Chapter 3
Models of Personality

Sandra Matz, Yin Wah Fiona Chan and Michal Kosinski

Abstract In this chapter, we introduce and discuss some of the most important and widely used models of personality. Focusing on trait theories, we first give a brief overview of the history of personality research and assessment. We then move on to discuss some of the most prominent trait models of the nineteenth century— including Allport's trait theory, Cattell's 16 Factor Model, Eysenck's Giant Three, and the Myers–Briggs Type Indicator (MBTI)—before focusing on the Big Five Model (Five Factor Model), which is the most widely accepted trait model of our time. Next, we introduce alternatives to the Big Five that appear to be useful in the context of personalized services (the HEXACO and RIASEC models), and subsequently outline the relationships between all the models discussed in the chapter. Finally, we provide an outlook on innovative methods of predicting personality with the help of digital footprints.

3.1 Introduction

We all have an intuitive concept of personality that guides our everyday social interactions. For example, we use descriptions such as "the party animal" to refer to a friend who differs systematically from "the nerdy geek"; we explain our partner's sudden outburst of anger with his "impulsive and neurotic" character; and we predict that our sister will be a good lawyer as a result of her "competitive" nature. While these lay conceptualizations of personality are only loosely defined and often implicit, scientific models of personality provide a structured approach for describing, explaining, and predicting individual differences. Rather than accounting for the full complex-

S. Matz (✉) · Y.W.F. Chan
University of Cambridge, Downing Street Cambridge, Cambridge CB2 3EB, UK
e-mail: sm917@cam.ac.uk

Y.W.F. Chan
e-mail: ywfc2@cam.ac.uk

M. Kosinski
Stanford Graduate School of Business, 655 Knight Way, Stanford, CA 94305, USA
e-mail: michalk@stanford.edu

ity of individual differences, they are pragmatic approximations and standardized frameworks for generating and validating new scientific hypotheses and research questions. Similarly, they provide practitioners in a variety of applied contexts, e.g. personnel selection, coaching and psychotherapy, or marketing with a tool to reduce the complexity of human nature to a manageable level. The theories that have been suggested in the context of personality are diverse. While some of them focus on biological differences (biological paradigm) or behavioral learning and conditioning (behavioral paradigm), others highlight the importance of childhood experiences (psychoanalytic paradigm) or cognitions and social learning (social-cognitive paradigm). However, although all of these theories provide valuable insights into the development and expression of personality, the most prevalent and widely accepted approach to personality is the trait approach. Trait theorists assume that our cognitions, emotions, and behaviors are determined by a number of consistent and relatively stable traits. Therefore, in this chapter, we will focus on different trait models that have been suggested during the last century. We begin with a brief introduction to the idea of trait models in Sect. 3.2. We then move on to some of the most important trait models of the nineteenth century in Sect. 3.3, before discussing the Big Five (the most widely accepted trait model of our time) in Sect. 3.4. Section 3.5 introduces two alternatives to the Big Five: the HEXACO model (a modification of the Big Five) and the RIASEC model (a vocational interest model). Finally, Sect. 3.6 outlines the relationships between these models. Given the breadth of the topic, this chapter serves as a comprehensive introduction to personality models. Readers who are interested in learning more are encouraged to read [17, 18, 49].

3.2 Trait Theories of Personality

Trait theories of personality are not only the most researched and widely used theories among all personality paradigms, but they also correspond most closely to our lay conceptualization of personality. Researchers following the trait approach suggest that personality consists of a range of consistent and relatively stable characteristics (traits) that determine how a person thinks, feels, and behaves. This idea dates back to the Greek philosophers and physicians, Hippocrates (460–377 BC) and Galen of Pergamum (AD 130–200), who first formulated the theory of the four humors represented by different body fluids: black bile, yellow bile, phlegm, and blood. These humors were believed to be a balanced system in the human body that determined one's health. For instance, a deficit or a surplus of any humor would cause an imbalance of the system and lead to physical illness or mental diseases. In his temperament theory, Galen first suggested that the four humors were also the basis of differences in human temperament and behavior. His four temperaments of sanguine (excess blood), choleric (excess yellow bile), melancholic (excess black bile), and phlegmatic (excess phlegm) reappear in writings of Wilhelm Wundt, one

of the fathers of modern psychology, and Hans Eysenck, the author of the three-factor personality model. Although Hippocrates' and Galen's theories on the links between body fluids and temperament are not supported by modern science, their idea that people systematically differ, with regard to a number of distinct characteristics, set the basis for the study of individual differences and modern trait theories.

Factor analysis: Factor analysis is a statistical method aimed at reducing complexity by summarizing the information of a large number of variables (e.g. questions in a questionnaire) by a limited number of factors (e.g. personality traits). The composition of dimensions depends on the correlations (the degree to which two variables are related) between the variables, so that related variables become summarized within one dimension. For example, it is very likely that a person who indicates a strong agreement with one Extroversion question will also indicate a strong agreement with other Extroversion questions. Based on the resulting intercorrelations of questions, factor analysis summarizes those items under one latent factor (latent = not directly observable). Once the optimal number of factors has been extracted, variables are assigned to the factor with the highest factor loading (correlation of variable with factor). Eventually, each factor can be interpreted by looking at the "common theme" of its items (e.g. Extroversion contains items such as "I am the life of the party" or "I start conversations").

The development of modern trait theories in the second half of the twentieth century was mainly driven by new advancements in the field of data collection, measurement, and statistical analysis. Perhaps, most importantly, the development of factor analysis allowed for reducing the diversity of behaviors and preferences to a limited number of meaningful factors. Most of the trait theories presented in this chapter were derived using factor analytical approaches, and often went hand in hand with the development of new questionnaire measures. The main contributors to this trend were psychologists working in the field of individual differences, such as Raymond Cattell, Paul Costa, Robert McCrae, or Charles Spearman.

3.3 Early Trait Theories

Numerous trait models have been suggested before the introduction of the Big Five. Here, we focus on the four most prominent and influential ones: Allport's Trait Theory [2]; Cattell's 16 Factor Personality [15]; Eysenck's Three Dimensions of Personality [25, 27]; and the Myers–Briggs Type Indicator (MBTI [57]).

3.3.1 Allport's Trait Theory

Building on the idea first introduced by Sir Francis Galton, Gordon Allport (1897–1967) hypothesized that important personal characteristics must be encoded in language, and the most important characteristics will be described by a single word (referred to as the lexical hypothesis [2, 3]). Together with Henry Odbert, Allport examined in this hypothesis by extracting from an English dictionary 17,953 words that could be used to describe others. They grouped these words into four categories: (1) personality traits; (2) present states, attitudes, emotions, and moods; (3) social evaluations; and (4) miscellaneous. Personality traits were further divided into cardinal traits, central traits, and secondary traits. A cardinal trait is one that dominates any given person's behavior (e.g. the bad-tempered David). Central traits are, to some degree, found in everyone. For instance, everyone could be described by some positive (or negative) level of honesty. Finally, secondary traits are not shared by all people and are expressed only in certain contexts, such as "disliking formal dinners." The lexical hypothesis spawned an enormous amount of research. Many of the most popular personality models—including Cattell's 16 Factor Model and the Big Five—were based on the comprehensive collection of personality traits identified by [2, 3].

3.3.2 Cattell's 16 Personality Factor

A chemist by training, Raymond Cattell (1905–1998) was driven by the idea of identifying "basic psychological elements" resembling those of the periodic table. Cattell made an important conceptual distinction between surface traits and source traits. According to Cattell, surface traits are superficial behavioral tendencies that exist "on the surface," and thus can be observed directly. Source traits, in contrast, represent deeper psychological structures that underlie surface traits and explain their correlations. For example, the surface traits of shyness, being reserved and quiet among strangers, or avoiding big crowds, can all be explained by the underlying source trait of Introversion. Accepting Allport's lexical approach, Cattell stated that "all aspects of human personality, which are or have been of importance, interest, or utility, have already become recorded in the substance of language" [14], p. 483). He reduced Allport's word list from over 4,500 to 171, by excluding rare or redundant traits. Cattell used factor analysis to reduce people's self-ratings on each of those 171 traits to a smaller number of essential factors. Furthermore, he supplemented those results using similar analyses of life records (natural behavior observed in everyday situations) and objective test data (behavior in artificial situations examining any given trait). The idea behind Cattell's multisource approach was that the most basic and fundamental psychological traits should reappear in all three data sources. He eventually suggested that the variance in human behavior could be sufficiently described by 16 primary factors, or source traits. Further factor analyses of the 16 primary traits led Cattell to report five global personality traits, which are sometimes referred to as the original Big Five: (1) Extroversion/Introversion, (2) High Anxiety/Low

Table 3.1 Cattell's 16 primary factors and five global traits

Extroversion/ Introversion	High anxiety/ Low anxiety	Tough-mindedness/ Receptivity	Independence/ Accommodation	Self-control/ Lack of restraint
Warmth	Emotional	Warmth	Dominance	Liveliness
Liveliness	Stability	Sensitivity	Social boldness	Perfectionism
Social boldness	Vigilance	Abstractedness	Vigilance	Abstractedness
Privateness	Apprehension	Openness to Change	Openness to Change	Rule
Self-reliance	Tension			Consciousness

Since Cattell's global factors are not conceptualized as independent, primary factors can appear in multiple global factors

Anxiety, (3) Tough-Mindedness/Receptivity, (4) Independence/Accommodation, and (5) Self-Control/Lack of Restraint. Table 3.1 illustrates the primary and secondary factors.

Cattell's development and application of advanced factor analytical techniques, as well as his systematic analysis of different data sources, have paved the way for the development of later trait models such as the Big Five. However, although the 16 Personality Factor Questionnaire [15], measuring both primary and secondary traits, is still in use and available in more than 30 languages, the 16 factor model has never acquired the academic popularity that Cattell had hoped for. Probably the most important reason for this is that the 16 factor model is more difficult to understand and remember than more parsimonious models such as Eysenck's Giant Three or the Big Five.

3.3.3   Eysenck's Giant Three

Another popular trait model is the Three Dimensions of Personality proposed by Hans Eysenck (1916–1997), which is also known as the Giant Three. Like Cattell, Eysenck used factor analysis of questionnaire items to derive common personality traits (low-level traits) and secondary factor analysis to infer a smaller number of higher order factors (superfactors). In his initial model, Eysenck identified two superfactors: Extroversion and Neuroticism (1947). Whereas the Extroversion factor refers to the degree to which people like to engage with the social world around them, and seek excitement and activity, the Neuroticism factor reflects the degree to which people experience and express their emotions. Contrary to Cattell, Eysenck conceptualized personality factors as independent (orthogonal), and used their continuous nature to create a two-dimensional personality space. According to Eysenck, this Neuroticism-Extroversion space was not entirely new but reflected the four humors introduced by the Greek philosophers. The melancholic type, for example, resembles a combination of high Neuroticism and low Extroversion, while the sanguine type is a mixture of low Neuroticism and high Extroversion.

Table 3.2 Big Five traits, facets, and sample items

Superfactor	Primary traits
Psychoticism	Aggressive, cold, egocentric, impersonal, impulsive, antisocial, unempathetic, creative
Extroversion	Sociable, lively, active, assertive, sensation-seeking, carefree, dominant, surgent, venturesome
Neuroticism	Anxious, depressed, guilt feelings, low self-esteem, tense, irrational, shy, moody, emotional

Later on, Eysenck and his wife Sybil Eysenck added the Psychoticism superfactor [27]. Contrary to the other two factors, Psychoticism is concerned with what one might consider "abnormal" rather than normal behavior. It includes low-level traits such as aggression, antisocial behavior, and impulsiveness. The three resulting superfactors form the acronym PEN. Acknowledging that Psychoticism, Extroversion, and Neuroticism might not be sufficient to account for the complexity of individual differences, Eysenck included a number of low-level primary traits to further specify the superfactors (see Table 3.2).

One of the most noteworthy contributions from Eysenck was his systematic investigation of the biological correlates and foundations of personality traits. According to Eysenck, the identification of biological systems and mechanisms underlying the expression of personality traits is particularly important in avoiding circular explanations of traits. For example, Extroversion is often validated by measuring its relationship with the frequency and quality of a person's social interactions. If the trait of Extroversion, however, is measured with items such as "I meet my friends frequently," "I am a sociable person," or "I make friends easily," substantial correlations between Extroversion and social behaviors do not prove Extroversion's existence as a real psychological trait. Although Eysenck investigated the biological correlates and causes for all of the three super-traits, he was most successful in providing evidence for the links between Extroversion and a person's level of cortical arousal [26]. His work suggests that people who avoid social occasions (Introverts) have a relatively high baseline of cortical arousal, which leads them to perceive further stimulation as unpleasant. In contrast, outgoing people (Extraverts) tend to have a lower baseline of cortical arousal, which leads them to seek stimulation by attending social occasions.

3.3.4 The Myers–Briggs Type Indicator (MBTI)

The Myers–Briggs Type Indicator (MBTI [57]), named after its two developers, Katharine Cook Briggs (1875–1968) and her daughter Isabel Briggs Myers

Table 3.3 The four MBTI dimensions

Dichotomous dimensions of the MBTI
Extroversion (E)–(I) Introversion
Sensing (S)–(N) Intuition
Thinking (T)–(F) Feeling
Judging (J)–(P) Perception

(1897–1980), was developed on the basis of the psychological type theory by Carl Gustav Jung (1875–1961). Jung's type theory classified people according to the three dimensions of (1) Extroversion versus Introversion; (2) Sensing versus Intuition; and (3) Judging versus Perception. Although Jung acknowledged that people are likely to engage in both categories of one dimension (e.g. Sensing and Intuition), he believed that they differ in regard to their preferences for and frequency in use of them [38]. For example, a counselor might focus on sensing, while an artist might rely more on his or her intuition; a programmer might predominantly use rational thinking, while a poet might emphasize feeling. Contrary to the models discussed previously, Jung's type model therefore does not conceptualize personality traits as continuous dimensions, but as dichotomous and mutually exclusive categories. Being aware of the potential of Jung's model, Briggs and Myers further refined it by adding the Judging versus Perception dimension, and later developed the MBTI with four dimensions (see Table 3.3). As the name "Type Indicator" implies, the MBTI assigns specific personality types by combining the dominant categories of the four dimensions. Each of the 16 types is associated with a specific pattern of personality characteristics. While people of type ENTP, for example, are driven by their motivation and desire to understand and make sense of the world they live in, people of type ISFJ are characterized by their desire to serve others as well as their 'need to be needed'.

Although the MBTI is widely used in applied contexts, it has been heavily criticized for (1) its oversimplification of the complex nature of individual differences; and (2) its questionable reliability and validity in explaining real-life outcomes (e.g. [63]). Since the results of the MBTI are given in the form of a four-letter code representing the dominant categories of each dimension (e.g. ENTJ), the MBTI reduces the theoretically unlimited space of personality profiles to only 16 distinguishable personality types. Taking into account the nature of individual differences in the population, the dichotomous classifications offered by the MBTI appear to be dramatically over-simplistic. First, it fails to distinguish between moderate and extreme levels of a given trait. Second, as personality traits are normally distributed in the population, most of the people are characterized by scores close to average. Consequently, even a small inaccuracy in the measurement leads to a person being misclassified. In fact, several studies showed that even after short test-retest intervals of five weeks, up to 50 % of participants were classified into a different type [35]. Third, the MBTI's validity is questionable, given that many studies were unable to replicate its factor

structure [63]. Finally, the MBTI was found to be poorly predictive of real-life outcomes. Taken together, the questionable validity and other psychometric properties of the MBTI warrant caution in its application in research and applied settings. While the MBTI is still relatively popular in the industry, especially in the U.S., it is usually avoided in science due to the reasons outlined above.

3.4   The Big Five

The variety of competing personality models, differing in their numbers and types of dimensions, largely prohibited the systematic integration of personality research conducted during that time. It was not until the late 1980s that with the introduction of the Big Five, a framework of personality was proposed that could be agreed upon by the vast majority of personality researchers. The Big Five model is a trait theory that posits five independent domain traits, including: Openness to Experience (O), Conscientiousness (C), Extroversion (E), Agreeableness (A), and Neuroticism (N). Each of the traits can be broken down into facets that further specify the nature and scope of the factors (see Table 3.4).

Table 3.4   Big Five traits, facets, and sample items

Trait	Facets	Sample items
Openness to experience	Fantasy, aesthetics, feelings, actions, ideas, values	"I have a vivid imagination"
		"I have difficulty understanding abstract ideas" (R)
Conscientiousness	Competence, order, dutifulness, achievement-striving, self-discipline, deliberation	"I am always prepared"
		"I leave my belongings around" (R)
Extroversion	Warmth, gregariousness, assertiveness, activity, excitement-seeking, positive emotions	"I feel comfortable around people"
		"I don't like to draw attention to myself" (R)
Agreeableness	Trust, straightforwardness, altruism, compliance, modesty, tender-mindedness	"I take time out for others"
		"I feel little concern for others" (R)
Neuroticism	Anxiety, angry hostility, depression, self-consciousness, impulsivity, vulnerability	"I am easily disturbed"
		"am relaxed most of the time" (R)

Big Five versus Five Factor Model: The terms "Big Five" and "Five Factor Model" are often used interchangeably to refer to the five personality dimensions outlined in Table 3.4. Those models, however, they were developed independently and differ in their underlying assumptions [69]. While the Big Five is based on a lexical approach and is mostly associated with the work of Lewis R. Goldberg, the Five Factor Model was developed on the basis of factor analysis of questionnaire results, and is most closely linked to the work of Robert R. McCrae, Paul Costa, and Oliver P. John. Despite these differences, the two models use the same factor labels and are highly consistent (proving the generalizability of the five factor approach).

3.4.1   Description of the Big Five Traits

The trait of *Openness to Experience* refers to the extent to which people prefer novelty over convention; and it distinguishes imaginative, creative people from down-to-earth, conventional ones. People scoring high on Openness can be described as intellectually curious, sensitive to beauty, individualistic, imaginative, and unconventional. People scoring low on Openness, on the other hand, can be characterized as traditional and conservative, and are likely to prefer the familiar over the unusual.

Conscientiousness refers to the extent to which people prefer an organized or a flexible approach in life, and is thus concerned with the way in which we control, regulate, and direct our impulses. People scoring high on this trait can be described as organized, reliable, perfectionist, and efficient, while people scoring low on this trait are generally characterized as spontaneous, impulsive, careless, absentminded, or disorganized.

Extroversion refers to the extent to which people enjoy company, and seek excitement and stimulation. It is marked by pronounced engagement with the external world, versus being comfortable with one's own company. People scoring high on Extroversion can be described as energetic, active, talkative, sociable, outgoing, and enthusiastic. Contrary to that, people scoring low on Extroversion can be characterized as shy, reserved, quiet, or withdrawn.

The trait of *Agreeableness* reflects individual differences concerning cooperation and social harmony. It refers to the way people express their opinions and manage relationships. People scoring high on this trait are generally considered as being trusting, soft-hearted, generous, and sympathetic, while people scoring low on this trait can best be described as competitive, stubborn, self-confident, or aggressive.

Finally, *Neuroticism* refers to the tendency to experience negative emotions, and concerns the way people cope with and respond to life's demands. People scoring high on Neuroticism can be characterized as being anxious, nervous, moody, and

worrying. On the other hand, people scoring low on Neuroticism can be described as emotionally stable, optimistic, and self-confident.

It should be noted that there are no fundamentally good or bad personalities, as scoring high or low on each of the traits has its advantages and disadvantages. One might, for example, be tempted to consider high Agreeableness as a "good" trait. However, although being friendly and trusting certainly has its advantages in some aspects of life (e.g. relationships and team work), Agreeableness is also expressed as gullibility and a lack of assertiveness. Disagreeable individuals, while often less friendly, are particularly good at making difficult decisions when necessary, taking the lead in a competitive environment, or pointing out when something is wrong. Consequently, low agreeableness can prove extremely valuable in many contexts, such when as leading a team or a company.

3.4.2 Big Five's Significance

According to McCrae and John [54, p. 177], the Big Five model "marks a turning point for personality psychology" by providing "a common language for psychologists from different traditions, a basic phenomenon for personality theorists to explain, a natural framework for organizing research, and a guide to the comprehensive assessment of individuals." Indeed, the impact of the Big Five on personality research has been remarkable and, as of yet, there is no other model of personality that has been used and researched as extensively as the Big Five. Unlike previous models, the Big Five was found to be stable across cultures [53], as well as instruments and observers [51]. Furthermore, the Big Five has been linked to numerous life outcomes. Table 3.5 displays some of the most important associations (for a more comprehensive overview, we advise consulting the review paper by Ozer and Benet-Martnez [61]). By providing researchers around the world with a common model to describe and predict individual differences, the Big Five did not only allow for the efficient integration of existing literature, but also encouraged the joint development

Table 3.5 Examples of links between the Big Five traits and real-life outcomes

Trait	Associated life outcome
Openness	Intelligence [1], verbal intelligence [58], liberal political attitudes [50]
Conscientiousness	Academic achievement [58], job performance [68], (-) risky health-related behavior [9], (-) antisocial behavior [71]
Extroversion	Subjective well-being [32], job satisfaction [72], leadership effectiveness [33]
Agreeableness	Volunteerism [13], cooperative behavior [46], job performance [68]
Neuroticism	Clinical mental disorders [59], (-) subjective well-being [32], relationship satisfaction [39]

*Note* (-) indicates negative correlations

of a framework in which empirical findings could be validated and accumulated. Today, the Big Five constitutes the most popular and prevalent model of personality.

3.4.3 Big Five Assessment

The Big Five has been traditionally associated with questionnaire measures. Although there is a number of questionnaires assessing the Big Five dimensions, the public domain item International Personality Item Pool (IPIP [30]), the Big Five Inventory (BFI [36]), and the commercial NEO-Personality Inventory Revised (NEO-PI-R [20]) are the most frequently used and thoroughly validated ones. All three measures rely on participants indicating their agreement with statements describing their preference or behavior (e.g. "I get stressed out easily" in IPIP) using a five-point Likert scale (ranging from "very inaccurate" to "very accurate" in IPIP). Furthermore, they are all characterized by excellent psychometric properties, including high reliability, convergent and discriminant validity with other measures [20, 30, 36], as well as robust criterion validity when predicting real-life outcomes such as academic achievement, job performance, or satisfaction with life (see Sect. 3.4.2 for a broader overview of Big Five correlates). Finally, the psychometric properties of the three measures were shown to be stable across cultures [8, 53]. Applying a scoring key to participants' responses to the IPIP, BFI, NEO-PI-R, or similar questionnaires produces raw scores. Raw scores can be used to compare the results between participants in a given sample; for example, a given participant might be more extraverted than 80 % of the other participants in a sample. However, one has to be extremely cautious when drawing inferences stemming from beyond the particular sample. A score that is high in the context of a given group of participants might be average (or low) in the context of another group or general population. Thus, the interpretation of the scores is often supported by the norms (or standards) established using some reference group: a nationwide sample, for example. The process of transforming the scores based on standards is called standardization. When giving feedback to test takers, it is best practice to represent their scores in an easily interpretable fashion. Hence, the common method is to transform standardized scores into percentiles. A percentile score represents one's location within the population; a percentile score of 68, for example, indicates that one's raw score is higher than that of 68 % of individuals in the reference population. Figure 3.1 illustrates two examples of Big Five profiles on the percentile scale.

Importantly, the practical use of personality measures is not trivial and requires considerable training. As in other psychometric measures, the validity of the results can be affected by a number of factors, including participants' deliberate misrepresentation, linguistic incompetence, inattentiveness, and social desirability [37]. For example, in a recruitment context, respondents are likely to present themselves as more in line with the job requirements (e.g. applicants for an accountant position may misrepresent themselves as more Conscientious than they really are).
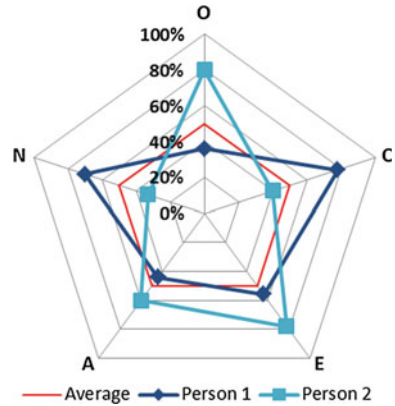
3.5 Other Models of Individual Differences: HEXACO and RIASEC

Although the Big Five is arguably the most widely accepted and used personality model of our time, there are also other models that can be useful in investigating individual differences. The HEXACO model expands on the Big Five by introducing an additional dimension, while the RIASEC model focuses on personal interests rather than classical personality traits.

3.5.1 The HEXACO Model

The HEXACO model is a six-dimensional trait theory proposed as an extension of the Big Five [44]. The acronym HEXACO refers to the six dimensions of Honesty-Humility (H), Emotionality (E), Extroversion (X), Agreeableness (A), Conscientiousness (C), and Openness to Experience (O). The Honesty-Humility dimension is meant to distinguish between sincere, loyal, faithful, honest, and genuine people on one hand; and cunning, arrogant, disloyal, pretentious, and envious people on the other hand. While adding the sixth factor to the Big Five structure does not significantly change the content of the Extroversion, Openness, and Conscientiousness traits, it alters the Agreeableness and Neuroticism factors. Trait indicators related to temper, for example, are linked to the Neuroticism trait in the Big Five, but are summarized under the Agreeableness dimension in the HEXACO framework. Although there is a growing body of empirical evidence that supports the six-dimensional structure across a number of different languages [4, 44], the HEXACO model is still relatively rarely used. Furthermore, some studies reported difficulties in replicating the Honesty-Humility factor [23].

3.5.2 The RIASEC Model

The RIASEC model was developed by John Lewis Holland [34]. Unlike the models discussed in previous sections, RIASEC is not a personality model in the conventional sense. While traditional personality models are conceptualized to be context-independent, RIASEC focuses on individual differences in vocational interests. Corresponding to the acronym RIASEC, Holland suggests that people as well as work environments can be classified into six different types: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). Based on their closeness, the six types are typically organized into a hexagonal structure (see Fig. 3.2). While the definitions of personality types are based on preferences for and aversions to certain types of work characteristics, the definitions of work environments are derived from typical work activities and job demands placed on individuals. RIASEC assumes that people flourish and excel in work environments that match their personality type. Although the matching can be done on the basis of individual types, Holland suggests combining the three types with the highest score to form a higher order profile (e.g. REA or CSE). The dimensions can be assessed with the Strong Interest Inventory [12], or with the help of open source questionnaires online (e.g. at http://www.mynextmove.org/explore/ip).

Following the logic of personality-environment types, Realistic people ("Doers") can be described as practical, persistent, and down-to-earth. They prefer dealing with things rather than with people or abstract ideas, and flourish in work environments that involve tactile, mechanical, or physical tasks (e.g. Electrician). Investigate people ("Thinkers") are described as being intellectual, curious, inquisitive, and scholarly. They prefer work environments that allow them to explore their surroundings, solve problems, and satisfy their curiosity (e.g. Researcher). Artistic people ("Creators")
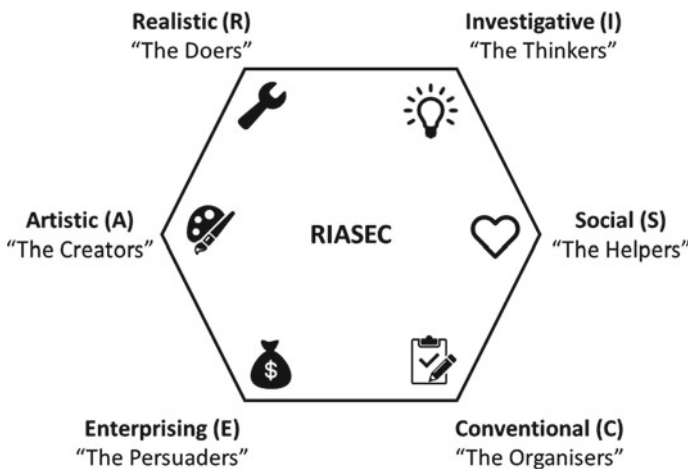

Fig. 3.2 The hexagonal structure of the RIASEC model

can be described as creative, original, articulate, and open-minded. They excel in unstructured work environments in which they can express their creativity and imagination, as well as develop their own ideas and concepts (e.g. Actor). Social people ('Helpers') can be described as empathetic, cooperative, caring, and patient. They prefer interpersonal, service-oriented work environments that highlight teamwork and that allow them to help and teach others (e.g. Social Worker). Enterprising people ("Persuaders") can be described as enthusiastic, ambitious, energetic, and optimistic. They excel in competitive work environments that involve persuading and motivating others; and require leadership, public speaking, and salesmanship skills (e.g. Politician). Finally, Conventional people ("Organisers") can be described as efficient, organized, detail-oriented, and reliable. They prefer structured and stable work environments that involve practical tasks and precise instructions (e.g. Accountant).

3.6 Relationships Between Personality Models

Considering that the trait models introduced in this chapter have substantial similarities with the Big Five when it comes to their conceptualization and naming of traits, it is not surprising that research has established strong empirical correlations between them. Since the RIASEC model is not a trait model in the traditional sense, and most distant from the Big Five conceptually, its correlations with the Big Five are by far the smallest. The relationships between the models are illustrated in Table 3.6.

3.7 Discussion and Conclusion

Decades of psychological research suggest that individuals' behaviors and preferences are not random, but are driven by latent psychological constructs: personality traits. This chapter focused primarily on the most widely used and accepted model, namely the Big Five [20, 30, 36]. Its five broad dimensions (Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism) are believed to capture the fundamental dimensions on which individuals differ most apparently. The Big Five were found to be stable across the lifespan and are, at least to some extent, heritable [10, 24, 47, 64]. For example, Loehlin and Nichols [47] examined the personality of nearly 850 twins and showed that personality profiles of identical twins were more similar than those of fraternal ones. Having said this, however, it is important to note that there is nothing like an "Extroversion" or "Conscientiousness" gene. Rather, it is the complex interaction of different genes and environmental influences (gene–environment interaction) that predisposes us to behave in a certain way.

The trait models introduced in this chapter focus on the stability of behaviors within individuals to investigate differences in behaviors across individuals. They assume that an individual's behavior is highly consistent across situations. For example, extraverted individuals are expected to consistently display extroverted behav-

Table 3.6 Correlations between the Big Five traits and other personality models

Model	Op	Co	Ex	Ag	Ne
Cattell's Global Factors	Receptivity (r = 0.62) Self-control (r = −0.50)	Self-control (r = 0.66) Receptivity (r = −0.32)	Extroversion (r = 0.63) Independence (r = 0.49)	Independence (r = −0.34)	Anxiety (r = 0.80)
Eysencks Giant Three	–	(Psychoticism) (r = −0.31)	Extroversion (r = 0.69)	Psychoticism (r = −0.45)	Neuroticism (r = 0.75)
HEXACO	Openness (r = 0.69)	Conscientiousness (r = 0.80)	Extroversion (r = 0.83)	Agreeableness (r = 0.36) Honesty–Humility (r = 0.36) Emotionality (r = 0.38) Extroversion (r = 0.37)	Emotionality (r = 0.51) Agreeableness (r = −0.45)
MBTI	Sensing (r = 0.72)	Judging (r = −0.49)	Extroversion (r = −0.74)	Thinking (r = 0.44)	
RIASEC	Artistic (r = 0.34) Investigative (r = 0.21)	Conventional (r = 0.17)	Enterprising (r = 0.39) Social (r = 0.25)	Social (r = 0.13)	Investigative (r = −0.11)

Note Except for the RIASEC Model, we only included correlations of r > 0.30. The correlations for Cattell's Global Factors are based on [67]; the correlations for Eysencks Giant Three on [21]; the correlations for the HEXACO model on [45]; the correlations for the MBTI on [52]; and the correlations of the RIASEC model on [7]

iors no matter whether they are at work, among friends, or at home with their family. Although the majority of personality models follows this traits approach, some personality psychologists have argued that its assumption of stable personality traits is fundamentally flawed [55]. They argue that behaviors can differ as much within individuals as they differ across individuals. For example, an individual might display very extraverted behaviors at work, where the situation requires her to do so, but be very quiet when spending time with her family. Hence, rather than conceptualizing personality as a stable set of traits that explain behaviors across a variety of contexts, they emphasize the influence of situation-specific exigencies to explain and predict reoccurring patterns of behaviors ([56], e.g. if she is around work colleagues, she is highly sociable and assertive, but if she is around her family, she takes on the role of a quiet observer). In an attempt to reconcile these two seemingly contradictory approaches, researchers have suggested an interactionist perspective [28]: while individuals might be generally more extroverted at social occasions than at home with their families, extroverts should still be more extroverted than introverts when investigating the same occasion. While individuals behaviors might indeed be partially determined by situational factors, the existence of stable and distinct personality traits is valuable in practice: it is a pragmatic way of describing individuals by a small number of variables (e.g. five) that can subsequently be used to accurately predict behavior and preferences across different contexts and environments. In fact, research has shown that personality traits are predictive of many life outcomes, including job performance (e.g. [6, 68]), attractiveness (e.g. [11]), drug use (e.g. [66]), marital satisfaction (e.g. [40]), infidelity (e.g. [60]), and happiness (e.g. [61]).

Expressions of our personalities can be found in many aspects of our everyday interactions with our physical and social environment. Researchers, for example, have shown that individuals can identify other people's personality traits by examining their living spaces [31] or music collections [65]. Following the shift in human interactions, socializing, and communication activities toward online environments, researchers have noted that personality-related behavioral residues are not restricted to the offline environment. They showed that personality is related to keyboard and mouse use [41], smartphone logs [19, 22], contents of personal websites [48, 73], Facebook profiles [42], Facebook Likes [43, 74], or Facebook profile pictures [16].

However, practical applications of personality models have been severely limited in the context of online platform and services. This has been predominantly caused by the time and effort-consuming nature of traditional questionnaire-based assessments. Making use of the unique opportunities offered by the digital environment, however, those limitations might be overcome by assessing personality directly from behavioral footprints. In fact, digital products and services offer an unprecedented repository of easily accessible and yet highly valid records of human behavior [5]. Recent studies show that personality assessment based on such digital footprints can rival those based on well-established questionnaire measures. Potential sources of footprints include personal websites [48], Facebook Likes [43, 74], Facebook Status updates [62, 70], or Twitter messages [29]. Furthermore, the digital environment offers an enormous potential for the development of new models of personality.

The unprecedented ability to inexpensively and conveniently record the behavioral residues of large groups of people, and across long periods of time, can be used to identify patterns of behavior representing existing or yet undiscovered latent psychological dimensions. Factor analytical methods—such as those used to develop personality models based on questionnaire responses or manually recorded behavior—could be applied to much wider records of digital footprints. While extracting interpretable dimensions from digital footprints is not a trivial task, it could eventually lead to the development of new and more robust personality models. Taken together, the personality models identified in this chapter offer valuable insights into the most fundamental dimensions underlying individual differences. They can be a useful source when trying to explain and predict an individual's needs, motives, preferences, and aspirations, all of which can contribute to the development and refinement of personalized systems. Especially when considering the richness of information available on Internet users, a personality-based approach to personalized systems could help reduce the complexity of individual differences and channel our attention to the aspects that are most important.

References

1. Ackerman, P. L., Heggestad, E.D.: Intelligence, personality, and interests: evidence for overlapping traits. Psychol. Bull. **121**(2), 219 (1997)
2. Allport, G.W.: Personality: a Psychological Interpretation. H. Holt and Company (1937)
3. Allport, G.W., Odbert, H.S.: Trait-names: a psycho-lexical study. Psychol. Monogr. **47**(1), i (1936)
4. Ashton, M.C., Lee, K., de Vries, R.E.: The hexaco honesty-humility, agreeableness, and emotionality factors: a review of research and theory. Pers. Soc. Psychol. Rev. **18**(2), 139–152 (2014)
5. Back, M.D., Stopfer, J.M., Vazire, S., Gaddis, S., Schmukle, S.C., Egloff, B., Gosling, S.D.: Facebook profiles reflect actual personality, not self-idealization. Psychol. Sci. **21**(3), 372 (2010)
6. Barrick, M.R., Mount, M.K.: The Big Five personality dimensions and job performance: a meta-analysis. Pers. Psychol. **44**(1), 1–26 (1991)
7. Barrick, M.R., Mount, M.K., Gupta, R.: Meta-analysis of the relationship between the five-factor model of personality and Holland's occupational types. Pers. Psychol. 56 (2003)
8. Benet-Martínez, V., John, O.P.: Los Cinco grandes across cultures and ethnic groups: multitrait-multimethod analyses of the big five in Spanish and English. J. Pers. Soc. Psychol. **75**(3), 729 (1998)
9. Bogg, T., Roberts, B.W.: Conscientiousness and health-related behaviors: a meta-analysis of the leading behavioral contributors to mortality. Psychol. Bull. **130**(6), 887 (2004)
10. Bouchard, T.J., Lykken, D.T., McGue, M., Segal, N.L., Tellegen, A.: Sources of human psychological differences: the Minnesota study of twins reared apart. Science **250**(4978), 223–228 (1990)
11. Byrne, D., Griffitt, W., Stefaniak, D.: Attraction and similarity of personality characteristics. J. Pers. Soc. Psychol. (JPSP) **5**(1), 82 (1967)
12. Campbell, V.L.: Strong-Campbell interest inventory. J. Couns. Dev. **66**(1), 53–56 (1987)

13. Carlo, G., Okun, M.A., Knight, G.P., de Guzman, M.R.T.: The interplay of traits and motives on volunteering: agreeableness, extraversion and prosocial value motivation. Pers. Individ. Differ. **38**(6), 1293–1305 (2005)

14. Cattell, R.B.: The description of personality: basic traits resolved into clusters. J. Abnorm. Soc. Psychol. **38**(4), 476–506 (1943)

15. Cattell, R.B., Eber, H.W., Tatsuoka, M.M.: Handbook for the sixteen personality factor questionnaire (16 PF): in clinical, educational, industrial, and research psychology, for use with all forms of the test. Institute for Personality and Ability Testing (1970)

16. Celli, F., Bruni, E., Lepri, B.: Automatic personality and interaction style recognition from Facebook profile pictures. In: Proceedings of the ACM International Conference on Multimedia, pp. 1101–1104. ACM (2014)

17. Cervone, D., Pervin, L.A.: Personality: Theory and Research, 12th edn. (2013)

18. Chamorro-Premuzic, T.: Personality and Individual Differences. BPS Textbooks in Psychology, Wiley (2011)

19. Chittaranjan, G., Blom, J., Gatica-Perez, D.: Mining large-scale smartphone data for personality studies. Pers. Ubiquit. Comput. **17**(3), 433–450 (2013)

20. Costa, P.T. Jr, Mccrae, R.R.: Revised NEO-PI-R and NEO five-factor inventory (NEO-FFI) professional manual (1992)

21. Costa Jr., P.T., McCrae, R.R.: The NEO Personality Inventory manual. Psychological Assessment Resources, Odessa, FL (1985)

22. de Montjoye, Y.-A., Quoidbach, J., Robic, F., Pentland, A.S.: Predicting personality using novel mobile phone-based metrics. In: Proceedings of the Social computing, Behavioral-cultural Modeling and Prediction, pp. 48–55. Springer (2013)

23. De Raad, B., Barelds, D.P.H., Levert, E., Ostendorf, F., Mlačić, B., Di Blas, L., Hřebíčková, M., Szirmák, Z., Szarota, P., Perugini, M., et al.: Only three factors of personality description are fully replicable across languages: a comparison of 14 trait taxonomies. J. Pers. Soc. Psychol. **98**(1), 160 (2010)

24. Eaves, L., Heath, A., Martin, N., Maes, H., Neale, M., Kendler, K., Kirk, K., Corey, L.: Comparing the biological and cultural inheritance of personality and social attitudes in the Virginia 30,000 study of twins and their relatives. Twin Res. **2**(02), 62–80 (1999)

25. Eysenck, H.: Dimensions of Personality. Paul, Trench, Trubner & Co, London (1947)

26. Eysenck, H.: The Biological Basis Personality. Transaction publishers (1967)

27. Eysenck, H., Eysenck, S.B.G.: Psychoticism as a Dimension of Personality. London, Hodder and Stoughton (1976)

28. Fleeson, W.: Situation-based contingencies underlying trait-content manifestation in behavior. J. Pers. **75**(4), 825–862 (2007)

29. Golbeck, J., Robles, C., Edmondson, M., Turner, K.: Predicting personality from Twitter. In: Proceedings of the International Conference on Privacy, Security, Risk and Trust and IEEE International Conference on Social Computing, pp. 149–156 (2011)

30. Goldberg, L.R.: A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. Pers. Psychol. Eur. **7**, 7–28 (1999)

31. Gosling, S.D., Ko, S., Mannarelli, T., Morris, M.E.: A room with a cue: personality judgments based on offices and bedrooms. J. Pers. Soc. Psychol. (JPSP) **82**(3), 379–398 (2002)

32. Hayes, N., Joseph, S.: Big 5 correlates of three measures of subjective well-being. Personality Individ. Differ. **34**(4), 723–727 (2003)

33. Hogan, R., Curphy, G.J., Hogan, J.: What we know about leadership: effectiveness and personality. Am. Psychol. **49**(6), 493 (1994)

34. Holland, J.L.: Making Vocational Choices: A Theory of Careers. Prentice-Hall, Prentice-Hall series in counseling and human development (1973)

35. Howes, R.J., Carskadon, T.G.: Test-retest reliabilities of the Myers-Briggs type indicator as a function of mood changes. Res. Psychol. Type **2**(1), 67–72 (1979)

36. John, O.P., Srivastava, S.: The Big Five trait taxonomy: History, measurement, and theoretical perspectives. Handbook of personality: theory and research, vol. 2, pp. 102–138 (1999)

37. Johnson, J.A.: Ascertaining the validity of individual protocols from web-based personality inventories. J. Res. Pers. **39**(1), 103–129 (2005)
38. Jung, C.G.: Psychological types: or, the psychology of individuation. International library of psychology, philosophy, and scientific method. K. Paul, Trench, Trubner (1923)
39. Karney, B.R., Bradbury, T.N.: Neuroticism, marital interaction, and the trajectory of marital satisfaction. J. Pers. Soc. Psychol. **72**(5), 1075 (1997)
40. Kelly, E.L., Conley, J.J.: Personality and compatibility: a prospective analysis of marital stability and marital satisfaction. J. Pers. Soc. Psychol. (JPSP) **52**(1), 27 (1987)
41. Khan, I.A., Brinkman, W-P., Fine, N., Hierons, R.M.: Measuring personality from keyboard and mouse use. In: Proceedings of the European Conference on Cognitive Ergonomics: the Ergonomics Of Cool Interaction (2008)
42. Kosinski, M., Bachrach, Y., Kohli, P., Stillwell, D.J., Graepel, T.: Manifestations of user personality in website choice and behaviour on online social networks. Mach. Learn. 1–24 (2013)
43. Kosinski, M., Stillwell, D.J., Graepel, T.: Private traits and attributes are predictable from digital records of human behavior. In: Proceedings of the National Academy of Sciences (PNAS) (2013)
44. Lee, K., Ashton, M.C.: Psychometric properties of the hexaco personality inventory. Multivar. Behav. Res. **39**(2), 329–358 (2004)
45. Lee, K., Ogunfowora, B., Ashton, M.C.: Personality traits beyond the big five: are they within the hexaco space? J. Pers. **73**(5), 1437–1463 (2005)
46. LePine, J.A., Van Dyne, L.: Voice and cooperative behavior as contrasting forms of contextual performance: evidence of differential relationships with big five personality characteristics and cognitive ability. J. Appl. Psychol. **86**(2), 326 (2001)
47. Loehlin, J.C., Nichols, R.C.: Heredity, environment, and personality: a study of 850 sets of twins (1976)
48. Marcus, B., Machilek, F., Schütz, A.: Personality in cyberspace: personal web sites as media for personality expressions and impressions. J. Pers. Soc. Psychol. (JPSP) **90**(6), 1014–1031 (2006)
49. Matthews, G., Deary, I.J., Whiteman, M.C.: Personality Traits. Cambridge University Press (2009)
50. McCrae, R.R.: Social consequences of experiential openness. Psychol. Bull. **120**(3), 323 (1996)
51. McCrae, R.R., Costa, P.T.: Validation of a five-factor model of personality across instruments and observers. J. Pers. Soc. Psychol. **52**, 81–90 (1987)
52. McCrae, R.R., Costa, P.T.: Reinterpreting the Myers-Briggs type indicator from the perspective of the five-factor model of personality. J. Pers. **57**(1), 17–40 (1989)
53. McCrae, R.R., Allik, I.U.: The Five-Factor Model of Personality Across Cultures. Springer, International and Cultural Psychology (2002)
54. McCrae, R.R., John, O.P.: An introduction to the five-factor model and its applications. J. Pers. **60**(2), 175–215 (1992)
55. Mischel, W.: Personality and Assessment. Wiley, New York (1968)
56. Mischel, W., Shoda, Y.: A cognitive-affective system theory of personality: reconceptualizing situations, dispositions, dynamics, and invariance in personality structure. Psychol. Rev. **102**(2), 246 (1995)
57. Isabel, M.: MBTI manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator instrument, 3rd edn. Mountain View, Calif, CPP (2003)
58. Noftle, E.E., Robins, R.W.: Personality predictors of academic outcomes: big five correlates of GPA and SAT scores. J. Pers. Soc. Psychol. **93**(1), 116 (2007)
59. Ormel, J., Bastiaansen, A., Riese, H., Bos, E.H., Servaas, M., Ellenbogen, M., Rosmalen, J.G., Aleman, A.: The biological and psychological basis of neuroticism: current status and future directions. Neurosci. Biobehav. Rev. **37**(1), 59–72 (2013)
60. Orzeck, T., Lung, E.: Big-Five personality differences of cheaters and non-cheaters. Curr. Psychol. **24**, 274–287 (2005)
61. Ozer, D.J., Benet-Martnez, V.: Personality and the prediction of consequential outcomes. Annu. Rev. Psychol. **57**(1), 401–421 (2006)

62. Park, G., Schwartz, H.A., Eichstaedt, J.C., Kern, M.L., Kosinski, M., Stillwell, D.J., Ungar, L.H., Seligman, M.E.P.: Automatic personality assessment through social media language. J. Pers. Soc. Psychol. (JPSP), pp. 934–952

63. Pittenger, D.J.: The utility of the Myers-Briggs type indicator. Rev. Educ. Res. **63**(4), 467–488 (1993)

64. Plomin, R., Caspi, A.: DNA and personality. Eur. J. Pers. **12**(5), 387–407 (1998)

65. Rentfrow, P.J., Gosling, S.D.: Message in a ballad: the role of music preferences in interpersonal perception. Psychol. Sci. **17**(3), 236–242 (2006)

66. Roberts, B.W., Chernyshenko, O.S., Stark, S., Goldberg, L.R.: The structure of conscientiousness: an empirical investigation based on seven major personality questionnaires. Pers. Psychol. **58**(1), 103–139 (2005)

67. Rossier, J., Meyer de Stadelhofen, F., Berthoud, S.: The hierarchical structures of the neo pi-r and the 16pf5. Eur. J. Psychol. Asses. **20**(1), 27 (2004)

68. Sackett, P.R., Walmsley, P.T.: Which personality attributes are most important in the workplace? Perspect. Psychol. Sci. **9**(5), 538–551 (2014)

69. Saucier, G.: Recurrent personality dimensions in inclusive lexical studies: Indications for a big six structure. J. Pers. **77**(5), 1577–1614 (2009)

70. Schwartz, A.H., Eichstaedt, J.C., Kern, M.L., Dziurzynski, L., Ramones, S.M., Agrawal, M., Shah, A., Kosinski, M., Stillwell, D., Seligman, M.E.P., et al.: Personality, gender, and age in the language of social media: the open-vocabulary approach. PloS one **8**(9), e73791 (2013)

71. Shiner, R.L., Masten, A.S., Tellegen, A.: A developmental perspective on personality in emerging adulthood: childhood antecedents and concurrent adaptation. J. Pers. Soc. Psychol. **83**(5), 1165 (2002)

72. Thoresen, C.J., Kaplan, S.A., Barsky, A.P., Warren, C.R., de Chermont, K.: The affective underpinnings of job perceptions and attitudes: a meta-analytic review and integration. In: 17th Annual Conference of the Society for Industrial and Organizational Psychology, Toronto, ON, Canada; An Earlier Version of This Study Was Presented at the Aforementioned Conference., vol. 129, p. 914. American Psychological Association (2003)

73. Vazire, S., Gosling, S.D.: E-perceptions: personality impressions based on personal websites. J. Pers. Soc. Psychol. (JPSP) **87**, 123–132 (2004)

74. Youyou, W., Kosinski, M., Stillwell, D.: Computer-based personality judgments are more accurate than those made by humans. Proc. Natl. Acad. Sci. **112**(4), 1036–1040 (2015)