

University of Tartu
Psychology Department

Siim Andres

Critical Analysis of The Cybernetic Big Five Theory

Bachelor's thesis

Advisors: Alan Voodla, Andero Uusberg

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Abstract

Although the replication crisis has raised concerns about the scientific rigor in many disciplines of psychology, the field of personality psychology has demonstrated notable resilience. To move forward in understanding the mechanisms underlying the emergence of personality traits, more predictive, formalized and comprehensive theories need to be put forward. For this purpose existing theories can be systematically assessed in order to identify strengths and weaknesses that need to be overcome. I critically analyze DeYoung's The Cybernetic Big Five Theory (CB5T) via seven criteria (coherence, predictive, generality, refutability, data priority, analogy, acceptance) for theory appraisal in a hybrid framework of inference to the best explanation (IBE). Results show that CB5T is a strong candidate for a grand theory of personality psychology.

Keywords: personality, big five, cybernetics, cybernetic big five theory, IBE

Küberneetilise Suure Viisiku Teooria Kriitiline Analüüs

Kokkuvõte

Isiksusepsühholoogia on näidanud märkimisväärselt vastupanu replikatsioonikriisile. Viimane on esile toonud mitmete psühholoogiaharude puudujääke. Isiksuseomaduste ilmumise alusmehhanismide mõistmine nõuab senisest enam ennustatavaid, formaliseeritud ja laialdasemaid teooriaid. See omakorda eeldab tänaste teooriate süstemaatilist hindamist, leides nende tugevad aga ka parandamist nõudvad küljed. Käesolevas töös analüüsiti DeYoungi küberneetilist suure viisiku teooriat (CB5T; The Cybernetic Big Five Theory) kasutades parimat selgitusest tuletamise (IBE; inference to the best explanation) hübriidset raamistikku ja seitset kriteeriumit: sidusus, ennustatavus, üldistatavus, ümberlükatavus, andmepõhisus, analoogia, heakskiit. Antud töö põhjal võiks CB5Tst kujuneda isiksusepsühholoogia "suure" teooria tugev kandidaat.

Märksõnad: isiksus, suur viisik, küberneetika, küberneetiline suure viisiku teooria, IBE

Introduction

Even as the replication crisis has raised concerns about the scientific rigor of many fields of psychology, the discipline of personality psychology has demonstrated notable resilience. In “The Life Outcomes of Personality Replication Project”, Soto (2019) found high replicability (87%) across 78 trait-outcome studies. Although the main research targets in personality psychology - traits - have predictive value, the mechanistic understanding of how they come about is still unclear. To move forward in understanding the mechanisms underlying the emergence of personality traits, more predictive, formalized and comprehensive theories need to be put forward (Borsboom et al., 2020; Gigerenzer, 2010; Oberauer & Lewandowsky, 2019). For this purpose existing theories can be systematically assessed in order to identify their strengths as well as weaknesses that need to be overcome. The primary goal of this thesis is to analyze DeYoung’s (2015) The Cybernetic Big Five Theory (CBT5) from this perspective. CBT5 has been recently proposed as a synthetic mechanistic theory that aims to give an account of how the Big Five personality traits can be explained from the perspective of the person as a cybernetic system. It is a good candidate for moving towards formalized personality theories owing to its ease of comprehension, adaptability and the substantial body of work that precedes it.

Going forward in this thesis I will first summarise and outline a brief history of the core components of the Cybernetic Big Five Theory. I will first provide a reminder and description of the five factor model - a refresher on how neuroticism, extraversion, conscientiousness, agreeableness and openness to experience are currently understood in modern personality psychology. Secondly, I will describe the neurobiological and behavioral aspects of the two metatraits stability and plasticity. Thirdly, I will introduce the idea of cybernetic systems and the five stages of a cybernetic loop that forms the basis for understanding CBT5. Fourth, I will explain how Cybernetics is connected to the aforementioned findings in neurobiology and personality as a whole.

I will then analyze CBT5 as a potentially explanatory theory for understanding the mechanisms underlying Big-5 personality traits. The analysis will rely on a set of seven

criteria: coherence, predictive, generality, refutability, data priority, analogy and acceptance. These were selected by the author as synthesis of a number of different suggestions on how to conduct theory appraisal within the inference to the best explanation framework

Personality and The Big Five

“Descriptively, personality refers to relatively enduring, socially and/or personally important patterns of behaviour, thought, and psychological (e.g., emotional and motivational) states, that are characteristic to an individual” (Konstabel, 2019, p. 261). Consistent with that modern definition of personality is the predominant Big Five, first assembled using factor analysis on a selection of personality describing adjectives and existing questionnaire measures (Goldberg, 1993). The Big Five is a hierarchical model of personality trait structure, in which relatively narrow and specific traits are grouped into five broader factors: Neuroticism, Extraversion, Conscientiousness, Agreeableness and Openness to Experience (McCrae & Allik, 2002). This approach relies on the assumption that the most important individual differences in the daily transactions of people would eventually become encoded into their language (Galton, 1949; Goldberg, 1981). Furthermore, there seems to be validity and consensus to this idea as similar traits have been found across cultures, languages, religions and genes (McCrae & Allik, 2002; Yamagata et al., 2006). Thus, the research on Big-5 traits has culminated in the modern and widely accepted understanding of the five-factor model (FFM), but with the acknowledgement that personality is not limited to those five factors (Fiske et al., 1995). To further describe the central traits in FFM, I will provide a brief overview of them.

The Five Traits

Neuroticism (vs. Adjustment) reflects the intensity with which people construct, perceive, and feel reality as being problematic, and in general the tendency to experience negative emotions (i.e. anxiety, irritation, sadness, insecurity, shame, and anger) (McAdams et al., 2018; McCrae & Allik, 2002).

Extraversion (vs. Introversion) reflects the quantity and intensity of relationships with one's environment (i.e. how outgoing, gregarious and dominant the person is), and is in general

strongly characterized by the tendency to experience positive emotions (McAdams et al., 2018; McCrae & Allik, 2002).

Agreeableness (kindness, empathy vs. cynicism, hostility), like the other traits in the FFM, is a bipolar dimension. Unlike extraversion it concerns the nature of one's relationships - specifically, the social sphere and the tone of relationships with others (McCrae & Allik, 2002). Low levels of agreeableness reflect tendencies to be aggressive, hostile, manipulative, callous, oppositional, and strongwilled (McAdams et al., 2018).

Conscientiousness (vs unreliable) is the personality dimension that covers actions such as planning of behavior and impulse control. This dimension comprises dynamic elements (anticipation, success-orientation, task-orientation) and control and inhibition elements of behavior (organization, perseverance across tasks, thoroughness, respect for standards and procedures) (McAdams et al., 2018; McCrae & Allik, 2002).

Openness (vs narrow-mindedness), the fifth major dimension in FFM, is independent of cognitive aptitude and combines different types of behavior related to an active search for and a love of new experiences (McCrae & Allik, 2002). Although there is variety to its constituents, depending on the method used to abstract Openness, it broadly describes Openness to experience, which manifests itself in a wide range of interests (i.e. intellectual, creative, cultural and political) (McAdams et al., 2018).

Although the 5 dimensions previously described are considered to be the classical traits in FFM, the Big Five is not just a reference to the five-factor model, but also an allusion to McAdams & Pals (2006) "New Big Five" a set of principles for an integrative science of personality:

Personality is conceived as (a) an individual's unique variation on the general evolutionary design for human nature, expressed as a developing pattern of (b) dispositional traits, (c) characteristic adaptations, and (d) self-defining life narratives, complexly and differentially situated (e) in culture and social context. (p. 204)

After these principles, DeYoung (2015) defines personality traits and characteristic adaptations as follows:

“Traits are probabilistic descriptions of relatively stable patterns of emotion, motivation, cognition, and behavior, in response to classes of stimuli that have been present in human cultures over evolutionary time” (DeYoung, 2015, p. 35). As an example, someone low on extraversion is not as talkative as someone who’s high on it yet they both still speak. For example, Siim is in the 85th percentile for extraversion. He’s less likely to find social gatherings tiresome and more likely to seek them out. He’s likely to be described by peers as outgoing and likely to say yes to new experiences. But given the right circumstances the opposite is also possible. In CB5T traits are considered to be universal. Characteristic adaptations on the other hand, cover a wide range of personality idiosyncrasies, but they can all be generalized into three categories: goals, interpretations and strategies (DeYoung, 2015). Characteristic adaptations are limited and enabled by traits. They are cultural rather than biological. The differences in characteristic adaptations come into being due to variation between environmental and biological factors in a person's life. A person might have the goal of being an astronaut if this is culturally possible. However, a tribe in the depths of the Amazon will have no concept of an astronaut and accordingly can have no goals, interpretations or strategies to accommodate that. Furthermore, unlike the original New Big Five, self-defining narratives are considered a characteristic adaptation in CB5T.

Although with certain discussion over the exact number of traits, this picture of personality structure seems to be the current consensus (McCrae, 2009). However, the questions of where do these traits come from and what are their underlying mechanisms remains unclear. The aim of Cybernetic Big Five theory is to bridge this gap.

The Cybernetic Big Five Theory

Personality develops from the variation within the interaction of the various stages and cybernetic cycles (DeYoung, 2015). It is in the differential pre-existing knowledge, environmental opportunities and genes that the variation in cybernetic functioning comes into play and creates a unique person.

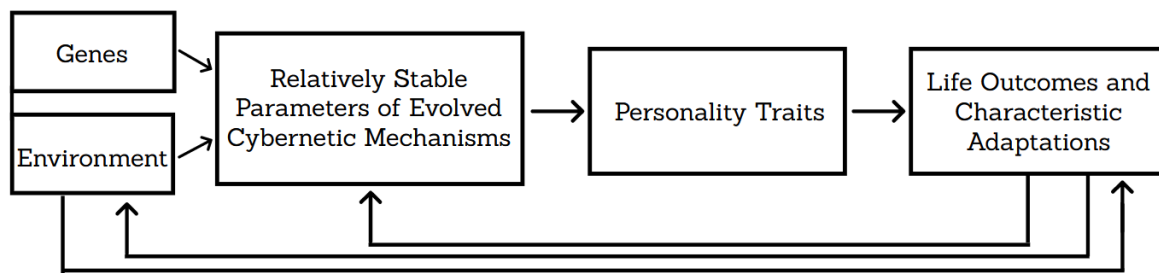


Fig 1. A simplified model of a human personality as an evolved cybernetic system. Adapted from DeYoung, C. G. (2015). Cybernetic big five theory. *Journal of research in personality*, 56, 33-58.

A common criticism and shortcoming put forward to the five-factor model is that it's atheoretical (Block, 2010). To be specific, the established five traits are abstracted from personality describing adjectives or existing questionnaires without a strong epistemological argument. CB5T attempts to address this issue and ground the underlying etiology of traits in the premise that fundamentally any adequate theory of personality must be based on an understanding of a person as a cybernetic system (DeYoung, 2010b; Van Egeren, 2009; Wiener, 2019). Therefore, to understand CBT5, it is first necessary to understand cybernetics.

Person as a cybernetic system

Wiener (2019), known as one of the pioneers of cybernetics, described cybernetics as the scientific study of control and communication in the animal and the machine. Today, this has come to mean the study of goal-directed, self-regulating feedback systems. A great textbook example of a feedback system is the thermostat in the modern oven. Once the roast reaches the set goal of a certain inner temperature, the oven shuts down. Self-regulation refers to the ability of a system to receive information from the environment (e.g., the temperature of the roast), compare that information to a standard or a goal (e.g., the desired temperature set by the cook), and to adjust the system to changes in the environment with the goal to minimize the discrepancy between the environment and the goal. Thinking of organisms as goal-directed self-regulating systems is both parsimonious and useful. It is apparent in our predispositions for sustenance, shelter, reproduction and the physiological system of

homeostasis. Because of the innate need to propagate and maintain the integrity of the whole organism, we have to fulfill a number of basic and abstract goals - from temperature regulation to writing a bachelor's thesis.

One way to analyze cybernetic systems is to describe them in terms of a cybernetic cycle, that consists of 5 stages - goal activation, action selection, action execution, outcome interpretation and goal comparison (Figure 1).

Complex Behavior in the 5 Stages of a Cybernetic Cycle

The first stage of the cybernetic cycle is goal activation. This refers to construction of a representation of a valued intero- or exteroceptive state, that can be more or less abstract. For example, obtaining higher education is an abstract goal that has some value for a student. As goals can be hierarchically organized, this higher level goal can also drive lower level goals of writing a thesis. Graduation as the overarching goal steers and guides the rest of the cybernetic cycle and has an influence on its subgoals.

The second phase in the cybernetic cycle is action selection. This refers to the selection of proper sequence of actions that lead to achieving the goal state. For example, in preparation to accomplish his goal of writing a thesis the student attends a number of optional seminars and finds a group of academics wondering about methodology in psychology. He weighs his options. Due to his prior intense interest in conducting good science and a healthy dose of fear over the replication crisis he decides to ask some nearby senior scientists if there is a thesis project he could do.

In the third stage the action is executed. Having done a quick cost-benefit analysis in the previous stage. The student proceeds to approach relevant senior scientists and asks for guidance.

In the fourth - outcome interpretation stage, information of the encounter, after the action, is analyzed and structured using preexisting knowledge. The student observes that the senior scientists share his enthusiasm. He incorporates this information into his working knowledge of the world.

In the final, fifth stage goal comparison is done to determine whether the cybernetic cycle was successful or not. What follows is the perseverance of the goal, a new goal or abandonment of the previous goal. Because of the discrepancy between the goal state and the

actual state, the student perseveres in his goal. Another subgoal in the overarching graduation goal is chosen and executed where he introduces himself and so on until the goal is accomplished or progress is impossible and the goal is abandoned. This cycle can be used as a model for goal directed behaviour on more abstract goals on longer time-scales as well as for more concrete goals (e.g grabbing a cup) on faster time-scales.

CB5T hypothesizes that these conceptual five cybernetic stages consist of functional neurological counterparts expressed as the latent phenomena we call the Big Five (DeYoung, 2015).

How Big-5 traits map onto the Cybernetic Cycle

The main author behind CBT5, DeYoung, defines personality traits as “relatively stable patterns of emotion, motivation, cognition, and behavior **caused by relatively stable parameters of evolved psychobiological cybernetic mechanisms**” (my emphasis) (DeYoung, 2015, p. 37).

In order to further flesh out his theory DeYoung brought in factors above the classical Big Five as explanatory targets. The metatraits Alpha and Beta, were abstracted from Big Five correlations in 14 studies in three different age groups, and broadly reflect a number of personality theories from the past (Digman, 1997). Alpha consists of the shared variance of Conscientiousness, Neuroticism and Agreeableness and Beta consists of the shared variance of Extraversion and Intellect (Openness) (Digman, 1997). These metatraits DeYoung renamed and adjusted to Stability and Plasticity as they seemed to address the fundamental Stability & Plasticity problem raised by Grossberg (Grossberg, 1987). The problem as stated by Grossberg (1987) is that a learning system must be capable of maintaining stable functioning, but also be adaptive enough to adjust to changing events. CB5T, inspired by Peterson’s (1999) known and unknown as adaptive forces in shaping humans, addressed the Stability & Plasticity dilemma brought forward by Grossberg in claiming that we can think about behavior in terms of two broad classes of evolved mechanisms concerned with maintaining the integrity and integrating new information - that are represented by metatraits Stability and Plasticity (DeYoung, 2015).

Stability is responsible for what might be described as the behavioral equivalent of maintaining homeostasis. A class of traits and characteristic adaptations that encompass routine, focus on long term goals and respecting the prevalent social norms. As DeYoung (2015) noted “Not only do human beings possess evolved mechanisms designed to operate when events are unfolding as anticipated and one knows what to do, they also possess evolved mechanisms designed to operate when events do not unfold as anticipated” (p. 47).

Correspondingly, Plasticity fulfills the role of creating new goals and dealing with the unknown (DeYoung, 2015). An example is that once an individual has an English breakfast it does not become the only meal they consume. An individual will often vary their diet. Although they are taking some risks in trying new foods, they also increase their access to other important nutrients that might not be included in their traditional diet. Furthermore, this propensity for variety will also give them flexibility should seasons and the available resources change. A cybernetic system must stay consistent in the day-to-day, but also cope with a rapidly changing world (DeYoung, 2015). According to CB5T, these metatraits can also be tied to neurobiology - CB5T hypothesizes that the serotonergic and dopaminergic systems are the major biological substrates of Stability and Plasticity (DeYoung, 2010a, 2013).

The aforementioned example of a cybernetic cycle and the elaboration of traits, become important, because of how they map onto another and as such theoretically ground the Big Five into known neuropsychological and cognitive phenomena. However, CB5T does not expect a one-to-one mapping of the five traits to each of the cybernetic stages.

Extraversion, posited to stem from variation in parameters of the mechanisms designed to respond to rewards, is most closely related to the first stage - goal activation, but which also influences action selection, action execution and goal comparison (DeYoung, 2015). Specifically, CB5T hypothesizes that aspects of extraversion, assertiveness and enthusiasm, represent the two classes of rewards - wanting and liking as described by Berridge (2007). Although intertwined, the two major aspects of extraversion associate best with different cybernetic stages. Whereas Assertiveness is best associated with goal activation, reflecting wanting—that is, motivation to attain desired goals, Enthusiasm would be best associated

with the last stage, goal comparison, which reflects individual differences in the tendency to enjoy reward attainment, but also want rewards (DeYoung, 2015) (Figure 2). The aspects being intertwined does not propose a problem for the theory, due to the nested nature of goals and subgoals, the accomplishment of a subgoal can act as both incentive and consummatory reward (DeYoung, 2015). Furthermore, Extraversion also predicts strategies for goal pursuit and the intensity at which a goal is pursued (DeYoung, 2015).

Neuroticism, defined as defensive responses to uncertainty, threat, and punishment, is most related to the last stage goal comparison, when the current status is compared to the desired goal (DeYoung, 2015). According to CB5T, Gray and McNaughton's (2003) distinction of the brain systems active defence fight-flight-freeze system (FFFS) and passive avoidance in the form of the behavioral inhibition system (BIS), correspond to the two aspects of Neuroticism - Volatility and Withdrawal (DeYoung, 2015). Volatility describes the tendency to be emotionally labile and to get upset, irritated, or angry easily and, thus, appears to reflect individual differences in the tendency toward active defense (DeYoung, 2015). Withdrawal, the aspect manifesting the tendency towards anxiety and depression, refers to the automatic withdrawal of motivation, either partially or completely, from particular strategies or goals, in response to uncertainty (DeYoung, 2015). Avoidance goals involve increasing or maintaining the discrepancy between the current state and some undesired state (Carver & Scheier, 2001). Neuroticism may also manifest in the cybernetic stage of goal activation. Avoidance goals may arise when one with limited prudence attempts to write a theoretical paper and is unsure how to proceed. Such a case may end up in procrastination, since avoidance goals do not specify an alternative approach goal to follow instead - further influencing action selection and action execution (DeYoung, 2015).

“Openness/Intellect describes individual differences in cognitive exploration, the tendency to seek, detect, appreciate, understand, and utilize both sensory and abstract information” (DeYoung, 2015, p.44). The name comes from the two facets Openness to experience and Intellect, which describe empirically different and distinct, but related subfactors within the broader trait (DeYoung, 2015). Intellect, which also encompasses IQ and working memory (DeYoung et al., 2009, 2012, 2014), reflects intellectual engagement with abstract and semantic information, whereas Openness to Experience, which has been linked to implicit learning (Kaufman et al., 2010), reflects engagement with sensory and perceptual information and thus involves aesthetic interests and fantasy proneness” (DeYoung, 2015). Both are most

closely related to the fourth stage of outcome interpretation. Intellect appears to be responsible for logical and causal knowledge of the world, while Openness appears to be responsible for correlational knowledge about spatial and temporal patterns (DeYoung, 2015)

Conscientiousness is posited to reflect “variation in the mechanisms that allow people to follow rules and prioritize non-immediate goals” (DeYoung, 2015, p.45). It consists of the two aspects Industriousness and Orderliness - Industriousness measures involve self-discipline and the tendency to work hard and effectively without being distracted before tasks are completed and Orderliness involves neatness, perfectionism, and attention to rules (DeYoung et al., 2007). Functionally it is most closely related to the first three stages of the cybernetic cycle - goal activation, action selection and action execution. Industriousness should predict whether valuable long term goals are activated, selected, executed and prioritized over other short term goals (DeYoung, 2015). There is some preliminary evidence for the underlying biology of Conscientiousness. In the context of brain structure DeYoung et al. (2010) and (Kapogiannis et al., 2013) found an association between the volume of dorsolateral prefrontal cortex, a brain structure important for activation of abstract goals and executing planned action based on abstract rules, and Conscientiousness (DeYoung, 2015).

Agreeableness manifests variation in a set of mechanisms that evolved because humans are social mammals whose survival is enhanced by exchanging information (goals, strategies and interpretation) and coordinating teamwork (Van Egeren, 2009; DeYoung, 2015). According to CB5T the two aspects that compose Agreeableness are Compassion and Politeness. These are not strictly required for a completion of a cybernetic cycle, however they do influence goals activated and strategies selected and how information of the world is interpreted, because inextricably social mammals perceive the world through a social lens (DeYoung, 2015). Compassion, a dedicated affiliative bonding system, reflects emotional automatic processes such as empathy, concern and caring, while Politeness, a social regulation system, reflects restraint of aggression and other socially disagreeable behaviors, that require more conscious control (DeYoung, 2015). The most likely neural correlates are the parts of the default network that take part in decoding the mental states of others (Allen & DeYoung, 2015).

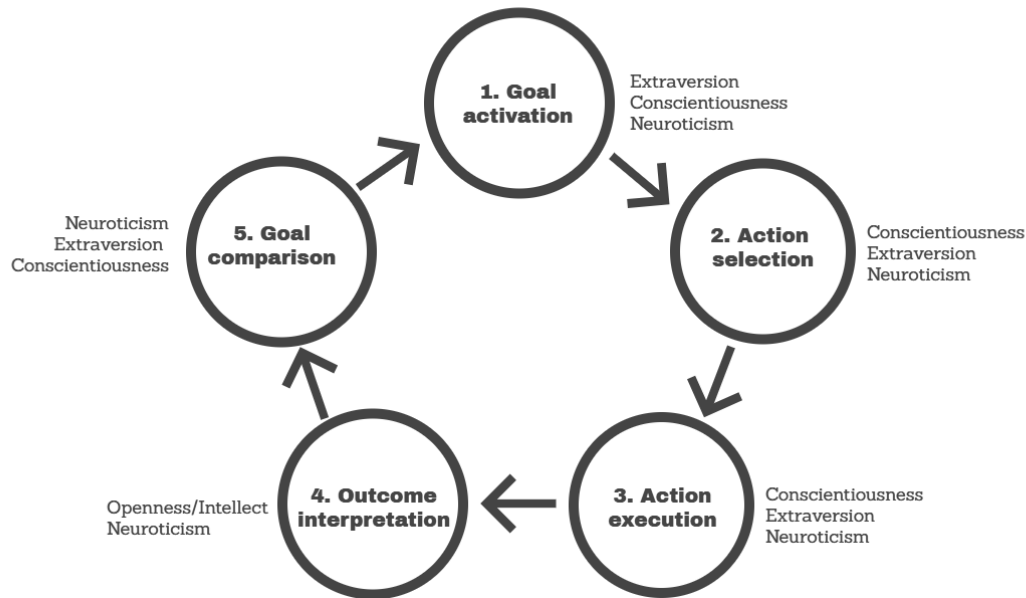


Figure 2. A simplified mapping of traits onto cybernetic stages. It's important to note that CB5T recognizes that the human brain works both in serial processes, with a bottleneck at action execution, and parallel processes. Agreeableness, although not explicitly included, is expected to modulate how each stage in the cybernetic cycle is carried out.

I have now given a short overview of the major innovative and integrative aspects of CB5T - the integration of personality, cybernetics, IQ and neurobiology. Going forward this concise theoretical base allows us to conduct the following critical analysis.

Critical Analysis of Cybernetic Big 5 Theory

The aim of the next part of the work is to take a critical stance towards CBT5 and evaluate it with regards to criteria of a good scientific theory. This analysis will take the form of inference to the best explanation (IBE). IBE is a framework for theory appraisal, in which theories are pitted against each other in terms of explanatory criteria or virtue. In this paper, I will use a hybrid of IBE, meant for psychology, put forward by Haig (2009) - evaluating a psychological theory purely in terms of criteria indicative of a good theory. Of these criteria, predictive accuracy and falsifiability are perhaps the most known, but theory appraisal is generally not a simple matter of algorithmically going through a set of principles. Because, although successful computational models for theory evaluation like Thagard's (1992) ECHO

exist, they are often difficult to put into practice. Complications arise in practice as two opposing theories can be true if they measure different constructs using conflicting or even the same criteria with different interpretations (Kuhn, 1977). As the ready-made sets of theory evaluation criteria are often unsuitable for specific domains of science and might miss some relevant advantages and disadvantages of a theory, for this analysis it was decided to construct a new set of criteria, building upon major accounts in philosophy of science. More specifically, after working through several accounts of theory appraisal, I arrived at seven criteria set forth by Kuhn (1977), Quine & Ullian (1970), McMullin (1982) and Thagard (1992) and combined them into a new theory evaluation framework. These seven criteria are amalgams, formed on the basis of conceptual analysis of similarity and distinctiveness: coherence, predictiveness, generality, refutability, data priority, analogy and acceptance. Using each criteria as an evaluation tool, I will analyze the scientific status of CBT5. As this analysis is necessarily heuristic and limited by the author's scope of perception, I have nevertheless aimed to be systematic and rigorous throughout the analysis. I consider the main outcomes of this kind of analysis to be the mapping of possible inadequacies as well as strengths of the theory and outlining ways to overcome these challenges, which I will discuss in the final part of the thesis.

Coherence

The criteria of coherence embodies why we value the concept of theory. Its function is to clarify how a hypothesis fits into the rest of our working knowledge of the world. The less it contradicts with our already existing beliefs or studies the better it is (Kuhn, 1977; Quine & Ullian, 1978; McMullin, 2012). To be more specific, there is internal coherence. For example, if one were to suggest a theory of infinite willpower then it would contradict with our already available evidence on the limits of willpower. Internal coherence implies that a theory should be without internal contradiction - no logical inconsistencies nor coincidences (McMullin, 2012). Furthermore, there is also external consistency - consistency with other theories and with the general background of expectation (McMullin, 2012). For instance infinite willpower would contradict with our knowledge of physics, since there is no documented case of a perpetual motion machine, it would stand to reason that people are also incapable of perpetual willpower, since the same laws of physics apply.

External consistency of CBT5

Attempts to compare humans to cybernetic machines have been made before, and although we cannot absolutely exclude the possibility that the human mind is something entirely different, the comparison of behavior to a cybernetic system is apt. The principle of feedback control has an extensive history in the behavioral sciences, it has also seen use in the study of Bayesian inference, optimal feedback control, and reinforcement learning (Uusberg et al., 2019). Furthermore, conceptually, the metatraits stability and plasticity fit our knowledge of allostasis. Allostasis is the capability of the brain to take bottom-up sensory data and to integrate it with knowledge of the world to predict what resources the organism is likely to need, and to direct action towards acquiring those resources (Sterling, 2012). The exploratory nature of Plasticity similarly directs behavior towards actions that may result in acquiring those resources, to serve the long term stability of the organism. Furthermore, the aforementioned aspects Intellect (causal knowledge of the world) and Openness (correlational knowledge of the world), were also found to be consistent with McLaren et al's. (2014) propositional and associational learning (DeYoung, 2015).

Internal coherence of CBT5

CB5T however, inherits some internal incoherence from the Big Five. For example, the question whether the Big Five are universal is not settled. Although today there is considerable replicability for the five-factor model internationally (McCrae, 2009), there are also exceptions. In the Bolivian Amazon, the Big Five failed to robustly replicate, instead significant covariance was found among items across the standard Big Five, and it was hypothesised that personality may instead be organized along fewer and differently composed dimensions (Gurven et al., 2013). However, one must recognize the difficulty in studying cultures that have a limited vocabulary and which may express invariability due to selective forces in their immediate environments. One cannot show less conscientiousness than others because if one does not work then one does not eat. Perhaps in less advanced cultures personality is simply more homogenous because there is less potential for personality dimorphism (Schmitt et al., 2008).

A further problem surfaces if a theoretician ignores the emic approach to researching personality. Practical implications exist in terms of whether an emic (psycho-lexical - derived from native language) or etic (standardised questionnaire - imported from another country

and adapted) approach was used (McCrae & Allik, 2002). For instance in the emic tradition Paunonen and Jackson (2000) reevaluated the original adjectives by Goldberg and found that 50 out of 74 adjectives had factor loadings lower than 0.4, meaning they did not load onto any of the established Big 5 meaningfully. This and similar incongruent findings however may be a red herring. Although some trait level structures vary among languages, this does not necessarily mean the underlying structure of personality is meaningfully different, but rather that this variance reflects more universal lower level traits (Saucier et al., 2005) such as the 10 aspects brought forward by DeYoung et al. (2007).

Finally, DeYoung has brought together numerous psychological phenomena under the umbrella of Cybernetic Big Five Theory and integrated them in a way that could be loosely construed as mechanistic (Hommel, 2020). The strongest example is extraversion - the trait most extensively elaborated in terms of its mechanisms (DeYoung, 2015). Although not incontrovertible, CB5T brings forward extensive evidence for the link between Extraversion and the reward system of the brain. Multiple studies have found Extraversion to moderate the effects of pharmacological manipulation of dopamine (DeYoung, 2013), furthermore it is associated with the volume of the ventromedial prefrontal cortex, a brain region crucial for representation of the reward value of stimuli (DeYoung et al., 2010; Omura, Constable, & Canli, 2005; Rauch et al., 2005) and fMRI and EEG studies show brain activity in response to emotionally positive stimuli that is associated with Extraversion (Cohen et al., 2005; Mobbs et al., 2005; Schaefer et al., 2011; Smillie et al., 2011)

The least neurobiologically elaborated trait in the CBT5 is Agreeableness. According to Allen & DeYoung (2017) the low end of the aspect Politeness is reflected by measures of aggression. Which begs the question how does it differ from the aggression seen in the high end of the aspect Volatility? Furthermore, the mapping of traits does seem at least partially incongruent. If neuroticism with its negative emotions affects the 4th stage of outcome interpretation, then that should also be the case for extraversion. According to the Broaden-and-Build theory positive emotions broaden how people perceive the world (Fredrickson, 2001), therefore the aspect of enthusiasm should also effect outcome interpretation.

The weight of evidence is substantial, but as Allen & DeYoung (2017) point out that currently personality neuroscience suffers from small sample sizes, lack of direct causal chains and differences in methods, which make it difficult to draw definitive conclusions.

Predictive

Ideally a theory should be predictive. But as McMullin (2012) eloquently said: “Nearly every theory is “born refuted”; there will inevitably be anomalies it cannot handle. There will be idealizations that have to be worked out in order to test the theory in complex concrete contexts.” (p. 698) However, eventually a theory should prove useful and exhibit predictive accuracy. A good theory should go beyond the initial explanada, remain fruitful, uncover and explain phenomena that are not part of the initial theory (Kuhn, 1977; McMullin, 2012). For instance what we have learned from physics has bearing beyond the academic discipline. As an example, the electromagnetic spectrum is significant for deeper understanding of psychology (visible light) and entomology (ultraviolet light), surely beyond what the physicists originally intended.

CB5T is predictive

CB5T inherits the predictive capacity of the FFM, but also puts forth new hypotheses. Since DeYoung’s paper the predictiveness of the Big Five in context of life outcomes has been mostly replicated to a large degree. Soto (2019) found major overlap with review of the trait outcome literature by Ozer & Benet-Martínez (2006). Soto (2019) replicated findings such as that extraversion positively and emotional negativity (neuroticism) negatively predicted subjective-well being (happiness); it was found that conscientiousness was negatively associated with substance abuse and criminal behavior, but positively related with occupational performance, religious beliefs, romantic and family satisfaction, sensitivity to intrinsic & extrinsic success and conservatism; agreeableness had a negative association with heart disease; negative emotionality was positively associated with anxiety; open-mindedness was positively associated with investigative occupational interests, artistic occupational interests and substance abuse. On the metatrait level, in adolescent males Plasticity has been shown to predict risk of externalizing problems such as delinquency, hyperactivity, and drug use (DeYoung et al., 2008).

Furthermore, CB5T allows for a broad range of new testable hypotheses, because it specifies the mechanistic functions that underlie different traits. For instance, DeYoung (2015) proposes a testable hypothesis that Assertiveness and Enthusiasm, the aspects of Extraversion, should make opposite predictions of motivation for further goal pursuit following immediate attainment of a subgoal. Or that the aspects Intellect (in particular IQ) positively and Openness negatively related to frontal white matter integrity (Allen & DeYoung, 2017).

Generality

Generality is achieved with a unifying idea throughout known phenomena - both simple and complex (Quine & Ullian, 1978). The utility of the simplicity criteria (Kuhn, 1973, Quine & Ullian, 1978; McMullin, 2012) is clear when we graph the relationship between temperature and air pressure to see boiling points. A hypothesis that uses air pressure as a predictor of boiling points would predict better than the alternative of altitude, because altitude would not give expected results inside flying airplanes, pressurised rooms or cooking utensils. However, this is not an absolute principle, because not all phenomena are simple. Take as an example the sex pheromone of the cabbage leaf looper moth (*Trichoplusia ni*). In 1966, a single molecule was thought responsible, a few years later another active ingredient was found, until 1984, when the discovery was made that 6 molecules are required for full biological activity (Hoffmann et al., 1996). This is a clear case of how the parsimonious explanation is not always appropriate. To illustrate Generality, Quine & Ullian (1970) use the example of how Einstein's relativity was incorporated into physics while not contradicting Newtonian physics.

CB5T and Generality

CB5T achieves generality because once we place a behavior within the context of a cybernetic loop we discover that we can place all behavior within a cybernetic loop. Regardless of the complexity involved, one could observe a human being at a random place in time and fit their behavior into the context of one of the 5 cybernetic stages - goal activation, action selection, action execution, outcome interpretation and goal comparison.

Even pathological cases, with the exception of a coma, can be framed in terms of cybernetics. For instance, the dysfunctioning of individuals with anterograde amnesia could be understood better since they should exhibit deficits in the 4th stage of outcome interpretation, because of their inability to adapt to new information.

Refutability

How does one tell apart a good general theory from a lesser one? Although some philosophers of science seem to have moved on from Popper's falsification, I think they have done so prematurely. For their argument against falsification is that anything can be falsified if the scientist is willing to risk little (Quine & Ullian, 1978). Whereas Popper stated that the riskiest hypothesis needs to be made (Popper, 2014). Quine & Ullian (1970) recognizes the weakness of refutability but eloquently agree: "... some imaginable event, recognizable if it occurs, must suffice to refute the hypothesis. Otherwise the hypothesis predicts nothing, is confirmed by nothing, and confers upon us no earthly good beyond perhaps a mistaken peace of mind. "

Refutability and CB5T

CB5T integrates a diverse set of fields (intelligence, learning, genetics, personality, neurobiology and cybernetics), with this DeYoung exposes his theory to a wide range of potential empirical tests. Which according to Popper is a strength of a theory, because this is the riskiest thing a scientist could do. The author of this paper feels this threat distinctly as a critical analysis on such a broad subject matter also exposes his thinking to many vectors of potential scrutiny. Although the phenomena included are fairly mainstream and accepted, they are not without their challengers. In time not only does CB5T have to reconcile any discrepancies in its subtheories, but also the hypothesis it sets.

Data Priority

The principle of data priority tells us that we should prefer direct observations over hypothetical or theoretical explanations (Thagard, 1992). A popular myth exists that according to known theories one might conclude that the bumblebee cannot fly. But of course a direct observation of a bumblebee would tell us otherwise. Clearly in such a situation we

should conclude that our assumptions are wrong, not the bumblebee. This bears on the recent observation of many scientists that many psychological phenomena are not ergodic.

Ergodicity and CB5T

Psychology is focused on variation between cases (interindividual variation). Results thus obtained are considered to be generalizable to the understanding and explanation of variation within single cases (intraindividual variation). It is indicated, however, that the direct consequences of the classical ergodic theorems for psychology and psychometrics invalidate this conjectured generalizability: only under very strict conditions--which are hardly obtained in real psychological processes--can a generalization be made from a structure of interindividual variation to the analogous structure of intraindividual variation. (Molenaar, 2004). (p. 201)

Simply put, ergodicity in psychology would mean that individuals are like uniform fair dice. The group average of 100 fair dies will be the same as throwing 1 fair die a 100 times. However, individuals are not like uniform fair dice (Fisher et al., 2018). This is already implicitly accepted in psychology research when it comes to distinguishing female and male statistics. E.g. it would take a very brave scientist to say that during his lifespan a man visits all the emotional, cognitive, and physical states of a woman. Mathematically, the problem becomes clear if you calculate averages based on fair and unfair die. Each side of a fair die has a 1 in 6 probability of being rolled, whereas an unfair die (a better approximation of a human being in context of other human beings) would not have an equal distribution of probability for each side of the die. The extreme aggression of a violent offender has no bearing on what a pacifist will do or is even capable of doing in their life.

Similar empirical observations have been made in psychiatry - Wolfers et al. (2018) found, in mapping of interindividual differences in brain structure, that group level differences disguised the heterogeneous nature of individual brain abnormalities (p. 1146). Gonzalez-Castillo et al. (2012) also noted that language tasks are bilateral, but the BOLD response in an fMRI does not differentiate a unilateral lesion causing aphasic symptoms and therefore offers no clues to which half of the brain is important for functioning.

As Lewis Carroll (2010) said in *Alice in Wonderland*: "but it's no use going back to yesterday, because I was a different person then" (p. 69). The problem of ergodicity impacts personality psychology too. Beckman, Wood and Minbashian (2010) noted that although an individual might act conscientiously they also feel more neurotic as a result, regardless of the fact that interpersonally the statistics show a standard negative correlation between Conscientiousness and Neuroticism. However, CB5T recognizes that interpersonal covariance structure does not necessarily correspond to intrapersonal covariance structure, and that further theory development is required for proper understanding of the latter (DeYoung, 2015).

Analogy

Another helpful indicator of a good theory is analogy to another well known phenomena. For example, Darwin's theory of evolution by natural selection gained credibility by analogy to the well-known process of artificial selection (Thagard, 1992). Similarly, DeYoung (2015) hypothesizes that personality traits are a result of classes of stimuli in the evolutionary history of human cultures.

CB5T and Analogy

However, CB5T does not systematically describe those classes of stimuli that shape the Big Five. Although CB5T notes the importance of social cooperation, the necessity of a cybernetic framing of behavior, and the abstract forces of the known and unknown, they are insufficient for reconstructing the Big Five, or its variations, from the ground up. An ideal theory should predict any possible discrepancies that have been observed by other personality scientists like in Bolivia (Gurven et al., 2013). Assuming that either the lexical or the questionnaire method of discovering personality traits are valid we still need to know how they come to be. Merely positing the emergence of the Big Five is not enough, because a plausible explanation may not be the correct one. To put it another way, although natural selection is highly likely a cause for personality, one cannot simply invoke evolution to add credibility to a theory. Without a reliable theoretical framework such abstractions may be potentially misleading, because abstractions can take infinitely many forms, not all of them useful (Quine & Ullian, 1978). A good theory should tell us what personality traits are

possible, which are not, and ideally do that before a method such as factor analysis creates a set. This ties in with Popper's falsification and Quine & Ullian's refutability.

There is a precedent for this type of thinking. In order to set future expectations perhaps we can borrow an example from Richard Alexander, an entomologist and evolutionary theorist, who successfully hypothesized the existence of an eusocial vertebrate. In order to make his prediction, he needed a thorough understanding of the selective forces in the evolution of eusocial insects. Based on this body of knowledge he created a 12-part model for a hypothetical eusocial vertebrate, which was proved true in the form of the naked mole-rat (*Heterocephalus glaber*). He hypothesized the diet, the social relationships and the living conditions of the naked mole-rat before ever becoming aware of them (Braude, 1997, p. 12–15). Similarly, one would wish for a broad strokes predictive theory of personality that should outline a possible set of trait factor solutions that may come up in a culture or ecological niche when given a set of parameters.

Acceptance

Both Thagard (1992) and Quine & Ullian (1970) put forward that there should be a degree of compatibility between criteria. This last principle (acceptance) asserts that propositions are accepted or rejected based on their degree of coherence with other propositions (Thagard, 1992). CB5T stands out because it effortlessly meets many of the criteria for theory appraisal put forward in this critical analysis. But most importantly there is a high degree of coherence between the criteria. The theory is parsimonious but it also succeeds in that without sacrificing complexity. Furthermore it is analogous and externally consistent with other theories and processes known to us. What it lacks so far is predictive accuracy beyond what it has already explained. But DeYoung has opened avenues for further research to refute his hypothesis, which as has been established is another virtue of a good theory. One might say that CB5T fails on the account of data priority, but this depends on what you expect interindividual statistics to tell you.

Discussion

The purpose of this analysis was to find out if the Cybernetic Big Five Theory is a good theory capable of explaining the emergence of personality traits. For this purpose it was critically analysed with seven criteria for theory appraisal. On the account of being predictive, CB5T inherits the predictive capability of the FFM, but also boldly lays out a theory that should provide a fruitful starting point for further testing. It is also interesting in the context of other criteria such as coherence - methodological squabbles over etic or emic methods become redundant once one realises that shared underlying evolved cybernetic mechanisms could explain incongruent results (Saucier et al., 2005). In terms of the criteria of data priority, psychometrics and the vast scientific research that CB5T is based on, it should largely be assumed that it is possible to make inferences of intraindividual variation based on interindividual variation (Molenaar, 2004). This might be an erroneous assumption. As Fisher et al. (2018) pointed out, researchers can only be confident about accuracy of measurement if they first have explicitly tested for equivalence of processes at the individual and group level. But this has little bearing on how personality is conceived in CB5T, because it implicitly recognizes how personality and the nature of human psyche development is not ergodic. However, the question remains how the concept of ergodicity impacts other fields CB5T encompasses (IQ, interpersonal theory, psychopathology, developmental psychology or learning theories). In terms of criteria for theory appraisal CB5T passes on most accounts. It exhibits considerable coherence in how integrative it is, it is predictive in a variety of domains, general with broad application, refutable in the riskiest sense possible, and cognizant of nuances in examples of data priority. It was found lacking in analogy due to an inadequate description of selective forces in the evolution of personality, however, this is a high bar for any psychological theory. Lastly, in terms of the final criteria acceptance it shows a high degree of compatibility between the criteria.

Limitations

There are at least three potential limitations concerning the results of this analysis. The first limitation concerns the availability and confirmation bias of the author. To circumvent this

problem future interdisciplinary research may be best served by a compendium of predominant theories and models from established fields, which a theoretician can consult for the general background knowledge against which to appraise a theory. Therefore strengthening the theory appraisal in terms of coherence, analogy, refutability and generality. A second potential limitation is the incomprehensiveness of the criteria for theory appraisal. Most of these criteria were developed retrospectively by examining the history and development of great theories in science and are not considered a conclusive set (Kuhn, 1977; McMullin, 2012; Quine & Ullian, 1970; Thagard, 1992). These limitations could be lessened with a larger interdisciplinary review of theoretical approaches, methods and other appraisal techniques.

The third limitation is the scope of this article. I believe I included the major aspects of CB5T and went over the important points, but the theory itself is grander and more nuanced than I could do justice in the time allotted.

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