factor loadings over .4 are given in bold. λ1 (Intellectual Engagement) = 4.6 (30.41% Variance), λ2 (Affective Engagement) = 2.75 (18.33% Variance), λ3 (Explicit Cognitive Ability) = 1.36 (9.03% Variance), λ4 (Aesthetic Engagement) = .97 (6.50% Variance). Total Variance Explained: 64.2%. The structure matrix is presented in this table.

Table 3 shows the correlations among the four factors. Although separable, Explicit Cognitive Ability, Intellectual Engagement, and Aesthetic Engagement were all moderately intercorrelated with one another. There was no relation, however, between Affective Engagement and either Explicit Cognitive Ability or Intellectual Engagement.

PERSONALITY

Table 4 lists the correlations between the Four-Factor model of openness to experience and the Big Five model of personality.

The only Big Five domain that was significantly associated with Explicit Cognitive Ability was the Openness/Intellect domain. Intellectual Engagement was significantly correlated with Conscientiousness, Extraversion, and Openness/Intellect. Affective Engagement was significantly correlated with Agreeableness, Extraversion, and Openness/Intellect. Finally, Aesthetic Engagement was positively associated with Agreeableness, Extraversion, and Openness/Intellect and negatively associated with Conscientiousness. Interestingly, Affective Engagement had the lowest correlation with the Openness/Intellect domain of personality and the highest correlation with Agreeableness.

To further investigate the particular aspects of each Big Five domain that were related to the four factors, I assessed the correlation between each of the four factors and the 10 aspects of the Big Five as measured by the Big Five Aspect Scales (BFAS; DeYoung et al., 2007). Table 5 shows the correlations among Openness/Intellect and the 10 aspects of the Big Five.

While Intellectual Engagement was significantly correlated with Conscientiousness and Extraversion (see Table 4), these correlations appear to be due to Intellectual Engagement's relation to the Industriousness aspect of Conscientiousness and the Assertive aspect of Extraversion (see Table 5). Explicit Cognitive Ability was significantly related to BFAS Intellect ($r = .48$, $p < .01$) and BFAS Openness ($r = .26$, $p < .01$), although the correlation with BFAS Intellect was higher (see Table 5). While Affective Engagement was positively related to Agreeableness and Extraversion, and the positive correlation with Neuroticism approached significance (see Table 4), these correlations seem to be due to Affective Engagement's relation to the Volatility aspect of Neuroticism, the Compassion aspect of Agreeableness, and both aspects of Extraversion (Enthusiasm and Assertiveness; See Table 5). Note that correlation between Affective Engagement and Compassion was particularly high ($r = .64$, $p < .01$). Finally, while Aesthetic Engagement was positively related to Conscientiousness and

TABLE 3. Correlations among the four factors (N = 146)

Factor	1	2	3	4
1. Intellectual engagement	–			
2. Explicit cognitive ability	.43	–		
3. Affective engagement	.01	−.12	–	
4. Aesthetic engagement	.38	.29	.50	–

TABLE 4. Correlations between the Four-Factor Model of Openness to Experience and the Big Five model of personality (N = 146)

Factor	Neuroticism	Agreeableness	Conscientiousness	Extraversion	Openness/Intellect
Intellectual engagement	−.08	−.01	.18*	.22**	.73**
Explicit cognitive ability	−.02	.00	−.13*	−.02	.48**
Affective engagement	.15	.43**	−.12	.44**	.27**
Aesthetic engagement	.09	.23*	−.24**	.25**	.83**
Reliability (α)	.89	.83	.87	.91	.77

Note. Because BFAS Openness/Intellect scores were included in the factor analysis of the four factors, the correlations with Openness/Intellect are artificially inflated. Reliability is based on N = 177.

*p < .05, **p < .01.

TABLE 5. Correlations among the Four-Factor Model of Openness to Experience and the 10 Aspects of the Big Five (N = 146)

Factor	Neuroticism		Agreeableness		Conscientiousness		Extraversion		Openness/ Intellect	
	Volatility	With-drawal	Compassion	Politeness	Industriousness	Order-liness	Enthusiasm	Assertiveness	Openness	Intellect
Intellectual engagement	−.08	−.07	.09	−.10	.24**	.08	.02	.35**	.28**	.90**
Explicit cognitive ability	−.09	.06	.04	−.04	−.09	−.14	−.12	.09	.26**	.48**
Affective engagement	.19*	.07	.64**	.07	−.09	−.12	.52**	.26**	.53**	−.11
Aesthetic engagement	.06	.09	.38**	.00	−.22**	−.20*	.23*	.20*	.96**	.32**
Reliability (α)	.87	.80	.87	.75	.83	.82	.88	.89	.72	.77

Note. Because BFAS Openness/Intellect scores were included in the factor analysis of the four factors, the correlations with Openness/Intellect are artificially inflated. Reliability is based on N = 177.

*p < .05, **p < .01.

Extraversion, and negatively correlated with Conscientiousness (see Table 4), these correlations appear to be due to Aesthetic Engagement's positive relation to the Compassion aspect of Agreeableness, Aesthetic Engagement's negative relation to both the Industriousness and Orderliness aspects of Conscientiousness, and Aesthetic Engagement's positive relation to both aspects of Extraversion (Enthusiasm and Assertiveness).

Table 6 shows the correlations between the Four-Factor model of Openness/Intellect and the Four-Factor model of impulsivity.

The Intellect factor was not related to impulsivity, whereas the Openness factor was positively related to a lack of premeditation, urgency, sensation seeking, and average impulsivity. Intellectual Engagement was only related to the perseverance facet of impulsivity, in that those higher in Intellectual Engagement also reported higher perseverance, planning and organizational skills. Explicit Cognitive Ability was not related to any of the facets of self-reported impulsivity. This is consistent with Intellectual Engagement's correlation with the Industriousness aspect of Conscientiousness (see Table 6). Intellectual Engagement was not related to the other components of impulsivity, although it was negatively related to average impulsivity. Both Affective and Aesthetic Engagement were positively related to a lack of premeditation, urgency sensation seeking, and average impulsivity. In addition, Aesthetic Engagement was positively related to a lack of perseverance.

CREATIVE ACHIEVEMENT

Explicit Cognitive Ability was correlated with being perceived as an absent-minded professor ($r = .18$, $p < .05$), whereas Intellect was not significantly related with perceptions. Both Affective Engagement ($r = .24$, $p < .01$) and Aesthetic Engagement ($r = .26$, $p < .01$) were significantly correlated with perceptions as creative. Between the two Openness factors, Aesthetic Engagement was more strongly related to being perceived as having an artistic temperament ($r = .34$, $p < .001$ vs. $r = .17$, $p < .05$). Affective Engagement was negatively related to being perceived as an absent-minded professor ($r = -.19$, $p < .05$) whereas there was no relation between Aesthetic Engagement and being perceived as an absent-minded professor.

Table 7 shows the relationships between the Four-Factor model and creative achievement across domains. As the distribution of creative achievement was heavily skewed with many zero values, traditional regression methods cannot be employed due to violations of the assumptions of normal residuals and homoscedasticity (Silvia & Kimbrel, 2010; Silvia et al., 2012). Therefore, Poisson regression was employed, using the robust Huber-White sandwich estimator to account for overdispersion. Note that the unstandardized values are not as intuitively interpretable as more traditional regression standardized coefficients.

Each of the four factors differently predicted creative achievement across domains. Intellectual Engagement was significantly related to self-reported creative achievement in inventions and scientific discovery. Explicit Cognitive Ability was positively related to creative achievement in scientific discovery and negatively related to creative achievement in culinary arts. Affective Engagement showed posi-

TABLE 6. Correlations between the Four-Factor Model of Openness to Experience and the Four-Factor Model of Impulsivity (N = 145)

Factor	(lack) Premeditation	Urgency	Sensation seeking	(lack) Perseverance	UPPS average
Intellectual engagement	−.06	−.15	.00	−.23**	−.17*
Explicit cognitive ability	.04	.01	.07	.08	.08
Affective engagement	.33**	.24**	.23**	.14	.35**
Aesthetic engagement	.31**	.18*	.21**	.17*	.33**
Reliability (α)	.87	.83	.85	.87	

Note. Reliability is based on N = 177.
*p < .05, **p < .01.

tive relations to creative achievement in music, dance, humor, theater and film, and total creative achievement scores, and was negatively related to creative achievement in scientific discovery. Aesthetic Engagement was positively related to creative achievement in visual arts, music, dance, theater and film, and total creative achievement scores.

To assess correlations with the arts and sciences, I grouped areas according to the classification system of Carson et al. (2005), but excluded culinary arts from the sciences category. This resulted in arts creative achievement consisting of visual arts, music, dance, creative writing, humor, and theater and film and creative achievement in the sciences consisting of inventions and scientific discovery.

Table 8 shows the relationships between the Four-Factor model and creative achievement in the arts and sciences.

Intellectual Engagement and Explicit Cognitive Ability were not related to creative achievement in the arts, but were positively related to creative achievement in the sciences. Both Affective and Aesthetic Engagement were significantly related to creative achievement in the arts. While Aesthetic Engagement was not related to creative achievements in the sciences, Affective Engagement was *negatively* related to creative achievement in the sciences.

Putting all four factors into a Poisson regression model with robust estimation, none of the four factors independently predicted creative achievement in the arts, although Affective Engagement approached significance ($b = .236$, Wald $\chi^2 = 3.61$, $p = .057$). In contrast, Intellectual Engagement remained the only independent predictor of the Sciences ($b = .553$, Wald $\chi^2 = 8.76$, $p < .01$).

TABLE 7. Relationships among the Four-Factor Model of Openness to Experience and Creative Achievement (N = 146)

Domain	Intellectual engagement		Explicit cognitive ability		Affective engagement		Aesthetic engagement	
	b	Wald χ^2	*b*	Wald χ^2	*b*	Wald χ^2	*b*	Wald χ^2
Visual arts	.035	.096	−.003	.001	.166	3.022	**.371**	**19.476**
Music	.021	.015	.119	.843	**.401**	**9.224**	**.466**	**12.648**
Dance	.014	.009	−.228	1.513	**.885**	**25.511**	**.299**	**5.945**
Architectural design	−.051	.079	−.307	1.098	−.284	.763	−.227	.863
Creative writing	.146	2.514	−.109	1.411	.097	.631	−.038	.230
Humor	.007	.006	−.078	.661	**.269**	**5.567**	.147	2.071
Inventions	**.430**	**7.677**	.363	2.624	−.149	1.044	.023	.028
Scientific discovery	**.678**	**20.207**	**.501**	**8.952**	**−.328**	**6.396**	−.104	.499
Theater and film	.198	2.630	−.055	.112	**.541**	**12.858**	**.502**	**13.291**
Culinary arts	−.140	.944	**−.345**	**5.135**	−.099	.287	−.185	1.239
Total creative achievement	.094	1.736	.001	.982	**.286**	**16.496**	**.261**	**18.209**

Note. The coefficients are unstandardized Poisson regression weights with robust estimation. All values in bold are statistically significant $p < .05$.

TABLE 8. Relationships among the Four-Factor Model of Openness to Experience and Creative Achievements in the Arts and Sciences (N = 146)

Factor	Arts		Sciences	
	b	Wald χ^2	*b*	Wald χ^2
Intellectual engagement	.062	.561	**.545**	**21.547**
Explicit cognitive ability	−.022	.092	**.428**	**7.590**
Affective engagement	**.380**	**23.658**	**−.235**	**5.807**
Aesthetic engagement	**.327**	**23.283**	−.038	.103

Note. The coefficients are unstandardized Poisson regression weights with robust estimation. All values in bold are statistically significant $p < .05$.

DISCUSSION

In the Big Five taxonomy of personality traits, the openness to experience domain lumps together a wide range of traits relating to cognition, affect, aesthetics, and imagination. This study aimed to clarify the openness to experience domain and its relation to different forms of creative achievement by situating it within dual-process theory. Factor analysis of a large battery of measures of cognitive ability, working memory, Intellect, Openness, intuition, and affect revealed two clearly distinct openness to experience factors: Intellect and Openness.

Further analysis revealed four factors. Intellect split off into both ability and engagement factors, with measures of cognitive ability and working memory loading on the *Explicit Cognitive Ability* factor and self-report measures of Intellect loading on *the Intellectual Engagement* factor. This finding is consistent with prior research showing that Intellect is a larger construct consisting of both the ability and drive to engage in complex problem solving and reasoning (DeYoung, 2011; DeYoung et al., 2007; Stanovich, 2009; Stanovich & West, 2000). The essence of the Intellectual Engagement factor appears to be a drive to engage in complex ideas, rational thought, and the search for "truth" (Johnson, 1994), and this form of engagement is at least partially separable from explicit cognitive ability.

Inclusion of self-reported intuition and affect measures proved useful by allowing Openness to split off into two factors: *Affective Engagement*—relating to a preference for using emotions, gut feelings, and empathy to make decisions and *Aesthetic Engagement*—relating to a preference for aesthetics, fantasy, and emotional absorption in artistic and cultural stimuli. The essence of this factor appears to be a drive to engage in aesthetics, imagination, and the search for "beauty" (Johnson, 1994). This splitting of a more affective-based Openness factor and a more holistic, imaginative-based Openness factor is consistent with recent research on cognitive and daydreaming styles (Kaufman, 2009a,b; Norris & Epstein, 2011; Pretz & Totz, 2007; Zhiyan & Singer, 1997).

PERSONALITY

The pattern of relations between the Four-Factor model and personality is in line with dual-process theory. Explicit Cognitive Ability showed no relation to any of

the personality variables other than the larger openness to experience domain and a weak negative correlation with Conscientiousness (but not any of the Conscientiousness aspects). This is partly consistent with Eysenck's (1994) assertion that intelligence is not related to personality, but suggests that the exception is the openness to experience domain (see DeYoung, 2011). Those scoring high in Intellectual Engagement tended to be more industrious, assertive, and persevering—dispositions associated with goal-directed behavior and higher levels of working memory. This is consistent with DeYoung et al. (2007), in which the two aspects most strongly positively related to Intellect were Industriousness and Assertiveness. In contrast, both Openness factors were more strongly related to experiential/affective forms of engagement, including an intuitive cognitive style and impulsivity. The most notable difference between the two forms of Openness is that Compassion was much more strongly related to Affective Engagement than Aesthetic Engagement. Future research should further investigate Affective Engagement, and further tease apart the intuition, empathy, compassion, and agreeableness aspects of this factor.

The results are also interesting in light of prior research on self-reported impulsivity (DeYoung, 2010; Whiteside & Lynam, 2001). Whiteside and Lynam (2001) show evidence that the Big Five traits Conscientiousness, Extraversion, and Neuroticism are related to impulsivity. While they did not find associations with the openness to experience domain, they did not separate Openness from Intellect. The results of this study suggest that this separation is revealing when looking at associations with self-reported impulsivity (DeYoung, 2010). Future research on impulsivity should keep this separation in mind.

CREATIVE ACHIEVEMENT

Predictions relating to creative achievement were confirmed. Aspects of openness to experience more strongly associated with Type 1 processes—Affective Engagement and Aesthetic Engagement—independently predicted creative achievement in the arts but not the sciences. In contrast, aspects of openness to experience more strongly associated with Type 2 processes—Explicit Cognitive Ability and Intellectual Engagement—independently predicted creative achievement in the sciences but not the arts. These results have implications for threshold effect theories of creative achievement (Kaufman et al., 2011), suggesting that creative achievement in the arts does not require a particular threshold for Type 2 processing. Put the other way round: the arts may require a *higher* threshold for Type 1 processing than creative achievement in the sciences! Indeed, as reported elsewhere, this same dataset reveals an association between the Type 1 processes of implicit learning and reduced latent inhibition with aesthetic and affective aspects of openness to experience, respectively (Kaufman, 2009a,b; Kaufman et al., 2010). This suggests that further research on the role of Openness and its underlying Type 1 cognitive processing in the arts may prove fruitful.

There was no relationship between Aesthetic Engagement and creative achievement in the sciences. Interestingly, there was a *negative* relationship between Affective Engagement and creative achievement in the sciences. While it remains unclear why this relationship exists, it may be the case that relying on intuitive feelings and

compassion to make decisions can impede creativity in the sciences. This intriguing possibility requires further investigation. Another interesting finding is that even though both Explicit Cognitive Ability and Intellectual Engagement were associated with creative achievement in the sciences, Intellectual Engagement predicted creative achievement above and beyond Explicit Cognitive Ability. This suggests that Intellectual Engagement is an important independent predictor of creative achievement in the sciences, and deserves research attention independently of traditional measures of intelligence. Consistent with this finding, von Stumm, Hell, and Chamorro-Premuzic (2011) found that having a "hungry mind" (intellectual curiosity) had a significant influence on academic performance independently of traditional measures of intelligence. The current findings extend those results to creative achievement in the sciences. It must be noted, however, that this study was conducted on high-achieving adolescents specializing in particular domains. Future research should look at adult creative achievers across an even wider range of domains.

CONCLUSION

This study supports the utility of separating various aspects of the openness to experience domain when assessing relationships across various domains of creative achievement. A Four-Factor model of openness to experience was presented. Traditional measures of intelligence and working memory helped clarify Intellect, whereas self-reported measures of aesthetics, fantasy, intuition, and affect helped clarify Openness. This more finely grained model of the openness to experience domain offered nuanced predictions of personality, impulsivity, and creative achievement across the arts and sciences in line with dual-process theory. An important future line of research will be the investigation of the different cognitive mechanisms underlying each of the four factors that were identified, at different levels of analysis (genetic, neurological, cultural). Taken together, this study suggests that the Intellect and Openness aspects of the broader openness to experience personality domain are independently related to different modes of information processing and uniquely predict important life outcomes.

REFERENCES

Ackerman, P.L., & Heggestad, E.D. (1997). Intelligence, personality, and interests: Evidence for overlapping traits. *Psychological Bulletin*, *121*, 219–245.

Allen, A.P., & Thomas, K.E. (2011). A dual process account of creative thinking. *Creativity Research Journal*, *23*, 109–118.

Batey, M., & Furnham, A. (2006). Creativity, intelligence, and personality: A critical review of the scattered literature. *Genetic, Social, and General Psychology Monographs*, *132*, 355–429.

Cacioppo, J.T., Petty, R.E., Feinstein, J., & Jarvis, W. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin*, *119*, 197–253.

Carson, S.H., Peterson, J.B., & Higgins, D.M. (2003). Decreased latent inhibition is associated with increased creative achievement in high-functioning individuals. *Journal of Personality and Social Psychology*, *85*, 499–506.

Carson, S.H., Peterson, J.B., & Higgins, D.M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal*, *17*, 37–50.

Conway, A.R.A., Cowan, N., Bunting, M.F., Therriault, D.J., & Minkoff, S.R.B. (2002). A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence. *Intelligence*, *30*, 163–183.

Conway, A.R.A., Jarrold, C., Kane, M., Miyake, A., & Towse, J. (2008). *Variation in working memory*. New York: Oxford University Press.

DeYoung, C.G. (2010). Impulsivity as a personality trait. In K.D. Vohs & R.F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd edn). New York: Guilford Press.

DeYoung, C.G. (2011). Intelligence and personality. In R.J. Sternberg & S.B. Kaufman (Eds.), *The Cambridge handbook of intelligence*. New York: Cambridge University Press.

DeYoung, C.G. (in press). Openness/Intellect: A dimension of personality reflecting cognitive exploration. In M.L. Cooper, & R.J. Larsen (Eds.), *APA handbook of personality and social psychology, volume 3, personality processes and individual differences*.

DeYoung, C.G., Grazioplene, R.G., & Peterson, J.B. (2012). From madness to genius: The Openness/Intellect trait domain as a paradoxical simplex. *Journal of Research in Personality*, *46*, 63–78.

DeYoung, C.G., Hirsh, J.B., Shane, M.S., Papademetris, X., Rajeevan, N., & Gray, J.R. (2010). Testing predictions from personality neuroscience. *Psychological Science*, *21*, 820–828.

DeYoung, C.G., Peterson, J.B., & Higgins, D.M. (2002). Higher-order factors of the Big Five predict conformity: Are there neuroses of health? *Personality and Individual Differences*, *33*, 533–552.

DeYoung, C.G., Peterson, J.B., & Higgins, D.M. (2005). Sources of openness/intellect: Cognitive and neuropsychological correlates of the fifth factors of personality. *Journal of Personality*, *73*, 825–858.

DeYoung, C.G., Quilty, L.C., & Peterson, J.B. (2007). Between facets and domains: 10 aspects of the Big Five. *Journal of Personality and Social Psychology*, *93*, 880–896.

DeYoung, C.G., Quilty, L.C., Peterson, J.B., & Gray, J.R. (2013). Openness to Experience, Intellect, and cognitive ability. *Journal of Personality Assessment*, doi: 10.1080/00223891.2013.806327.

DeYoung, C.G., Shamosh, N.A., Green, A.E., Braver, T.S., & Gray, J.R. (2009). Intellect as distinct from Openness: Differences revealed by fMRI of working memory. *Journal of Personality and Social Psychology*, *97*, 883–892.

Dunn, P.G., de Ruyter, B., & Bouwhuis, D.G. (2011). Toward a better understanding of the relation between musical preference, listening behavior, and personality. *Psychology of Music*, *40*, 411–428.

Engle, R.W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*, 19–23.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious. *American Psychologist*, *49*, 709–724.

Epstein, S. (2003). Cognitive-experiential self- theory of personality. In T. Millon, & M.J. Lerner (Eds.), *Comprehensive handbook of psychology* (Vol. 5, pp. 159–184). Personality and social psychology. Hoboken, NJ: Wiley.

Epstein, S., Pacini, R., & Norris, P. (1998). *The RationalExperiential Inventory: Long form*. Unpublished inventory. Amherst, MA: University of Massachsetts.

Evans, J.St.B.T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, *59*, 255–278.

Evans, J.St.B.T. (2010). *Thinking twice: Two minds in one brain*. Oxford, UK: Oxford University Press.

Evans, J.S.B.T., & Frankish, K. (2009). *In two minds: Dual-processses and beyond*. New York: Oxford University Press.

Eysenck, H.J. (1994). Personality and intelligence: Psychometric and experimental approaches. In R.J. Sternberg & P. Ruzgis (Eds.), *Personality and intelligence* (pp. 3–31). New York: Cambridge University Press.

Eysenck, H.J. (1995). Creativity as a product of intelligence and personality. In D. Saklofske & M. Zeidner (Eds.), *International handbook of personality and intelligence: Perspectives on individual differences* (pp. 231–247). New York: Plenum Press.

Feist, G.J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review*, *2*, 290–309.

Feist, G.J., & Barron, F.X. (2003). Predicting creativity from early to late adulthood: Intellect, potential, and personality. *Journal of Research in Personality*, *37*, 62–88.

Gilhooly, K.J., & Fioratou, E. (2009). Executive functions in insight versus non-insight problem solving: An individual differences approach. *Thinking and Reasoning*, *15*, 355–376.

Gilhooly, K.J., & Murphy, P. (2005). Differentiating insight from non-insight problems. *Thinking and Reasoning*, *11*, 279–302.

Goldberg, L.R. (2006). Doing it all bass-ackwards: The development of hierarchical factor structures from the top down. *Journal of Research in Personality*, *40*, 347–358.

Hirsh, J.B., DeYoung, C.G., & Peterson, J.B. (2009). Metatraits of the Big Five differentially predict engagement and restraint of behavior. *Journal of Personality*, *77*, 1085–1102.

Jang, K.L., Livesley, W.J., Angleitner, A., Riemann, R., & Vernon, P.A. (2002). Genetic and environmental influences on the covariance of facets defining the domains of the five-factor model of personality. *Personality and Individual Differences*, *33*, 83–101.

Johnson, J.A. (1994). Clarification of factor five with the help of the AB5C model. *European Journal of Personality*, *8*, 311–334.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus, and Giroux.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In T. Gilovich, D. Griffin & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 49–81). New York: Cambridge University Press.

Kahneman, D., & Frederick, S. (2005). A model of heuristic judgment. In K.J. Holyoak & R.G. Morrison (Eds.), *The Cambridge Handbook of Thinking and Reasoning* (pp. 267–293). New York: Cambridge University Press.

Kane, M.J., & Engle, R.W. (2002). The role of prefrontal cortex in working-memory capacity, executive attention, and general fluid intelligence: An individual-differences perspective. *Psychonomic Bulletin and Review*, *9*, 637–671.

Kane, M.J., Hambrick, D.Z., Tuholski, S.W., Wilhelm, O., Payne, T.W., & Engle, R.W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology*, *133*, 189–217.

Kaufman, S.B. (2009a). *Beyond general intelligence: The dual-process theory of human intelligence (Doctoral dissertation)*. New Haven, CT: Yale University.

Kaufman, S.B. (2009b). Faith in intuition is associated with decreased latent inhibition in a sample of high-achieving adolescents. *Psychology of Aesthetics, Creativity, and the Arts*, *3*, 28–34.

Kaufman, S.B. (2011). Intelligence and the cognitive unconscious. In R.J. Sternberg & S.B. Kaufman (Eds.), *The Cambridge Handbook of Intelligence* (pp. 442–467). Cambridge, UK: Cambridge University Press.

Kaufman, S.B., DeYoung, C.G., Gray, J.R., Brown, J., & Mackintosh, N. (2009). Associative learning predicts intelligence above and beyond working memory and processing speed. *Intelligence*, *37*, 374–382.

Kaufman, S.B., DeYoung, C.G., Gray, J.R., Jimenez, L., Brown, J.B., & Mackintosh, N. (2010). Implicit learning as an ability. *Cognition*, *116*, 321–340.

Kaufman, J.C., Kaufman, S.B., & Lichtenberger, E.O. (2011). Finding creativity on intelligence tests via divergent production. *Canadian Journal of School Psychology*, *26*, 83–106.

Keren, G., & Schul, Y. (2009). Two is not always better than one: A critical evaluation of two-system theories. *Perspective on Psychological Science*, *4*, 533–550.

King, L.A., Walker, L., & Broyles, S. (1996). Creativity and the five-factor model. *Journal of Research in Personality*, *30*, 189–203.

Kruglanski, A., & Gigerenzer, G. (2011). Intuitive and deliberate judgments are based on common principles. *Psychological Review*, *118*, 97–109.

Lieberman, M.D. (2003). Reflexive and reflective judgment processes: A social cognitive neuroscience approach. In J.P. Forgas, K.R. Williams & W. von Hippel (Eds.), *Social judgments: Implicit and explicit processes* (pp. 44–67). New York: Cambridge University Press.

Lieberman, M.D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology*, *58*, 259–289.

Lin, W.-L., & Lien, Y.-W. (2013). The different role of working memory in open-ended versus closed-ended creative problem solving: A dual-process theory account. *Creativity Research Journal*, *25*, 85–96.

Lohman, D.F. (2001). Fluid intelligence, inductive reasoning, and working memory: Where the theory of multiple intelligences falls short. In N. Colangelo, & S.G. Assouline (Eds.), *Talent development IV: Proceedings from the 1998 Henry B. and Jocelyn Wallace National Research Symposium on Talent Development* (pp. 219–227). Scottsdale, AZ: Gifted Psychology Press.

Lubow, R.E. (1989). *Latent inhibition and conditioned attention theory*. Cambridge, UK: Cambridge University Press.

Lubow, R.E., & Weiner, I. (2009). *Latent inhibition: Cognition, neuroscience, and applications to schizophrenia*. New York: Cambridge University Press.

McCrae, R.R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology*, *52*, 1258–1263.

The Mill Hill Vocabulary Scale, Form 1 Junior (1977 Revision).

Moutafi, J., Furnham, A., & Crump, J. (2006). What facets of openness and conscientiousness predict fluid intelligence score? *Learning and Individual Differences*, *16*, 31–42.

Mussel, P., Carolin, W., Gelleri, P., & Schuler, H. (2011). Explicating the openness to experience construct and its subdimensions and facets in a work setting. *International Journal of Selection and Assessment*, *19*, 145–156.

Myers, I., McCaulley, M.H., Quenk, N.L., & Hammer, A.L. (1998). *Manual: A guide to the development and use of the MyersBriggs Type Indicator* (2nd edn). Palo Alto, CA: Consulting Psychologists Press.

Norris, P., & Epstein, S. (2011). An experiential thinking style: Its facets and relations with objective and subjective criterion-measures. *Journal of Personality*, *79*, 1043–1080.

Nusbaum, E.C., & Silvia, P.J. (2011). Are openness and intellect distinct aspects of openness to experience? A test of the O/I model. *Personality and Individual Differences*, *51*, 571–574.

Osman, M. (2004). An evaluation of dual-process theories of reasoning. *Psychonomic Bulletin and Review*, *11*, 988–1010.

Pacini, R., & Epstein, S. (1999). The relation of rational and experiential information processing styles to personality, basic beliefs, and the ratio-bias phenomenon. *Journal of Personality and Social Psychology*, *76*, 972–987.

Peterson, J.B., & Carson, S. (2000). Latent inhibition and openness to experience in a high-achieving student population. *Personality and Individual Differences*, *28*, 323–332.

Peterson, J.B., Smith, K.W., & Carson, S. (2002). Openness and extraversion are associated with reduced latent inhibition: Replication and commentary. *Personality and Individual Differences*, *33*, 1137–1147.

Piedmont, R.L. (1998). *The revised NEO personality inventory: Clinical and research applications*. New York: Springer.

Pretz, J.E., & Totz, K.S. (2007). Measuring individual differences in affective, heuristic, and holistic intuition. *Personality and Individual Differences*, *43*, 1247–1257.

Raven, J., Raven, J.C., & Court, J.H. (1998). *Manual for raven's progressive matrices and vocabularly scales*. Oxford, UK: Oxford Psychologists Press.

Silvia, P.J., & Kimbrel, N.A. (2010). A dimensional analysis of creativity and mental illness: Do anxiety and depression symptoms predict creative cognition, creative accomplishments, and creative self-concepts? *Psychology of Aesthetics, Creativity, and the Arts*, *4*, 2–10.

Silvia, P.J., Nusbaum, E.C., Berg, C., Martin, C., & O'Connor, A. (2009). Openness to experience, plasticity, and creativity: Exploring lower-order, higher-order, and interactive effects. *Journal of Research in Personality*, *43*, 1087–1090.

Silvia, P.J., Wigert, B., Reiter-Palmon, R., & Kaufman, J.C. (2012). Assessing creativity with self-report scales: A review and empirical evaluation. *Psychology of Aesthetics, Creativity, and the Arts*, *6*, 19–34.

Silvia, P.J., Winerstein, B.P., Willse, J.T., Barona, C.M., Cram, J.T., Hess, K.I., … & Richard, C.A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts*, *2*, 68–85.

Simonton, D.K. (1999). Talent and its development: An emergenic and epigenetic model. *Psychological Review*, *106*, 435–457.

Simonton, D.K. (2005). Giftedness and genetics: The emergenic-epigenetic model and its implications. *Journal for the Education of the Gifted*, *28*, 270–286.

Simonton, D.K. (2010). Creative thought as blind-variation and selective-retention: Combinatorial models of exceptional creativity. *Physics of Life Reviews*, *7*, 156–179.

Stanovich, K.E. (2004). *The robot's rebellion: Finding meaning in the age of Darwin*. Chicago: University of Chicago Press.

Stanovich, K.E. (2009). Distinguishing the reflective, algorithmic, and autonomous minds: Is it time for a tri-process theory. In J.S.B.T. Evans & K. Frankish (Eds.), *In two minds: Dual-processes and beyond*. Oxford, UK: Oxford University Press.

Stanovich, K.E. (2011). *Rationality and the reflective mind*. New York: Oxford University Press.

Stanovich, K.E., & Toplak, M.E. (2012). Defining features versus incidental correlates of Type 1 and Type 2 processing. *Mind and Society*, *11*, 3–13.

Stanovich, K.E., & West, R.F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences*, *23*, 645–726.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *8*, 220–247.

von Stumm, S., Hell, B., & Chamorro-Premuzic, T. (2011). The hungry mind: Intellectual curiosity is the third pillar of academic performance. *Perspectives on Psychological Science*, *6*, 574–588.

The Psychological Corporation. (1995). *DAT for selection-verbal reasoning (European adaptation)*. Orlando, FL: Harcourt Brace and Company.

Turner, M.L., & Engle, R.W. (1989). Is working memory capacity task dependent? *Journal of Memory and Language*, *28*, 127–154.

Unsworth, N., & Engle, R.W. (2005). Working memory capacity and fluid abilities: Examining the correlation between operation span and raven. *Intelligence*, *33*, 67–81.

Vandenberg, S.G., & Kruse, A.R. (1978). Mental rotations: Group tests of three-dimensional spatial visualization. *Perceptual and Motor Skills*, *47*, 599–604.

Wainwright, M.A., Wright, M.J., Luciano, M., Geffen, G.M., & Martin, N.G. (2008). Genetic covariation among facets of openness to experience and general cognitive ability. *Twin Research and Human Genetics*, *11*, 275–286.

Whiteside, S.P., & Lynam, D.R. (2001). The five factor model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, *30*, 669–689.

Whiteside, S.P., Lynam, D.R., Miller, J.D., & Reynolds, S.K. (2005). Validation of the UPPS impulsive behaviour scale: A four-factor model of impulsivity. *European Journal of Personality*, *19*, 559–574.

Zhiyan, T., & Singer, J.L. (1997). Daydreaming styles, emotionality and the Big Five. *Imagination, Cognition and Personality*, *16*, 399–414.

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