

**The Structure, Measurement, and Development of Openness to Experience Across
Adulthood**

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“What I have is a malevolent curiosity. That’s what drives my need to write and what probably leads me to look at things a little askew.” – David Bowie

Openness to experience is a fundamental and universal personality trait (McCrae & Costa, 1997). Forty years of research have substantiated that this trait captures individual differences in motivation to explore and tendency to think in ways both broad and deep (DeYoung, 2014; McCrae & Costa, 1997; McCrae & Sutin, 2009). Of the Big Five personality traits, however, openness to experience has always been the least understood. There is still much to learn about the structure of this trait (DeYoung, 2014) and its development across the lifespan (Schwaba, Luhmann, Denissen, Chung, & Bleidorn, 2017). Even the label that best summarizes the diverse contents of this trait is still a subject of debate – should this trait be called openness to experience, intellect, or open-mindedness (Soto & John, 2017)? Here, we will refer to the trait by the term openness, for the sake of simplicity. Perhaps the most intuitive way to understand this broad personality trait is through profiling a single paragon of openness.

Bowie, in Brief

David Bowie, the musician, actor, and iconoclast, was a paragon of openness to experience. An examination into the childhood of Bowie, born David Jones in 1947 in South London, reveals first and foremost an insatiable desire to consume and create art. By age 10, Bowie was playing piano, bass, and ukulele in a local Rock n’ Roll band. At age 14, he had become enamored with jazz and took up saxophone. At age 17 he released his first single, *Liza Jane*, as part of a short-lived blues quintet (Sandford, 1998). By all accounts, these initial musical attempts were rather dismal, especially compared to the remarkable stage presence that Bowie displayed. Bowie’s feel for the stage and improvisational dance ability led him to study avant-garde theater and appear in a few TV commercials (Sandford, 1998). While none of these

initial musical and theatrical ventures amounted to much, they reveal an adolescent with an insatiable hunger to consume and produce art, regardless of genre or mode of expression.

“At the end of every year, all the music papers would make their predictions for the coming year, and they invariably said that next year was going to be David Bowie’s year, and it never was. They said he was just too talented and too good-looking not to make it.” – Nick Kent

Bowie’s breakthrough came in spurts, first with the well-timed rock opera single *Space Oddity*, which was released just before the Apollo 11 lunar landing (Wolk, 2016), and then, a few years later, with the psychedelic album *Ziggy Stardust and the Spiders from Mars*. While touring for the latter album, Bowie assumed the character of Ziggy Stardust, an androgynous rock star in contact with aliens. Bowie’s decision (and ability) to remain in character during the entirety of the tour speaks to his uniquely vivid fantasy life and capability to be absorbed into his own art.

Bowie’s superstardom brought him to Los Angeles, where he assumed another alter ego, the Thin White Duke, for his chart-topping albums *Young Americans* and *Station to Station*. As the Duke, Bowie saw great commercial success, but his personal life fell apart. He became addicted to cocaine, developed a growing paranoia, and isolated himself from society. Bowie’s inability to separate the Duke character from his own identity reveals a maladaptive quality of his high openness – it was unclear whether Bowie controlled his art or his art controlled him. In 1976, Bowie left Los Angeles for Berlin, leaving the Duke behind.

Bowie’s move to Europe allowed him to showcase his creativity in a new, healthier way. Rhythmic music by German bands such as Neu! and Kraftwerk, which made use of the recently invented synthesizer keyboard, enraptured Bowie. Bowie incorporated this sound into his next three albums, *Low*, *Heroes*, and *Lodger*. These three albums eschewed the qualities that made

Bowie famous and instead focused on rather eccentric ideas, such as playing the chord structure from an earlier Bowie composition backwards (*Lodger's Move On*) and incorporating white noise into compositions (*Low's Always Crashing in the Same Car*). Despite critical acclaim, these albums did not sell as well as his previous efforts, but this did not matter much to Bowie. Bowie's eye was always on innovation and creativity, and his stardom followed almost incidentally.

The Structure of Openness

When distilling his biography, a few key components to David Bowie's personality emerge. Bowie was constantly creating art, seemingly driven by near-obsessive intrinsic motivation. He was readily absorbed into fantasy and reflection, especially when it came to alternate identities he assumed. Bowie was always exploring, making art that was somehow both easily accessible and complexly layered. In each of these cognitive, behavioral, and motivational aspects, Bowie was an exemplar of openness to experience.

Departing from the life of Bowie, we define openness to experience as such: openness to experience captures individual differences in the motivation to approach and create novel stimuli as well as in patterns of convergent and divergent thought. This definition draws heavily on the conceptions of openness provided by DeYoung (2015) and McCrae and Costa (1997).

Motivation to approach novel stimuli is seen in the goal-directed and presumably evolved tendency for open people to prefer the new over the familiar and for open people to approach rather than avoid unfamiliar concepts and experiences (DeYoung, 2015). *Motivation to create novel stimuli* captures the drive that highly open people have to make art and think outside the box (McCrae & Costa, 1997). *Patterns of convergent thought* are seen in openness' associations with intelligence, and perhaps at a more fundamental level, individual differences in the ability to

learn from patterns (DeYoung, Grazioplene, & Peterson, 2012). And finally, *patterns of divergent thought* are made apparent through openness' associations with breadth of thought (McCrae, 1987), fantasy and daydreaming, and, at the clinical extremes, with the false pattern perception more commonly seen in highly open people (DeYoung et al., 2012).

This definition delineates the four ingredients that we believe lie at the core of openness to experience, but the trait itself contains many intriguing emergent properties that merit further discussion. The rest of this essay can be divided into two main sections. First, we detail the history and structure of openness. We review how the trait was and is conceptualized, commonly used measures of openness, and how and why the openness is associated with creativity, culture, intelligence, and political orientation. Second, we describe and explain the development of openness across adulthood. This section follows openness from emerging adulthood, through midlife, and into old age¹. Beyond age, however, recent research has implicated other important experiences in the development of an individual's openness. We review those experiences in the final section.

Throughout this chapter, we go beyond description and into explanation. We attempt to explain why open people do what they do and what mechanisms may drive changes in openness. There are ample reasons to stick to description and prediction when it comes to personality; the two are difficult enough as is (Yarkoni & Westfall, 2017). But we believe that explaining and theorizing, in measured doses, makes for a more thought-provoking chapter.

A History of Openness

Long before a critical mass of studies identified openness as a major dimension of personality, researchers theorized about the importance of other, roughly similar, constructs to

¹In this paper, we exclusively discuss openness to experience across adulthood. For an extensive review of the emergence of openness and its structure in childhood, we refer readers to De Pauw, 2017

personality. A first line of research that came to influence our understanding of openness to experience was motivated by the atrocities of World War 2. Investigations into the personality underpinnings of authoritarian and fascism led to research that sought to measure and understand fascist personality traits (Adorno, Frenkel-Brunswik, Levison & Sanford, 1950) and dogmatism (Rokeach, 1960). Rokeach's writings were particularly useful to the concept of openness, as his book "The Open and Closed Mind" provided the trait's eventual name.

A separate line of research investigated how a person's patterns of thinking color how they perceive the world. Tellegen and Atkinson developed an absorption scale that measured hypnotic sensitivity and other perceptual components of openness (1974). Further, research into field-independence demonstrated associations between the way in which a person made sense of an ambiguous figure and their cognitive styles and social preferences (Witkin & Goodenough, 1977).

A final thread that would be spun into the cloth of openness was done by researchers seeking to understand optimal human functioning. The clinical psychologist Carl Rogers (1961) asserted that openness to inner experience must be regarded as a criterion of good mental health. Coan (1972) sought to understand optimal cognitive functioning in college students, examining concepts such as aesthetic sensitivity and constructive utilization of fantasy. Finally, Loevinger (1979) developed an ego development scale aimed at identifying individuals who had rich and varied inner lives.

These research traditions were eventually united by studies that sought to understand the structure of adult personality *in toto*. These studies used a statistical technique called factor analysis to partition many correlated questionnaire responses into a smaller set of underlying dimensions. For example, people who respond "yes" to the question "I tend to daydream" also

tend to respond “yes” to the question “I like art.” However, these two responses are unrelated to whether a person responds “yes” to “I keep my things organized” or “I arrive on time to meetings.” Factor analysis would indicate that two dimensions underlie these four questions, one that captures the associations between the first two questions (we might term this dimension openness) and another that captures the associations between the latter two questions (we might term this dimension conscientiousness). While researchers agreed that factor analysis was an appropriate tool to understand the dimensions underlying personality, they were divided on the question of where to gather the material for an omnibus questionnaire that measured all of the important dimensions (John, Naumann, & Soto, 2008). Some researchers, the lexical group, believed that all important descriptors of individual differences would be found in natural language (Allport & Odbert, 1936). That is, the omnibus personality questionnaire should be built by consulting the dictionary. Other researchers, the questionnaire group, believed that the lexical group was too restrictive, because sometimes entire phrases are needed to capture an important individual difference (McCrae, 1990). This group believed that the omnibus personality questionnaire should be built by combing through existing questionnaires and selecting a diverse set of questions taken from these questionnaires.

Both the lexical and questionnaire groups, following their preferred methodology, found that human personality was best described by five factors (neuroticism, extraversion, conscientiousness, agreeableness, and openness to experience), and that this five-dimension solution replicated across multiple samples in the US and Europe (Digman, 1990). The fifth and final dimension to emerge was termed openness to experience (by the questionnaire group) and intellect (by the lexical group; McCrae & Costa, 1997). After the resolution of disagreements between these two camps (McCrae, 1990; Saucier, 1992), the term openness to experience

eventually gained traction as the de facto descriptor of the various affective, behavioral, and cognitive tendencies that comprise the fifth personality factor.

Modern Conceptualizations of Openness to Experience

Despite agreeing in principle on naming the trait openness to experience, the actual content of the trait differs depending on what measurement instrument one uses to assess the trait. Openness measures derived using the questionnaire methodology, such as the NEO-FFI inventory, emphasize the importance of motivational and experiential components in the trait (McCrae & Costa, 1997). Openness measures derived using the lexical methodology, such as the IPIP inventory, emphasize the importance of intellectual, cultural and cognitive components in the trait. Differences between questionnaire-derived and lexically-derived openness scores are more substantial than for the other four Big Five traits; NEO openness and IPIP openness only correlate about .5 (Goldberg, 1992). There is thus value in reviewing the specific content of the most commonly used openness questionnaires, as doing so allows us to better understand the current resting place of the questionnaire and lexical conceptualizations of openness as well as the construct of openness as a whole.

NEO Inventories

The flagship openness measures from the questionnaire tradition are the NEO series of inventories, developed by Costa and McCrae (1992). These inventories measure a broad and motivationally inclined latent openness construct. Costa and McCrae believed that the measurement of personality should, as best as possible, exclude measurement of ability. Therefore, the NEO asks whether the respondent is curious about e.g. theories and abstract ideas, but purposefully avoids interrogating the respondent about their ability to understand these theories and abstract ideas. The NEO-PI-R investigates six particular openness facets identified

by Costa and McCrae: openness to aesthetics and fantasy, which compose the center of the trait, openness to ideas, which relates more closely to the psycholexical conceptualization of openness as intellect, openness to values, which measures political orientation, openness to feelings, which measures breadth and depth of emotion, and openness to actions, which measures a blend of openness and extraversion (DeYoung et al., 2012). In abridged versions of the 240-item NEO inventory, the intellect and aesthetic facets are retained along with a blended “unconventionality” facet that contains a mixture of values and fantasy (Saucier, 1998).

IPIP inventories

The flagship openness measures of the lexical tradition come from the International Personality Item Pool (IPIP) Project (Goldberg, 1992; Goldberg et al., 2006). Goldberg and colleagues were less averse about including ability in their measurement of openness, perhaps because words such as “thoughtful,” “smart,” and “bright” are commonly used trait descriptors in the English language. Lexically-derived openness questionnaires therefore hew closer towards the measurement of ability and are more highly correlated with intelligence tests than the NEO inventories (DeYoung et al., 2012). The most extensive version of the IPIP openness inventory also distinguishes six trait facets: intellect, imagination, artistic interests (which is highly associated with NEO openness), emotionality, adventurousness, and liberalism. A further contrast between the IPIP and the NEO is their ability for use by researchers. While the NEO inventories require written permission to use, the IPIP inventories are freely available for any interested person to use at ipip.ori.org.

Other Measures of Openness: The BFI and BFAS

While the discrepancies between lexically-derived openness and questionnaire-derived openness are the most compelling, and illustrate stark differences in trait conceptualization, there

are a few other openness measures in common use today. These measures tend to conceptualize openness as somewhere in the between. One commonly used inventory is the Big Five Inventory (BFI), developed at Berkeley (John et al., 2008). The BFI, in its initial form, did not have a clear lower-order facet structure, which was addressed in the creation of the recent BFI-2 (Soto & John, 2017). The BFI-2 takes an ideological stance on the naming of openness, re-termining it open-mindedness. Further, while each of the other four traits in the BFI-2 have a central facet that best describes the trait, openness' three facets are given equal importance, reflecting the authors' opinion that there is no center to openness. These facets are creative imagination, aesthetic sensitivity, and intellectual curiosity.

A final omnibus personality measure commonly used in the assessment of openness is the Big Five Aspect Scales (BFAS; DeYoung, Quilty, & Peterson, 2007). The BFAS explicitly acknowledges the discrepancies between the lexical and questionnaire traditions by terming the trait Openness/Intellect. Rather than facets, BFAS openness measures two interstitial aspects of the trait: openness, which is more associated with aesthetic sensitivity, fantasy, and reflection, and intellect.

Correlates of Openness

To better understand the construct of openness, researchers have examined the associations of openness measures with various other measures of emotional, behavioral, and cognitive tendencies, goals, abilities, and values. These associations allow researchers to refine and revise theories about what openness is, and what it isn't. Some associations are rather intuitive. People who report that they are intellectually curious also report that they tend to speculate on the nature of the universe (McCrae & Costa, 1997). Other associations, however, are thought-provoking. People who enjoy abstract art also tend to vote for liberal political

candidates (McCrae, 1996). In this section, we describe and explain four major correlates of openness: creativity, intelligence, culture, and political views.

Openness and Creativity

Although the lexical and questionnaire groups disagree on many of the finer points about openness, both agree that creativity is a major component of the trait. Indeed, according to Saucier (1992), creativity may be the best summary term for the common space shared between lexically-derived openness and questionnaire-derived openness. Open people tend to be creative, in both senses of the word (Kandler et al., 2016). That is, creative people *create* cultural products, such as pop songs, and come up with *creative*, innovative ideas, such as pretending to be an alien while on tour. A plethora of research over the years has investigated associations between personality and performance in creativity tasks, such as writing down all the uses one can think of for a brick in a span of five minutes. This research has consistently found that openness is the strongest predictor of creativity test performance (McCrae, 1987; Silvia, Nusbaum, Berg, Martin, & O'Connor, 2009; extraversion also tends to predict performance, but less strongly). Additionally, people who score high in different aspects of openness tend to be creative in different ways. Kaufman and colleagues (2016) measured openness with the BFAS and split the trait into its openness and intellect aspects. Across four samples, they found that, when both of these facets were entered simultaneously into a predictive model, the aspect of openness predicted creative achievement in the arts, while the aspect of intellect predicted creative achievement in the sciences.

To explain these associations between openness and creativity, Kaufman and colleagues (2016) put forth a compelling dual-process model. They theorize that people who are open to experience may possess a combination of divergent and convergent thinking skills that allow

them to access and select semantically distant concepts. Asked to name a four-legged animal, a person who is not very open to experience may have the lexical concepts of “dog” and “cat” brought to mind, while a person scoring high on openness may have the divergent concepts “dog,” “cat,” and “buffalo,” brought to mind. Further, this highly open person may possess the convergent thinking ability to override their predominant feline and canine responses, providing an out-of-the box answer of “buffalo.” Beyond this, Kaufman and colleagues suggest that different facets of openness may be differentially associated with these two modes of thought. The facet of intellect may be particularly relevant to convergent thinking, while the facet of aesthetic sensitivity may be particularly relevant to divergent thinking. This hypothesis is intriguing but has yet to be seriously tested. One roadblock that prevents easy testing of this theory is that even common divergent thinking tasks, such as thinking of multiple uses for a brick, require convergent thinking to some extent because participants must select particular answers (convergently) from all that come to mind (divergently). To better understand the mechanisms that connect openness with convergent thinking, and divergent thinking, researchers must get creative with their assessment of creativity.

Openness and Intelligence

There has been a longstanding interest in the associations between personality and intellectual ability (Cattell, 1943). This research has found evidence that openness, more than any other Big Five trait, is associated with the general factor of intelligence, *g*, and its major subcomponents, fluid intelligence and crystallized intelligence (DeYoung et al., 2005; Ashton, Lee, Vernon, & Jang, 2000). These correlations vary by study, but are typically in the range of .2 to .4, which is as high or higher than the correlation between intelligence test scores and self-reported intelligence (Gignac, Stough, & Loukomitis, 2004). Fluid intelligence, which measures

reasoning *ability* (e.g. whether participants can correctly solve a novel puzzle that they have encountered before) is more highly associated with the intellect pole of openness, while crystallized intelligence, which measures accumulated reasoning *knowledge* (e.g. vocabulary) is associated with both intellect and openness (DeYoung et al., 2012, DeYoung, Peterson, & Higgins, 2005). These associations between openness and intelligence seem to be confined to the domains of semantic, logical, and visuo-spatial knowledge. Openness is not highly associated with mathematics ability (Ashton et al., 2000) or mathematics SAT scores (Nofle & Robins, 2007).

One partial explanation for the associations between Openness and intellectual abilities is differential investment (Ackerman, 1996; Cattell, 1946). Open people enjoy learning and more commonly engage in educational activities such as reading and attending museums (Schwaba et al., 2017). As open people spend time learning, their intelligence may increase. Simply put, open people want to learn and like to learn, so they learn a lot, and they become smart.

One recent study tested this differential investment hypothesis by examining the links between openness and musical discrimination ability (Thomas, Silvia, Nusbaum, Beaty, & Hodges, 2016). In this study, people who scored higher on openness were better at discriminating between similar sounding tones, but this effect was only found because those who scored higher on openness also tended to have more formal musical training. People who scored high on openness but who were musical novices were no better at the tone discrimination task than those who scored low on openness. These findings and others suggest that investing in enriching environments indeed drives associations between openness and intelligence (Ziegler, Danay, Heene, Asendorpf, & Buhner, 2012, but see Soubelet & Salthouse, 2010, for a contrasting perspective).

Openness and Culture

“[Bowie and I] were being given a personal tour of the Vatican, and we’re going from room to room and... gradually David starts talking about the pictures himself. He’s talking about Botticelli and he’s going into the history of Medici, and he’s going into extraordinary detail about the paintings and their provenance, and he’s like the Pied Piper of Hamelin. So I look around and there is now a line of people behind us, and soon that line is full of fifty people or so, and they all think that David is the official tour guide. They have no idea who he is, they don’t know that he’s David Bowie, they’re just listening to someone give them a history lesson.”

– Alan Edwards

Openness and the production and consumption of culture are highly intertwined, to the extent that some inventories measure openness through items that explicitly assess a person’s artistic preferences (cf Soto & John, 2017). As exemplified in David Bowie, highly open people tend to enjoy art, music, reading, and the theater (Kraaykamp & Van Eijck, 2005). And, within these modes of cultural expression, openness predicts specific cultural taste. For example, open people tend to enjoy abstract art more than their closed to experience peers, who prefer representational art (Belke, Leder, Strobach, & Carbon, 2010). These interests also extend to real-world behavior -- open people are more likely to visit cultural institutions such as museums, the theater, and concerts (Kraaykamp & Van Eijck, 2005; Schwaba et al., 2017).

A recent model of aesthetic preferences, developed without openness in mind, may partially explain why open people gravitate towards culture. Graf and Landwehr (2015), in their Pleasure-Interest model of Aesthetic liking, posit that aesthetic appreciation is driven by two processes. First, immediately after seeing an aesthetic object, people make a snap decision about how fluently the stimulus as a whole can be processed that determines how much they like the

object. This fluency “sweet spot” differs from person-to-person. Highly open people, who prefer complexity and novelty, may enjoy art that is relatively disfluent. After this first judgment, people who process the aesthetic object more fully then judge it based on the extent to which they understand the art and it remains interesting to them. If the art remains confusing (is too disfluent) or is boring (isn’t disfluent enough), they like it less. Highly open people may be more motivated to process the aesthetic object more deeply, and they may subsequently derive more meaning from it than people who are less open. However, because of their high tolerance for disfluency, open people may grow bored more easily. This relatively simple model may explain, at least in part, why open people tend to engage with complex culture. An obtuse Bowie song may appear dense and confusing at first listen. But highly open people enjoy this difficulty, find motivation to engage with it further, appreciate the difficulty in understanding the song, and eventually come to understand and enjoy it.

Openness and Political Views

A final correlate of openness that merits discussion is between openness and political views. Specifically, open people tend to be politically liberal: they advocate for social change and they reject inequality, and these correlations are substantial ($r =$ about .35) and greater than for other Big Five personality trait (Jost et al., 2003). As with culture, political views are central enough to the construct openness that openness questionnaires often include items measuring political orientation. But political preference correlates highly with openness even if you omit this facet (McCrae, 1996).

The attitudinal qualities associated with openness may explain these associations. Highly open people tend to believe strongly that diversity of opinion is a good thing, and they tend to distrust groups that appeal to authority as a source of truth (McCrae, 1996). When open people

apply these attitudes to form political preferences, they are attracted to the liberal ideals of progress and equality and repelled by the conservative ideals of tradition and respect for authority.

However, there is still much work to be done to fully understand associations between openness and politics. In particular, the extent to which these associations generalize to other political systems remains unclear. One study that compared measurement properties of the NEO-PI-R across US, Mexican, and Filipino samples found that the political values facet of openness was the *least* culturally-comparable of any Big Five personality facet (Church et al., 2011). If political values are indeed so central to openness that they can be used to measure levels of the trait, we would hope that these associations remain invariant across cultures.

Interim Summary

At this point in the chapter, we have synthesized a common definition of openness, reviewed the trait's structure and outlined some important trait associations. In other words, we've described open people as they are at a single point in time. But to truly understand openness, the trait must be considered longitudinally. For the remainder of this chapter, we will focus on describing and explaining the development of openness at the population and individual levels.

Ch-Ch-Changes: The Development of Openness to Experience Across Adulthood

"Time may change me, but I can't change time" – David Bowie

An early tenet in psychology was that personality tends to be set like plaster around age 30 (Allport, 1961; Block, 1971; McCrae & Costa, 1990). At this point in time, however, a massive body of research has been collected that definitively overturns this position. Personality

can, and does, change throughout the lifespan (Roberts & DelVecchio, 2000; Roberts, Walton, & Viechtbauer, 2006). These changes come in three important types (Schwaba & Bleidorn, 2017a).

The first type of change is mean-level change, which measures the average amount of *absolute* change in a personality trait across time. Mean-level change addresses the question, “how does the average person tend to change in their openness over time?” Second, and independent of mean-level change, are individual differences in change. An estimate of individual differences in change quantifies the amount of heterogeneity around the mean-level change trajectory. It addresses the question, “to what extent are people changing differently than the mean-level trend?” Finally, rank-order change measures the average amount of *relative* change in a sample over time. It addresses the question, “if we were to order a sample of people from most open to least open, wait an amount of time, and measure their openness again, how different would the order be?” For a more detailed explanation of these three measures of change, we direct the interested reader to Schwaba and Bleidorn (2017a). In the next section, we summarize the current state of research on mean-level, individual-level, and rank-order change in openness across the adult lifespan. We focus on three particular life stages: emerging adulthood, midlife, and older age.

Emerging Adulthood

“When I was 18, I thought that, to be a romantic, you couldn’t live past 30.” – David Bowie

Emerging adulthood is a life stage characteristic of modern, developed societies (Arnett, 2000). It describes the ages between roughly 18 and 30 when young adults typically explore in the domains of work and love, before they commit to adult identities (Arnett, 2000; Erikson, 1959). The mean-level development of openness to experience across emerging adulthood is a

research question that is still under investigation. Some research has found mean-level increases in openness during emerging adulthood (Roberts et al., 2006). Other research has found mean-level stability (Schwaba et al., 2017; Specht, Egloff, & Schmukle, 2011; Wortman, Lucas, & Donnellan, 2012). One hypothesis that accounts for these inter-study differences is that increases in openness during emerging adulthood are driven by the identity exploration central to this life stage. If different samples of emerging adults are differentially engaged in identity exploration, openness changes will vary from sample to sample (Bleidorn & Schwaba, 2017). Bleidorn and colleagues (2013) provided an initial investigation into this hypothesis using cross-sectional data from over 800,000 participants in 62 nations. They found that, in nations like Pakistan, where the average age of marriage and entering the workforce was earlier, age-related increases in openness were less strong. In nations like the Netherlands, however, where people tend to delay marriage and entrance into the workforce, increases in openness during emerging adulthood were steeper.

Beyond these mean-level increases in personality, emerging adulthood also appears to be the life stage with the most substantial individual differences in openness development (Schwaba & Bleidorn, 2017a) and the most rank-order change in openness (Roberts & DelVecchio, 2000). That is, during emerging adulthood, there are many people who are becoming much more open to experience and much less open to experience, making it more difficult to predict a person's future openness during emerging adulthood than at any other point in adulthood. These findings are also consistent with the notion of emerging adulthood as a period of identity exploration. Within a particular nation, not everyone follows the same progression and timing of life events. Americans who spend their 20s pursuing graduate education, dating around, and moving from

place to place, may increase in openness, and those who marry immediately after high school may decrease in their levels of the trait.

Overall, openness development during this stage is best understood as a time of relative heterogeneity in development. People take many paths through emerging adulthood, and the development of openness appears to be similarly variable.

Middle Adulthood

“I had such a struggle letting go of youthful things and learning how to exist and have enthusiasm while settling into the comfort of an older age.” – David Bowie

Middle adulthood, which we define as ages 30-60, is a relatively placid time in the development of openness. Mean levels of the trait appear to be relatively stable during this period, and there are fewer individual differences in openness development during this life stage than emerging adulthood (Schwaba et al., 2017; Schwaba & Bleidorn, 2017a). Rank order change decreases throughout middle adulthood, reaching its nadir at around age 60 (Roberts & DelVecchio, 2000; Wortman et al., 2012).

One common explanation for stability in openness across midlife, which appears across the Big Five personality traits, has been termed the cumulative continuity principle of personality development (Roberts et al., 2001; but see Costello, Saucier, & Srivastava, 2017). As they navigate midlife, people reach the peak of their ability and motivation to create stability in their environments. A person’s week-to-week environment across midlife may be remarkably repetitive, and with few environmental presses rewarding increases or decreases in openness, the trait may tend to remain stable (Caspi & Moffitt, 1992). We argue that this stability is a good thing for those committed to adult roles. Sticking to a single career allows one to develop steady sources of income. With children, one cannot easily move residences, and a person will probably

strain their marriage if they are still changing their core beliefs and behaviors in their mid-50s.

This is not to say that openness cannot change in midlife (as we will see later), but that for most people, it tends not to.

Older adulthood

“It’s the lack of years left that weighs far heavier on me than the age that I am” – David Bowie

“David was very much about growing. He was very much about changing and learning and becoming a better man. That was very eminent in his last fifteen to twenty years.” – Bebe Buell

Ages 60 and up are a time of resumed openness development at the population level. Across all large nationally-representative longitudinal studies of openness, mean levels of the trait decline increasingly rapidly across old age (Schwaba et al., 2017; Specht et al., 2011; Wortman et al., 2012). In terms of absolute magnitude, these changes of .5 to 1.5 standard deviations are the largest of any mean-level Big Five personality changes at any point in the lifespan. Further, during older adulthood there is the least heterogeneity in openness development – most people develop according to this decreasing trajectory (Schwaba et al., 2017).

Socioemotional Selectivity Theory (SST; Carstensen, Fung, & Charles, 2003), developed to explain affective processing and motivational changes in older adults, fits well as a partial explanation for mean-level openness decreases across older adulthood. SST posits that, as people near the end of their lives, they become less motivated to explore new domains and more motivated to savor what (and who) they already know. SST makes the claim that exploring is rewarding mostly because doing so offers extrinsic rewards such as social and cultural capital

that can prove valuable in the future (see also DeYoung, 2015, on the value of exploration). For older adults, who are nearer to death and who have already invested in exploration throughout their lives, trying new things and meeting new people is less valuable. Retirees don't need to build skills or social networks for future career success -- their career is over. And, given the choice between spending their last years alive with loved ones or with strangers, the choice for most older adults is obvious.

However, SST does not effectively explain openness declines found among highly open people. For people like David Bowie, exploration is most likely an intrinsically rather than extrinsically motivated behavior. To accompany the theoretical propositions made by SST, we posit that declines in intelligence and physical ability that come with old age may lead older adults to decline in openness.

Earlier in this article, we reviewed the cross-sectional associations between openness and both fluid and crystallized intelligence. A wealth of research has shown that mean levels of fluid intelligence peak in emerging adulthood and decline afterwards, while mean levels of crystallized intelligence peak later, around the mid-60s, and decline afterwards (Ronnlund, Nyberg, Backman, & Nilsson, 2005; Salthouse, 2010). Further, research has demonstrated that openness and intelligence tend to codevelop (Ziegler et al., 2012; Zimprich, Allemand, & Dellenbach, 2009) As aging older adults decline in intelligence, particularly crystallized intelligence, they may become less creative, less imaginative, and have fewer novel ideas. That is, the ability of people to be open may decline in older adulthood, spurring openness decreases.

Additionally, although openness has been conceptualized as primarily a cognitive construct, physical functioning plays a role in the trait's development as well. In a particularly dramatic example, a shoulder injury forced Bowie to end his touring career – his body was no

longer capable of performing for nights on end. In more quotidian cases, arthritis, declines in vision, and mobility problems may prevent people from attending Bowie tribute band concerts, using the computer, or reading the newspaper. People who are forced to divest from high-openness behaviors due to physical decline may subsequently decline in openness (Wrzus & Roberts, 2017).

In summary, older adulthood is a time of mean-level openness decreases. These changes may be driven by normative declines in both the extrinsic and intrinsic value of openness, as well as decreases in mental and physical functioning that come with old age.

Explaining an Individual's Openness Trajectory

As we have just shown, age is a major factor in the development of openness. If we know a person's age, we can predict how they may change in openness in the future. But, as there are substantial individual differences in openness change throughout the lifespan, age-graded experiences cannot be the only factor driving openness development (Allemand, Hertzog, & Zimprich, 2007; Robins, Fraley, Roberts, & Trzesniewski, 2001; Schwaba & Bleidorn, 2017a). In the following section, we investigate how genes and environment contribute to individual differences in openness development, as well as specific "candidate environments" that have been associated with the development of openness.

Nature and Nurture

"[Bowie] talked about his brother a little, as he was worried that he might have that potential [schizophrenia] gene, and that he could go off the rails the same way. Maybe it was true, but he just channeled whatever it was into a different direction" – Mick Garson

At the most fundamental level, explaining individual differences in openness development is a matter of nature versus nurture. Behavioral genetic studies have tracked sets of

twins across their lives to understand the relative contributions of genetics and environment to personality development (Briley & Tucker-Drob, 2014). Because identical twins share the same set of genes and fraternal twins share, on average, 50% of their genes, estimates of personality development that take this genetic similarity into account can partition change and stability into genetic and environmental components. Behavioral genetic studies have found that change in openness is roughly driven about half by genetic influences and half by environmental influences, and that environmental influences tend to make people different from one another rather than similar to one another (Bleidorn et al., 2009; Briley & Tucker-Drob, 2014).

After finding that personality development is guided substantially by genetics, a logical next step is to identify the specific genes that guide development. Unfortunately, researchers' lack of success in identifying particular genes associated personality traits in cross-sectional research has precluded research into developmental "candidate genes." Cross-sectional research on theoretically viable "candidate genes" that may influence personality traits has proceeded entirely unfruitfully (Chabris, Lee, Cesarini, Benjamin, & Laibson, 2015). Personality traits instead appear to be driven by a combination of very many genetic variants (Chabris et al., 2015). It makes intuitive sense that a single gene could not code for a behavioral pattern as broad as "creativity." However, even molecular genetic techniques such as genome-wide association, which investigate the entire sequenced genome instead of a few candidate genes, have only been able to predict about 10% of the observed variability in openness (Lo et al., 2017). While genetics clearly play a substantial role in openness development, asking "which genes matter" is, at least as of now, a dead-end question.

A similar line of questioning can be applied to understand how the environment drives openness development. Because about half of the variance in openness development is due to the

effects of the environment, researchers have begun to identify candidate experiences that may reliably affect openness development. Compared to a single gene, a single experience (such as studying abroad) often encapsulates a broad set of environments that put many points of pressure on personality development. In the next section, we describe and explain the candidate experiences that have been associated with change in openness. These experiences fall into three broad categories. First, events in the domains of work and love have been associated with openness development (cf. Bleidorn, Hopwood, & Lucas, 2017). Second, changes in mental and physical functioning have been associated with changes in openness to experience. Third, a collection of “mind-expanding” experiences have been associated with increases in openness.

Events in the Domains of Work and Love

Commonly experienced life events, such as entering college, having children, and retiring, may be catalysts for personality development, in part due to their wide-reaching consequences. As people anticipate, experience, and adapt to major life events, they make lasting changes to their behavioral repertoires, and they reconfigure their identity to conform to a new role with different expectations (Wrzus & Roberts, 2017; Roberts, Wood, & Caspi, 2008; Wood & Roberts, 2005). These changes may coalesce into lasting personality trait change.

In the domain of work, promotion, involuntary job loss, and retirement have been associated with changes in openness. With respect to promotion, a recent study of Australian workers found that people scoring high on openness were more likely to be promoted into managerial and professional positions at their jobs, and that these promotions corresponded to subsequent increases in openness measured four years later (Neiss & Zacher, 2015). After a promotion, managers may be thrust into a set of novel environments that prioritize learning: they must learn to work with new people and grapple with new ideas, and they often move to new

locations for their new job. To the extent that a recently promoted person adapts to this new environment, they are rewarded with success in their new job role, offering powerful incentives to increase in openness.

Beyond this, openness has also been shown to increase after a person is involuntarily laid off from their job. In a clever epidemiological study, Anger and colleagues examined changes in personality among workers who were unemployed due to manufacturing plant closure (2017). Because plant closure is almost entirely out of employees' control, this study allowed the authors to better disentangle cause and effect than in previous studies. Those who were unemployed for short amounts of time tended to increase in openness in the following years. The mechanism behind openness increases in unemployed workers may be similar to that driving openness increases following promotion. As people find and adapt to a new job, they must adapt to a novel work environment and learn the tools of the trade.

Finally, a recent study that investigated personality trait development across the transition to retirement found abrupt increases in openness corresponding to the month after retirement (Schwaba & Bleidorn, 2017b). During the five years before they retired, people tended to decrease in openness, consistent with the age-graded mean-level trends in older adulthood. But, in the month after they retired, people showed rapid increases in openness that were gradually counteracted over the following five-year period. This study was one of the first to investigate temporal patterns of personality development in response to an event. Openness increases appeared to evaporate with time, suggesting that the event-occasioned changes are impermanent and eventually overridden by other developmental influences, such as age-graded development. This short-lived increase in openness may reflect a brief exploratory period accompanying retirement. After leaving work, retirees must refill their day-to-day schedule, and this rebuilding

process may initiate a period of identity and behavioral exploration that soon ceases as retirees settle into their new role.

“When Angie [Bowie’s ex-wife] married David I think there was an arrangement where they would be free.” – Lindsay Kemp

Moving from the domain of work to the domain of love, both marriage and divorce have been associated with changes in openness. With respect to marriage, Specht and colleagues (2011) studied a large, nationally representative sample of Germans and found that, in the years after they married, both men and women tended to become less open to experience. For many people, marriage may signal the end of emerging adulthood and a conclusion to identity exploration. In the same study, Specht and colleagues also found that men, but not women, who divorced from their partner tended to increase in openness in the following years (2011). The authors termed this finding the “dirty diapers effect,” implying that divorced men may have a lot to learn in terms of childrearing once their spouse leaves, and this rapid accumulation of knowledge may lead to changes in openness. An alternative explanation for this finding is that men who are divorced often re-enter the dating world and begin to re-explore their interpersonal identity, leading to increases in openness.

Changes in Functioning

“After his heart attacks in 2004, and the subsequent operation, [Bowie] mellowed out completely.” – Dylan Jones (2019)

Changes in cognitive and physical functioning have also been associated with changes in openness to experience. Earlier in the chapter, we briefly reviewed two studies that found co-development between openness and intelligence in older adulthood (Zimprich et al., 2009; Ziegler et al., 2012). Beyond those observational studies, two additional studies have taken an

experimental approach to better understand how increases in cognitive functioning may cause increases in openness (Jackson et al., 2011; Sander et al., 2017). The initial Jackson and colleagues (2011) study followed 78 older adults who were part of a 16-week sudoku-and-crossword brain training program and 88 who were part of a waitlist control group. Across a period of 30 weeks, the experimental group increased in openness compared to the control group. This difference emerged gradually across the training sessions and generalized to each facet of openness. The second Sander and colleagues (2017) study measured 167 adults who participated in a 100-day long cognitive training intervention that consisted of one hour daily of basic perceptual speed, episodic memory, and working memory tasks. Development in this group was compared to a 71-adult control group. This study provided a more stringent test of whether or not cognitive training causes openness increases, as personality was measured two years after the intervention concluded. In this study, no between-group differences in openness development were found.

Time may be the moderating factor that explains why Jackson and colleagues found openness increases while Sander and colleagues did not. It may be that cognitive training regimens can bring about changes in identity such that someone sees themselves as more curious, intellectual, and creative in the short term, but these changes may eventually wear off rather than metastasize into lasting openness trait change. Indeed, a large body of research has failed to identify a single “brain training” game that builds broader cognitive skills (Simons et al., 2017). In other words, doing crossword puzzles may make a person better at crossword puzzles, and she may think of herself as more open because of this, but this practice won’t actually make her any better at solving math problems, and as soon as she stops solving crossword puzzles, her openness may return back to where it was.

Change in physical functioning, and exercise in particular, may also be relevant to the development of openness. Open people tend to be more physically active, possibly through a common link between openness and extraversion (Sutin et al., 2016). And, as people exercise more frequently, they tend to become more open than their sedentary peers (Stephan, Sutin, & Terracciano, 2014). In an aerobic exercise intervention targeted at sedentary older adults (N = 40), those who exercised rather than stretched over a period of 3 months exhibited greater levels of regional cerebral blood flow and volume as well as improvement on recognition memory tasks (Maass et al., 2011). This study, though it had a small sample size, provides a potential mechanism that explains the associations between exercise and openness. Exercise both spurs neurogenesis and improves blood flow to the brain, and these biological changes may lead to cognitive benefits that spill over into a broader increase in openness.

Overall, decreases in mental and physical functioning have been associated with decreases in openness, but it remains an open question as to whether interventions can cause increases in mental functioning that may lead to lasting increases in openness.

Mind-Expanding Experiences

A final set of experiences associated with openness change are those that fall under the loose umbrella of “mind-expanding.” These experiences include engaging in cultural activity, studying abroad, and using hallucinogenic drugs.

As mentioned earlier, openness and cultural experiences are closely related (Kraaykamp & van Eijck, 2005). On a longitudinal scale, as well, openness and cultural activity tend to codevelop. People who begin to attend more concerts, museums, and art galleries tend to become more open in the future, and vice versa (Jackson, 2011; Schwaba et al., 2017). What may be more surprising is that this association is found across the lifespan – openness and cultural

activity were found to codevelop similarly in emerging adults (age 16-26), in midlife (age 26-65) and in older age (age 65+; Schwaba et al., 2017). Although older adults show fewer individual differences in openness development than younger adults, changes in cultural activity appear to be related to individual differences in openness development at all ages. These changes may be due to changes in exploratory tendencies. For people who want to explore and be intellectually engaged, a perfect outlet may be a trip to the theater or a museum.

Studying abroad is another cultural experience that may provide a heavy and sustained dose of mind expansion, especially for those who immerse themselves in the local culture. In a quasi-experiment, Zimmermann and Neyer (2013) measured personality change in a sample of college students who studied abroad and compared change to those who signed up to study abroad but were put on a waitlist instead. Those who studied abroad tended to become more open to experience compared to the control group. The mechanism behind this change may be, in part, engaging with the mind-expanding novel environments, new people, and unique cultural experiences made possible by studying abroad. Additionally, in mediation analyses, Zimmermann and Neyer identified that people who made many friends while abroad tended to increase more on openness than those who did not. This provides evidence for a social mechanism in openness change. Perhaps meeting and befriending people from different backgrounds is a particularly horizon-broadening experience.

Open people also appear to be more attracted to mind-expanding drug experiences. While openness is not associated with alcohol use, cigarette use, cocaine use, or heroin use, people scoring higher on openness are more likely to use marijuana (Ruiz, Pincus, & Dickinson, 2003; Terracciano, Lockenhoff, Crum, Bienvu, & Costa, 2008). Use of marijuana, and other psychoactive drugs such as psilocybin mushrooms and LSD, appear to boost state openness, and

a compelling area of research has begun investigating how use of these drugs may occasion openness change. (Lebedev et al., 2016; MacLean, Johnson, & Griffiths, 2011).

One provocative study found that people who had a “mystical experience” during guided meditation sessions on psilocybin mushrooms displayed a 1.5 standard deviation increase in openness one year later, an effect that generalized across openness facets. This effect is one of the largest ever found in the personality change literature. In a similar study that took place across a shorter time scale, those who took LSD increased on openness over a period of two weeks, and this increase was proportional to the amount of entropic brain activity measured via fMRI (Lebedev et al., 2016).

These findings are particularly intriguing and merit further investigation. In particular, it is unclear whether these changes were brought about via top-down processes of identity reconfiguration following drug use or bottom-up processes of biological change caused by the drug use. Beyond questions of mechanism, two important limitations of these studies are that the sample size was relatively low for both studies and that those who signed up to participate were already quite high in openness at baseline. Future research is needed to understand whether increases in openness following psychoactive drug use are contingent on baseline levels of openness, and whether these effects extend to the use of marijuana, a much more commonly used but much less psychoactively potent drug.

Interim Summary

A review of the past research on candidate experiences in openness development suggests two common mechanisms underlying individual differences in openness change. First and foremost, changes in exploration may drive changes in openness. Specifically, changes in employment, marital status, cultural experience, and health may encourage or halt the motivation

to explore and exploratory behavior, leading to downstream changes in openness. Second, changes in a person's neurobiology may drive changes in openness. Specifically, changes in intelligence, exercise, and psychoactive drug use may alter a person's patterns of thought and ability to think, leading to downstream changes in openness.

Conclusion

In this chapter, we examined the history, structure, and development of openness to experience. As the last of the Big Five traits to emerge from factor analysis, openness has always held the distinction of being the most difficult of the Big Five to conceptualize and measure. Fundamental differences in trait conceptualization persist to this day, as different openness inventories measure slightly different openness constructs. Regardless of measurement instrument, however, openness has unique and intriguing associations with intelligence, political attitudes, culture, and creativity. Across the lifespan, openness follows an inverted-U shaped mean-level developmental trajectory, increasing slightly in emerging adulthood, remaining stable throughout midlife, and decreasing across old age. At each of these ages, and especially in emerging adulthood, there are substantial individual deviations from the mean-level developmental trajectory, which may be spurred by changes in exploration and neurobiology.

While openness is the last of the Big Five traits, it is by no means the least. The construct's breadth and complexity are what make it so compelling to study. Perhaps this is also why figures like David Bowie are so captivating.

Coda

For a final episode in the life of David Bowie, consider the circumstances surrounding his last album, *Blackstar*. Two days after the album was released, Bowie died of cancer, a disease he had not made publicly known. Even a cursory listen to this last album reveals that Bowie

positioned his death as a work of art. On the album's lead single, Lazarus (named after the biblical figure raised from the dead), Bowie opens with the lyrics, "Look up here, I'm in heaven." The cover art of the album simply features a black star, the only of Bowie's 25 studio albums to not feature him on the front. And as for the album's title, it is a reference to any and all of a particular type of cancer lesion, an Elvis song about death (Elvis and Bowie share a birthday), and a collapsed star(man). That Bowie invested his final months on earth into creating a work of art about his own death puts a capstone on his legacy as a man defined by his openness to experience.

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