2 Openness/Intellect

The Core of the Creative Personality

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Openness/intellect is perhaps the broadest, most contentious, and most quintessentially human of the Big Five personality traits. Capacity for imagination and artistic and intellectual curiosity, central components of the openness/intellect dimension, are part of what defines and advances our species. In terms of breadth, the openness/intellect domain encompasses traits ranging from intellectual abilities to aesthetic interests to potentially maladaptive cognitive tendencies related to psychosis (DeYoung, Grazioplene, & Peterson 2012). This remarkable breadth has driven a long-standing debate over how to best interpret and label this dimension.

The Big Five dimensions of personality, including openness/intellect, were empirically (i.e., atheoretically) derived using factor analysis, meaning that they were identified as patterns of covariation among a wide variety of more specific traits. Researchers then had to interpret these patterns, and this was particularly challenging with the openness/intellect factor. Various labels have been proposed over time, with *openness to experience* being the most prominent currently and *intellect* a distant second. We refer to this dimension with the compound label *openness/intellect* because it conveys that each of these two labels reflects a distinct but equally important aspect of the trait.

Though the labeling and characterization of openness/intellect have been a long and contentious process (described in more detail later), what is not disputed is the clear and robust relationship between this dimension of personality and creativity. More so than any other Big Five trait, openness/intellect is consistently related to measures of creativity, including creative thinking, creative achievement, creative professions, creative hobbies, and creative personality generally (Batey & Furnham 2006; Carson, Peterson, & Higgins 2003; Feist 1998; Feist & Barron 2003; S.B. Kaufman 2013; S.B. Kaufman et al. 2015; King, Walker & Broyles 1996; McCrae 1987; Silvia et al. 2008, 2009). In this chapter we review the history of the openness/intellect construct and summarize the empirical findings regarding the relation of creativity to the openness/intellect trait domain as a whole. Additionally, we differentiate openness/intellect into its two major subdimensions, openness and intellect, and discuss research regarding the specific relation of each to creativity. Finally, given that the link of openness/intellect to creativity is well established, we review specific motivational, cognitive, and neurobiological processes that may help to explain this link. In so

doing, we hope to paint a clearer picture of the creative person and the mechanisms underlying the creative process.

History, Interpretation, and Measurement of Openness/Intellect

Openness/intellect was discovered in conjunction with the other four Big Five traits: extraversion, agreeableness, conscientiousness, and neuroticism. The field of personality psychology has achieved a relatively high degree of consensus on this general taxonomy of personality traits (John, Naumann, & Soto 2008), though, of course, some disagreements remain, such as whether a six-factor model might be better (Saucier 2009). Even in the alternative six-factor model, however, the openness/intellect factor remains the same, so we will not go into detail on that debate. The Big Five dimensions were ultimately derived from analysis of the natural-language terms people use to describe themselves and others (Allport & Odbert 1936; John 1990). Thus they were born out of the lexical hypothesis, which asserts that most important attributes of people have become encoded as single words in natural language. This hypothesis posits that the personality vocabulary in dictionaries constitutes a comprehensive content universe of personality traits from which to sample. In the early lexical studies, researchers scoured the dictionary for all the terms that could describe people, and the resulting list of over 17,000 English words included 4,500 trait terms, which formed the basis of the research that eventually led to the Big Five (Allport & Odbert 1936).

The first discoveries of the Big Five (Fiske 1949; Norman 1963; Tupes & Christal 1961) were all made using a greatly reduced list of 35 variables culled by Cattell from the 4,500 trait terms in order to have a manageable number of variables for factor analysis in the days before computers. Later studies found that the same five factors were evident even in much larger lists of trait terms (Goldberg 1990). Two of the three early studies labeled the openness/intellect dimension *culture* because it was marked by attributes such as *cultured* and *polished*, but this is now typically viewed as a historical accident stemming from the idiosyncrasies of Cattell's short list, and *culture* is not considered a good label for this broad, basic dimension of personality (Peabody & Goldberg 1989).

The most commonly used label in lexical research had been *intellect* due to high loadings from adjectives such as *intelligent*, *insightful*, and *clever* (John 1990), but the label *openness to experience* has supplanted it in popularity (John et al. 2008). The latter label stems from the work of Costa and McCrae (1985), who found that measures of imagination, intelligence, openness to change, and emotional and aesthetic sensitivity tended to covary. They interpreted this factor based on previous work positing openness to experience as a construct (Coan 1972; Fitzgerald 1966; Tellegen & Atkinson 1974). After they created a widely used measure of the Big Five (the NEO Personality Inventory, Revised

[NEO PI-R]) (Costa & McCrae 1992), openness came to provide the *O* in *OCEAN*, a popular acronym for the Big Five dimensions.

Saucier (1992, 1994) observed that *imaginative*, *creative*, and *original* are three of the best and most specific markers of openness/intellect in lexical research, and he proposed the label "imagination" for this dimension. Using a slightly different method, Johnson and Ostendorf (1993) identified *artistic*, *creative*, and *imaginative* as three of the purest indicators of openness/intellect, leading Johnson (1994) to suggest that this dimension might best be labeled *creativity* or *creative mentality*. Although these labels have not caught on with psychologists, they serve to highlight that, from a descriptive standpoint, creativity is at the core of openness/intellect.

We believe that this assertion can also usefully be inverted: openness/intellect is the core of the creative personality. This means that the best route to understanding why some people are more creative than others is likely to be through research on openness/intellect. If we can understand why openness/intellect is one of the major dimensions of personality, we may better understand the significance of creativity in human functioning. And if we can understand the various components of openness/intellect and their sources in psychological and biological processes, we will be well on our way to understanding what it is about creative people that enables them to create.

The Hierarchy of Traits within Openness/Intellect

Personality is organized hierarchically, and the Big Five personality traits represent dimensions of individual differences at a very general level, each encompassing many more specific traits that covary (John et al. 2008). These more specific traits are typically described as *facets*, and there may be many facets within each of the Big Five. There is no consensus on how many facets exist or are important. Evidence does exist, however, for a level of personality structure in between the facets and the Big Five in which each of the Big Five traits has two major subfactors (i.e., *aspects*), which are likely to represent the most important distinctions for discriminant validity (DeYoung, Quilty, & Peterson 2007; Jang et al. 2002).

Perhaps unsurprisingly, the two aspects of openness/intellect can be well characterized as *openness* and *intellect*. Openness reflects the tendency toward engagement with aesthetic and sensory information (in both perception and imagination), whereas intellect reflects the tendency toward engagement with abstract and intellectual information. The correlation between openness and intellect is typically in the range of .3 to .5 (e.g., DeYoung et al. 2007), so it is possible to find individuals who are high in openness but not intellect or who are high in intellect but not openness. Figure 2.1 illustrates the structure of the openness/intellect domain. At the highest level of the diagram is the Big Five trait. (Note that there is evidence for a level of personality above the Big Five containing two dimensions representing the shared variance of openness/intellect and extraversion and of conscientiousness, agreeableness, and low

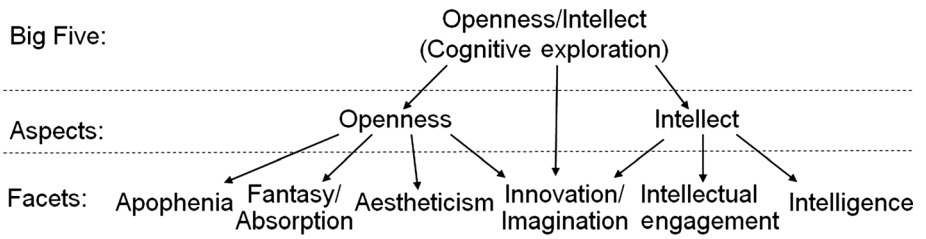

Figure 2.1 *Hierarchical structure of the openness/intellect trait domain. Levels of the hierarchy are labeled at left. Facets are arranged such that those closest together are most strongly related and those farthest apart are least related (DeYoung et al. 2012). Facet labels represent categories of facets and are not indivisible entities. No consensus exists as to the exact number and identity of facets, and this list is necessarily somewhat speculative.* Apophenia *is the tendency to detect patterns or causal connections where none exist. (Source: From DeYoung 2015.)*

neuroticism (Chang, Connelly, & Geeza 2011; DeYoung, 2006). This level of personality is not depicted in Figure 2.1.)

Various instruments are available to psychologists who wish to measure openness/intellect, many of which are free and publicly available. Any instrument designed to measure the Big Five personality traits – such as the Big Five Inventory (BFI) (John et al. 2008), the NEO-PI-R (Costa & McCrae 1992), the International Personality Item Pool (IPIP) Big Five scales (Goldberg 1999), the Mini-Markers (Saucier 1994), the HEXACO-PI (Lee & Ashton 2004), or the Big Five Aspect Scales (BFAS) (DeYoung et al. 2007) – includes a measure of openness/intellect at the level of the Big Five, and most of these will measure a blend of its two aspects regardless of their labels. The BFAS is the only instrument specifically designed to assess the openness and intellect aspects separately, but the aspects can also be assessed using a combination of lower-level facet scales. For example, the openness-to-ideas facet of the NEO-PI-R measures intellect reasonably well, and the openness-to-fantasy, aesthetics, and feelings facets of the NEO PI-R together assess openness reasonably well.

Notwithstanding the historical debate over how to best characterize the openness/intellect factor, reasonable consensus now exists that openness/intellect is a dimension reflecting a general tendency toward complexity and flexibility in information processing. Its core psychological function can be described as *cognitive exploration* (DeYoung 2015). People high in openness/intellect have both the desire and the ability to explore the world cognitively through both perception and reasoning. Openness reflects the tendency to explore sensory and aesthetic information through fantasy, perception, and artistic endeavor, whereas intellect reflects the tendency to explore abstract and semantic information through reasoning. Creativity, which manifests both artistically/aesthetically and intellectually, is thus straightforwardly related to either one or both of

the aspects of openness/intellect depending on the form of creativity in question. In the following sections we discuss the empirical findings on the relation of creativity and openness/intellect at the level of the Big Five, as well as unique relationships between openness, intellect, and creativity.

Facets of Openness/Intellect

A number of different lists and measures of facets of openness/intellect have been published, highlighting the lack of consensus on the number of facets of openness/intellect. For example, Saucier and Ostendorf (1999) analyzed lexical ratings and identified three facets: intellect, imagination/creativity, and perceptiveness. Connelly et al. (2014) categorized and meta-analyzed 85 personality scales conceptually related to the openness/intellect domain and identified four facets purely related to openness/intellect (aestheticism, openness to sensations, nontraditionalism, and introspection) and three additional facets with strong secondary loadings on other Big Five factors (variety seeking, innovation, and fantasy). Woo et al. (2014) factor analyzed 36 scales related to openness/intellect and identified six facets: intellectual efficiency, ingenuity, curiosity, aesthetics, tolerance, and depth. S.B. Kaufman (2013) used factor analysis of both questionnaires and cognitive tests to provide evidence for four facets: explicit cognitive ability, intellectual engagement, aesthetic engagement, and affective engagement (though the last of these was more strongly correlated with agreeableness than with openness/intellect).

Though it is unclear exactly how many traits exist at the facet level, it is evident that some facets are more central to the domain as a whole than others. This phenomenon appears most straightforwardly in the finding that some facets have higher factor loadings on openness/intellect than others and that some facets have strong loadings only on openness/intellect without cross-loadings on other factors (Connelly et al. 2014; DeYoung et al. 2012; Johnson 1994). Another way in which some facets are more central than others can be seen using a multidimensional scaling procedure to show that the relations among various openness/intellect facets are well described by a single scaling dimension, called a *simplex* (DeYoung et al. 2012). The simplex entails mapping the correlations among the facets by placing them all on a single line, with the distance between them representing the strength of their correlation. The facet level of Figure 2.1 is arranged to correspond to this simplex. Note that Figure 2.1 is not intended to assert that there are exactly six facets in openness/intellect; rather, these can be considered six categories of facets that we feel capture the range of facets reasonably well. Creativity would fall in the central category labeled *innovation/imagination*.

Two of the facets in Figure 2.1, intelligence and apophenia, bear additional comment. Apophenia is the tendency to detect patterns (either sensory or causal) where none objectively exist, manifested in phenomena such as superstition, magical ideation (e.g., belief in telepathy), and unusual perceptual experiences (e.g., hallucinations). The inclusion of intelligence and apophenia as facets within

openness and intellect is controversial, but they do typically have their primary loadings on openness/intellect when factor analyzed together with other Big Five facets (DeYoung et al. 2012). Still, their loadings are weaker than those of other facets, and they tend to be unrelated or even weakly negatively related to each other despite both loading positively on the same factor. Hence they can be viewed as peripheral (noncentral) facets of openness/intellect. With the rest of openness/intellect, they share the property that they are modes of cognitive exploration. This common feature explains how apophenia and intelligence may be nearly uncorrelated yet still part of the same trait domain.

Of particular interest here is that both IQ and apophenia are related to creativity (Benedek et al. 2014; Nettle 2006). The relation of creativity to IQ is less controversial than its relation to apophenia. Because apophenia is a core feature of symptoms of psychosis and characterizes the trait of schizotypy that represents normal-range variation in risk for psychosis (DeYoung et al. 2012), this association ties into the common tropes of the mad genius and the mentally ill artist. Although full-blown mental illness is rarely conducive to creativity, considerable evidence has accumulated to show that both questionnaire measures of apophenia and genetic risk for psychosis (as indicated by the presence of relatives with psychotic illness) are indeed associated with artistic creativity (Carson 2011; DeYoung et al. 2012; S.B. Kaufman et al., 2015; Kozbelt et al. 2014; Kyaga et al. 2013; Nelson & Rawlings 2010). A more thorough understanding of the openness/intellect domain as a whole, therefore, may lead to better theories of the link between creativity and risk for psychosis.

Openness/Intellect and Creativity

Creativity is typically defined as the generation of products that are simultaneously both novel and useful (J.C. Kaufman & Sternberg 2010). The second criterion is essential because it allows us to differentiate creative thought and behavior from thought and behavior that is merely eccentric or odd (Feist 1998) Usefulness is not limited to practical utility; creative works can also be deemed useful on intellectual or aesthetic grounds, which is why we prefer the terms *appropriate* or *meaningful* for this criterion. We note as well that creative products can be either material or abstract.

Based on the preceding definition, it is possible to conceive of creativity as a personality trait (the tendency to engage in creative activity and generate creative products), a process (the process by which a person generates creative products), or an appraisal of a product itself (Simonton 2003). Further, stable individual differences in creativity can take a variety of forms, and thus, when discussing creativity as a personality trait, it is useful to assess a broad range of constructs (e.g., Silvia et al. 2009). Examples include viewing oneself as a creative person, having creative hobbies, working on creative goals in everyday life, coming up with creative ideas in structured laboratory tasks, and attaining public markers of real-world creative achievement (Batey & Furnham 2006;

Carson et al. 2005; Feist 1998; Feist & Barron 2003; King et al. 1996; McCrae 1987; Silvia, J.C. Kaufman, & Pretz 2009; Silvia et al. 2008, 2009, 2012).

Regardless of how creativity is conceptualized and assessed, openness/intellect, more so than any other Big Five domain, is consistently and strongly related to it (DeYoung 2015; Feist 1998; J.C. Kaufman et al. 2010; S.B. Kaufman et al. 2015). This is true whether creativity is measured by performance on laboratory tasks or by real-life creative engagement and achievement. Further, creativity can be considered either a facet of or an outcome of openness/intellect depending on how it is conceptualized. Generally, if creativity is conceptualized as a trait (i.e., as individual differences in the tendency to be creative), then it can be considered a facet of the openness/intellect domain itself. Alternatively, if creativity is conceptualized as a characteristic of a product, then it can be considered an outcome of openness/intellect. For example, openness to aesthetics (a good marker of the openness aspect) predicted the creativity of fictional stories written in the laboratory and evaluated by expert judges using a consensual assessment technique (CAT) (Thrash & Elliot 2003). Another study found that openness/intellect correlated with the creativity of Thematic Apperception Test (TAT) stories and drawings (Dollinger, Urban, & James 2004). In these and similar cases, creativity, conceptualized as an appraisal of a product, can be viewed as an outcome of openness/intellect.

The relation of openness/intellect to creativity transcends domains. This is in contrast to the other four Big Five personality traits, which tend to relate to creativity inconsistently, weakly, or in a domain-dependent manner. For example, a study of the relations between the Big Five and creativity in five domains (general, math/science, drama, interaction, and arts) found that openness/intellect was the only Big Five trait to correlate positively with all domains of creativity (J.C. Kaufman et al. 2010). Similarly, Dollinger et al. (2004) assessed the relationship between the Big Five traits and creativity in the visual arts, literature, crafts, performances, music, and math/science and found a significant positive correlation between openness/intellect and every domain except music. (The correlation between openness/intellect and musical creativity was positive ($r = 0.14$), but it did not reach statistical significance. Other studies have found correlations between openness/intellect and musical ability and creativity [see Greenberg et al. 2015; S.B. Kaufman et al. 2015].)

Extraversion is the only other Big Five trait to reliably show positive correlations with creativity (see S.B. Kaufman et al. [2015] for a correlation with artistic creativity), but the patterns of correlation between creativity and extraversion tend to be weaker and less consistent than those of creativity and openness/intellect. In a latent class analysis of creative achievements (Silvia et al. 2009), people with creative achievements in any domain of creativity (visual arts or performing arts in this sample) were higher in openness/intellect than people with no creative achievements. People with achievements in performing arts, however, were higher in extraversion than the visual artists and people with no achievements. The effect of openness/intellect thus

was general, differentiating creative samples from noncreative ones, whereas extraversion's effect was specific, differentiating the kinds of creative domains people found appealing.

Additionally, a recent meta-analysis assessed the relation of the Big Five traits and creative self-beliefs, a broad set of characteristics including creative self-efficacy, creative personal identity, and self-rated creativity, in a number of domains (Karwowski & Lebuda 2015). Openness/intellect was consistently the strongest Big Five predictor of creative self-beliefs, and these relationships were strongest for domain general measures of creative self-beliefs. Consistent with this finding, Silvia et al. (2009) documented a strong relationship between openness/intellect and global creativity (assessed using the Creativity Scale for Different Domains) (J.C. Kaufman & Baer 2004). We do not attempt to solve the ongoing debate over whether there is a general creativity factor (analogous to a general intelligence factor) (e.g., Baer 1998, 2010; Silvia et al. 2009), but it is clear from the literature that the relation of openness/intellect to creativity pervades most, if not all, domains of creativity.

Given that creativity is central to the openness/intellect domain as a whole, and given that openness/intellect predicts creativity in nearly all domains, one might wonder about the utility in differentiating openness from intellect or in considering different domains of creativity. Until recently, little had been established regarding the discriminant validity of openness and intellect in the context of creativity, but recent work has provided evidence that openness and intellect differentially predict creative achievement. Specifically, in four demographically diverse samples (total N = 1,035), openness was found to independently predict creative achievement in the arts (but not the sciences), and intellect was found to independently predict creative achievement in the sciences (but not the arts) (S.B. Kaufman et al. 2015).[1] On a more fine-grained level, openness (but not intellect) correlated with creative achievement in music and film/theater, and intellect (but not openness) correlated with inventions and scientific discovery. Similarly, an earlier study using the NEO PI-R found that aesthetics, a facet of openness, related to artistic creativity and that ideas, a facet of intellect, related to scientific creativity (Perrine & Brodersen 2005).

This pattern of results for openness and intellect can be placed within a dual-process theoretical framework that differentiates type I processes that operate automatically from type II processes that require voluntary attentional resources (S.B. Kaufman 2011, 2013; J.C. Kaufman et al. 2010, 2015; Kahneman 2011). Artistic creativity seems likely to draw more heavily on type I processes associated with openness, such as implicit learning and pattern detection, whereas scientific creativity seems likely to draw more heavily on type II processes associated with intellect, such as reasoning and working memory. Thus it is useful to consider the different aspects of openness/intellect as well as different domains of creativity when examining relations among personality and creativity.

Regardless of how creativity is conceptualized and measured, it is consistently and robustly related to openness/intellect more so than to any other Big

Five trait. An obvious question raised by the research establishing this relation is why or how this relation comes about. In the following section we discuss cognitive, motivational, and neurobiological processes that may account for the link between openness/intellect and creativity.

Sources of the Link between Openness/Intellect and Creativity

Cognitive Processes

Openness/intellect is the Big Five personality trait most associated with cognition (Zillig, Hemenover, & Dienstbier 2002). There are several cognitive processes common to both creativity and openness/intellect, and these processes may help explain the strong association between them. Latent inhibition, for example, is an automatic process by which stimuli previously categorized as irrelevant are prevented from entering conscious awareness (Lubow 1989; Lubow et al. 1992). Although decreased latent inhibition is potentially maladaptive, being a common feature of psychosis (Baruch, Hemsely, & Gray 1988a, 1988b; Lubow et al. 1992), it can also benefit creativity and original thinking (Carson 2011). There is evidence that reduced latent inhibition is associated with both openness/intellect and creative achievement in high-functioning individuals (Carson et al. 2003; Peterson, Smith, & Carson 2002). Reduced latent inhibition may allow high-functioning individuals to consider more stimuli as potentially relevant, thus allowing for the novel and original associations important for creativity. Edgar Allen Poe (1899) once remarked, "Experience has shown, and a true philosophy will always show, that a vast, perhaps the larger portion of the truth arises from the seemingly irrelevant." This quotation highlights the idea that with adequate intellect, openness to the plausibility of seemingly irrelevant connections may help a person to discover new and useful ideas.

Implicit learning is another cognitive process that may allow those high in openness to detect associations and patterns in noisy and complex environments, thus contributing to their creativity. Much like latent inhibition, implicit learning is an automatic cognitive process, distinguished from more deliberate and conscious processes, such as working memory (S.B. Kaufman et al. 2010). Traditionally, individual differences in implicit learning were considered error or noise (e.g., Zacks, Hasher, & Sanft 1982), but more recent work has begun to treat implicit learning as an ability with meaningful individual differences (see Reber, Walkenfeld, & Hernstadt 1991; S.B. Kaufman et al. 2010). One study showed a double dissociation in which openness was independently associated with implicit learning but not with working memory, and intellect was independently associated with working memory but not with implicit learning (S.B. Kaufman et al. 2010). This finding is consistent with studies in which intellect (but not openness) was associated with working memory and with the hypotheses outlined earlier regarding the association of type I and type II processes

with openness/artistic creativity and intellect/scientific creativity, respectively (DeYoung et al. 2009; J.C. Kaufman et al. 2010).

Another cognitive process common to both creativity and openness/intellect is divergent thinking (McCrae 1987). Unlike intelligence or reasoning tasks that require people to *converge* on the one correct answer, divergent-thinking tasks invite participants to generate multiple clever, interesting, and creative responses (Plucker & Makel 2010). For example, participants might be asked to think of as many uses for a brick as they can. Responses can be algorithmically scored according to several criteria, such as the total number of responses made (fluency), the number of times participants switched between different categories (flexibility), and, for a given response, the portion of participants who also give that response (originality), with relatively infrequent responses earning more points for originality. The creativity of participants' responses can also be rated subjectively by others, and this approach appears to yield a better measure of creative potential than the more traditional algorithmic approaches (Benedek et al. 2013; Silvia et al. 2008). Creative thinking in the laboratory does not necessarily translate to creative outcomes elsewhere, and it is thus useful to know whether divergent thinking, as assessed in the laboratory, leads to real-life creativity (Jauk, Benedek, & Neubauer 2014).

Scores on traditional divergent-thinking tasks do indeed predict creativity outside the laboratory. For example, divergent thinking is related to creative achievement (Barron & Harrington 1981; S.B. Kaufman et al. 2015), the creativity of writing projects (Alpaugh et al. 1982), and the creativity of writing and art among academically advanced children (Runco 1986). Thus the ability of individuals high in openness/intellect to come up with original ideas is captured in their high performance on divergent-thinking tests (S.B. Kaufman et al. 2015; McCrae 1987).

Motivational Processes

For the abilities measured by laboratory tests of creativity to translate into real-life creative productions, a person must possess not only the potential to think creatively but also the *inclination* to be creative (McCrae 1987). Along with its cognitive components, openness/intellect encompasses a motivational component having to do with interest in novelty and complexity (DeYoung, Peterson, & Higgins 2005). This is consistent with our conceptualization of openness/intellect as involving a tendency or motivation to explore the world cognitively through perception and reason. At the core of openness/intellect is curiosity about information. This motivation to explore and tendency to find information rewarding may ultimately lead to novel ideas, the key to creativity.

In addition to the desire to explore novel ideas, one must be motivated to transform those ideas into creative products. Studies have found that inspiration, an approach-oriented motivational state, is associated with openness and creativity (Oleynick et al. 2014; Thrash & Elliot 2003; Thrash et al. 2010). Specifically, inspiration is posited to serve a transmission function such that an open

person is inspired by creative ideas and is subsequently motivated to transmit or actualize these ideas by turning them into creative products (Thrash et al. 2010).

One way to discern the motivational component of openness/intellect is to observe how people choose to spend time in their everyday lives. Cross-sectional research has found that people higher in openness/intellect have hobbies that involve making and creating as opposed to observing or participating (Wolfradt & Pretz 2001). Recent experience sampling and daily diary studies have shown that people higher in openness/intellect are substantially more likely to be doing something creative when signaled during a normal day (Silvia et al. 2014) and to report that they spent time on creative pursuits (Conner & Silvia 2015). Thus people's preferences for novel, creative activities are revealed by their spontaneous and voluntary activities in their real-world environments.

Shared Neurobiological Underpinnings of Openness/Intellect and Creativity

A number of findings suggest a similarity between openness/intellect and creativity at the neural level. Important evidence for this similarity has emerged from studies of resting-state functional connectivity, which assess patterns of synchrony in activation throughout the brain while people relax in a magnetic resonance imaging (MRI) scanner without working on a particular task. This method has allowed mapping of the major functional networks in the brain (Yeo et al. 2011). One of the most important of these has come to be known as the *default network*, a set of midline, temporal, and inferior parietal brain regions that tend to be active when people are awake but not engaged in externally directed tasks (see Chapter 3). The default network has been implicated in a range of cognitive processes that involve spontaneous and self-referential thought, such as mind wandering, day dreaming, autobiographical memory, future simulation, mental scene construction, and theory of mind reasoning (Andrews-Hanna, Smallwood, & Spreng 2014; Buckner, Andrews-Hanna, & Schacter 2008). Moreover, a growing literature suggests that the default network plays a critical role in creative cognition (Beaty et al. in press a; Jung et al. 2010; Spreng, Mar, & Kim, 2009; Takeuchi et al. 2012). Critically, the cognitive abilities noted earlier all draw on the capacity for imagination, which is central to openness/intellect.

In light of the apparent conceptual overlap between openness/intellect and the default network, DeYoung (2015) suggested that openness/intellect may be related to variation in default network functioning. This notion received support from neuroimaging research reporting increased functional connectivity between hubs of the default network and brain regions associated with cognitive control in individuals high in openness to experience (Adelstein et al. 2011). Beaty et al. (in press b) provided further evidence by examining the relation between openness/intellect and global functioning of the default mode network. Across two studies, the authors found that openness/intellect predicted

increased global efficiency of the default mode network, pointing to increased information processing within this network in people high in openness/intellect. Beaty and colleagues hypothesized that efficient access to the neurocognitive resources of the default network may partially account for the ability of people high in openness/intellect to generate creative ideas. Thus variation in the default mode network may be important for the link between openness/intellect and creativity.

In addition to similarities in brain function, parameters of brain structure have also been linked to both openness/intellect and creativity. Using diffusion tensor imaging, Jung et al. (2010) found that creativity (assessed using CAT with responses to a divergent-thinking task) and openness/intellect were both associated with decreased white matter integrity in the frontal lobes. A more recent study showed that this negative association was specific to the openness aspect and was not present for intellect (Grazioplene et al. 2016). This is consistent with findings that IQ is *positively* associated with frontal white matter integrity (Jung et al. 2010; Navas-Sánchez et al. 2014; Penke et al. 2012). Although decreased white matter integrity has been associated with reduced intelligence and risk for schizophrenia, it may also be associated with a more diffuse pattern of connectivity that facilitates divergent thinking and creativity.

Finally, openness/intellect and creativity appear to share a relationship with the neurotransmitter dopamine. The general function of the dopaminergic system is to promote exploration by facilitating engagement with reward or cues of reward (DeYoung 2013), which includes cognitive exploration prompted by the incentive reward value of information. There is behavioral, genetic, and neuroimaging evidence suggesting that variation in dopaminergic function is associated with variation in openness/intellect (DeYoung 2013; Passamonti et al. 2015).

In addition to its association with openness/intellect, dopamine also appears to be involved in many of the cognitive processes described earlier (i.e., reduced latent inhibition, working memory, and divergent thinking), which are related to both creativity and openness and/or intellect. Turning to creativity, neuroimaging studies have linked dopamine to performance on divergent thinking tasks (De Manzano et al. 2010). Studies have also found that creativity is predicted by eye-blink rate, which is a marker of dopaminergic activity (Chermahini & Hommel 2010; Depue et al. 1994). Thus the neurotransmitter dopamine appears to be common to both openness/intellect and creativity, and it may ultimately facilitate the cognitive processes that we have argued explain the openness/intellect–creativity link.

There is also evidence that dopamine influences the motivational processes described earlier. Dopamine facilitates exploration, and recent work suggests that dopamine plays a role in the incentive reward value of information and in the desire to explore cognitively (DeYoung 2013). Additionally, dopamine is hypothesized to influence the higher-order personality trait plasticity, which represents the shared variance between openness/intellect and extraversion (DeYoung 2013). In a study examining the factor structure of an integrative

model of creativity, inspiration was found to load highly (in fact, higher than openness/intellect or extraversion) on the plasticity factor (Ghisletta & Lubart 2014). Though this study did not directly examine whether dopamine is implicated in inspiration, theories regarding the role of dopamine in plasticity imply that this would be the case.

Conclusion

Openness/intellect is at the core of the creative personality. Despite historical disagreements over the interpretation of the openness/intellect dimension, its association with creativity is reliable and strong. This association is evident regardless of how creativity is assessed, and openness/intellect predicts creativity in nearly all domains of creative activity. By differentiating the two aspects, openness and intellect, one begins to see more fine-grained patterns of association. At the aspect level, openness is primarily associated with artistic creativity, and intellect is primarily associated with scientific creativity. This pattern of results points to the importance of attending to different traits within the openness/intellect trait domain as well as to the different domains in which creativity manifests.

Having established these relationships, researchers have begun to uncover the specific cognitive, motivational, and neurobiological mechanisms that may account for the link between creativity and openness/intellect. The cognitive processes divergent thinking, working memory, reduced latent inhibition, and implicit learning all share an association with both creativity and openness/intellect. Motivational processes linking openness/intellect include cognitive exploration, the reward value of information, and inspiration. At the neural level, diffuse white matter connectivity in the prefrontal cortex and functional connectivity within the default network may underlie both openness/intellect and creativity. Finally, dopamine, a neurotransmitter responsible for exploration and reward, is implicated in both openness/intellect and creativity. An integrated understanding of the basic neurobiological processes that underlie individual differences in openness/intellect and creativity can shed light on the purpose and function of these traits for our species.

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Note

1 Both openness and intellect exhibited significant positive zero-order correlations with creative achievement in the arts and the sciences, but the only significant unique relationships (controlling for the other aspect) were between intellect and scientific creative achievement and between openness and artistic creative achievement.