An Evolutionary Theory of Universal Values

Draft – Griffiths, Thomas & Dyer

Abstract

In the hierarchy of sciences, psychology sits above, and is sequentially dependent upon, biology, chemistry, and physics, yet, to its detriment, it is neither founded in nor fully integrated with these. We present a radical evolutionary theory that roots psychology in deeper science with reference to the second law of thermodynamics and complexity theory. Evaluating all systems, from atoms to human culture, in terms of their propensities to change and modes of change (cooperative to competitive), we argue that universal motivational equivalents to human values have been internalised sequentially by increasingly complex adaptive systems. The conscious realization of these values marks the final phase of internalization, yet developmental consolidation proceeds in sympathy with Maslow's Hierarchy of Needs. Accordingly, we suggest values and their equivalents are fundamental to understanding individual psychology and human systems. Offering our own supportive research findings, we invite extended research and explorations of widespread potentially beneficial applications.

Keywords

Evolution, Evolutionary Psychology, Personal Values, Personality Traits, Complex Adaptive Systems

Introduction

Why do we think and behave the way we do? Why the differences? Despite at least 3,500 years of psychological enquiry (Okasha, 2005) we still lack a comprehensive explanation. Perhaps because, understandably, the search has been anthropocentric in origin (Yerkes, 1933). Humanity's investigation of its place in the universe took until 1917 to overcome the final barrier in a sequence of false assumptions concerning the central place of humanity, and therefore of planet Earth, the Sun, and finally the Milky Way, in the universe (Curtis, 1988). The arrival of evolutionary psychology (Barkow, et al., 1992) marked a recognition that the human mind, like humanity itself, evolved according to the principles of natural selection. However, there is a tendency even in evolutionary psychology to concentrate on how genetic programming established in the Pleistocene epoch equips humans to deal with 21st century challenges (Smith, 2019) - i.e., to look back from now towards the horizon of humanity. Human evolution neither began nor ended with stone age man. As with all other organisms, homo-sapiens evolved from a common ancestor that lived approximately 3.7 billion years ago (Weiss, et al., 2016), which itself evolved from a self-sustaining protometabolism with prebiotic chemical antecedents (Glansdorff, et al., 2008). At present this evolutionary trail can be traced back through 13.8 billion years (Alves, et al, 2016) to the beginning of this universe: past organisms, complex molecules, simple molecules, heavy elements, light elements, and fundamental particles to Big Bang. The genetic phase of evolution most often associated with natural selection covers less than a quarter of this period, and multi-cellular life less than half again (Zhu et al., 2016).

Since almost immediately after Big Bang the universe and all its sub-systems have evolved in accordance with the same known laws of physics (e.g., Greene, 2004). If we are to gain a fundamental understanding of how human psychology evolved, theories developed from anthropocentric perspectives must be reconciled with those of physicists and others adopting a more universal approach. The evolutionary theory of universal values advanced here is an attempt to do just this.

There are many specialisations within psychology. Even evolutionary psychology has developmental, social, and cultural strands, divided between “high church” practitioners and others (Heyes, 2012). Given such fragmentation, a theory presenting an interdisciplinary argument that embraces quantum and classical physics, evolutionary biology, chemistry, psychology, and anthropology, all viewed through the lens of complexity theory, may seem too diffuse to be comprehensible. However, our argument is that relatively simple universal mechanisms motivate the evolution of all systems, from atoms to international cultures, in ways that can be understood in terms of abstract motivational fractals congruent in structure with Schwartz’s (1992) system of values - i.e., with orthogonal axes representing degree of change and mode of change - and that our distinctly human values are realized representations of these. Hopefully the explanations provided here require little or no prior knowledge of wider science to be readily comprehensible. In tracing the evolutionary lineage of human values from equivalents in the universal system, we illustrate how they, and their preconscious equivalents, shaped and continue to shape the human mind, human culture, and our shared environments.

The theory builds on universal scientific fundamentals more than existing psychological theory. However, widespread theoretical congruence readily facilitates integration with established thinking. To this end, toward the end of this article, we explore relationships with some prominent theoretical models in psychology. However, in the interests of brevity, we have been both highly selective and restrained in our treatment of them.

Personality as a universal descriptor

According to the APA (2022), personality concerns individual differences in characteristic patterns of thinking, feeling, and behaving, and how the various parts of a person come together as a whole. Personality may be considered as “a system of parts that is organized, develops, and is expressed in a person’s actions” (Mayer, 2007, p.1). This ‘system of parts’ includes such components as “motives, emotions, mental models, and the self” (Mayer, 2007, p.1). This aligns with Cloninger’s (2004, p.374) definition of “the dynamic organization within the individual of the psychobiological systems that modulate … adaptations to a changing internal and external environment”. Biologists also describe consistent differences in behavior between animals in terms of personality (Wolf & Weissing, 2012) - even single celled bacteria (AMOLF, 2017; Keegstra, et al., (2017). It is apparent that personality is inferred when categorically similar things consistently behave differently in the same environment, suggesting the presence of hidden internal mechanisms or motivations. For example, the bacteria investigated by Keegstra, et al. (2017) had identical DNA yet behaved differently in the same environment due to differences in their protein network (i.e., in the physical connections between cellular proteins).

All organisms are complex adaptive systems (CAS), (Adami, et al., 2002; Brown, 1995), i.e., dynamic networks of interactions in which collective and individual component behaviors change and self-organize in response to micro- and macro-events (Miller & Page, 2007). Other CAS include ecosystems and the wider environmental systems of which they are part, e.g., meteorological and oceanic (Carmichael & Hadzikadic, 2019). One of the characteristics of CAS is that perfect knowledge of all their components does not necessarily convey a perfect understanding of their behavior (Miller & Page, 2007). Accordingly, their behavior can be unpredictable and idiosyncratic: as if they have ‘a personality’. This may explain the personification of environmental CAS in the gods of ancient mythology: e.g., Horus, Thor, and Tempestes (weather), and Anuket, Poseidon, and Neptune (water).

An organism’s environment logically comprises all the information impacting upon it, whether external or internal in origin. Internally, all animal behavior reflects the function of neural systems (National Research Council (US), 1989). In humans this includes a brain with around 100 billion neurons with 10^{15} neural connections (DeWeerdt, 2019). Potential interactions in the internal environment of a human brain, and with the rest of the 3.72×10^{13} cells in the human body (Bianconi, et al., 2013), are unimaginably complex. Yet, their interactions with a vastly more complex and variable external environment comprising several orders of magnitude more systems, from atoms upward, give rise to systematic interactions of intractable complexity. However, human brains, and the greater CAS of which they are part, comprise and evolved from relatively simple atomic and molecular interactions. The interactions between hydrogen and carbon-based molecules that first evolved into an organic metabolism (e.g., Sousa, et al., 2013) may have lacked the type of complexity usually associated with personality, nevertheless they too are amenable to analysis in terms of behavior and underlying motivations.

Universals in motivation and behavior

The hidden motivational mechanisms of human personality include thoughts and feelings, which may be expressed through actions, statements, facial and bodily movements (e.g., Doherty, 2008). In common with all other organisms, such behavioral traits mediate the interaction of individuals with their environment (Sih, Ferrari, & Harris, 2011) toward meeting their needs (McEwen & Wingfield, 2003). As their environment changes so may their characteristic patterns of behavior.

Motivation related to survival and reproductive needs is readily comprehensible in the context of living CAS, but not to the hydrogen and carbon-based molecules of which they are made, and from which they evolved, nor to the atomic systems of these elements that first appeared in an earlier phase of the universe's evolution (Henning & Salama, 1997; Tanabashi et al., 2018). However, a universal equivalent of need – i.e., a compelling requirement – finds expression in the related principles of the second law of thermodynamics, minimization of total potential energy principle (MTPEP), and principle of least action. These underpin both evolution through natural selection (Kaila, & Annila, 2008; Ramstead, et al., 2018), in which the genes of the best adapted, most efficient organisms are preferentially selected, and Feynman and Hibb's (1965) quantum mechanical path integrals that describe how the most efficient trajectories for systems are 'selected' from infinite possibilities: i.e., how classical perceptions of reality relate to quantum mechanics.

According to the MTPEP, a body or system will tend to undergo change until it minimizes its total potential energy. Gravitational and electromagnetic fields imbue all massive and/or charged particles with potential energy, which is converted into kinetic energy through attraction and repulsion. Because of the infinite reach of these fields all things contribute to the environment of all other things, so giving rise to a universal, all-pervasive motivation for change. In practice, due to the strength of electromagnetic and gravitational fields diminishing by the square of the distance from their source, proximity exponentially exaggerates motivational influence on behavior. Therefore, it is the relationships between proximate particles and systems that most influences their behavior, and their ability to form new systems.

Prior to comparatively recent technological advances, relationships between people and their ability to form new systems were similarly dependent on proximity. That said, the proximity principal (Newcomb, 1960) remains a significant factor in the formation of friendships and national cultures, even in the Internet age (e.g., Fang, 2005; Preciadoa, at al., 2012, World Values Survey, 2020).

Protons and neutrons, the nucleons upon which all matter is based, only formed when environmental conditions in the early universe allowed, and only combined with electrons to form atoms of hydrogen, helium, and lithium c.370,000 years later, when the energy intensity of the environment had fallen such that stable relationships between their constituent particles could be maintained (Tanabashi et al., 2018). Due to nucleons being 20,000 times more massive than electrons and, in the case of protons, oppositely charged, they are the most important influence on electrons in their local environment: capturing them and determining their permitted orbital energy levels. Subsequently, in the intensely energetic environments of stars and supernovae, these atomic systems were forced to interact, giving rise to heavier, more energy-efficient systems; including the larger elemental building blocks of life: carbon, nitrogen, and oxygen (Henning & Salama, 1997). Further localised environmental changes potentiated the formation of progressively larger and more complex systems, each with distinctive emergent traits (e.g., Gregory, 2008).

As with any system, the shared internal environments of atoms both determine and potentiate their traits. The sizes of their nuclei determine their stability, mass, and the number and energy levels of electrons in their outer valence shells (Bethe & Bacher, 1936). These factors explain why potassium tends to be highly reactive and argon is considered inert. But even these innate propensities are the product of, and subject to, environmental interactions. For example, the masses of nucleons and of their constituents are derived from interactions between their binding energies and the Higgs field (CERN, 2020). These propensities potentiate different traits in different environments. Potassium bursts into flame in water, tarnishes in air, and remains a stable shiny metal in mineral oil. Even 'inert' argon can be induced to react in an appropriate environment of hydrogen and fluorine (Khriachtchev, et al., 2000). As with organisms, these traits mediate between the MTPEP-related 'needs' of atoms and their environment: largely through electrons seeking more energy-efficient configurations. The traits associated with simple chemical reactions may be predictable, but in more complex chain reactions this predictability may be lost.

All chemical reactions, including those underpinning biology, are facilitated by the emission and absorption of photons by electrons orbiting nearby atomic nuclei. The energy levels of permitted electron orbits follow prescriptive criteria characteristic of each element. As atomic systems undergo change electrons may be energised to jump to higher energy orbits, and then, in accordance with the MTPEP, release kinetic energy in a stream of photons as electrons drop back to lower, stable energy states (Bohr, 1913). Electrons emit and absorb photons with energy values matching differences between the permitted orbital energy levels of the elemental atomic system to which they belong (Bohr, 1913). Photons with energy levels that fail to correspond to such differences cannot be absorbed by other atoms, and so are 'ignored' by their electrons. When the energy received from photon bombardment exceeds the capacity of atoms to absorb it by moving electrons to higher orbits, electrons may break free (the photo-electric effect, e.g., Wheaton, 2009). This transforms neutral atoms to positively charged ions that are attractive to free electrons, thereby facilitating a flow of electrons from locations with higher potential energy values to those with lower potentials (electricity). However, the direction of photon emission, and therefore exactly where photons will be absorbed, appears randomly selected. This introduces variation upon which MTPEP based natural selection may act.

With what is effectively a photon-based currency, complex systems of atoms conduct energetic transactions that facilitate change. Each transaction operates like a binary switch: either a photon is emitted/absorbed or not. In the CAS of the human brain such transactions form the basis of all neural activity: all human perceptions, feelings, thoughts, and actions. Neural processing of information involves trillions of such binary yes/no 'decisions': neurons fire or not dependent on the rate of photon transactions, so representing numerous underlying 'decisions' of electrons and photons. In neural processing, like photon exchange, if information matches prescriptive values-based criteria it is more likely to be absorbed and acted upon (e.g., Herz, et al., 2016).

In systems of atoms, such as organisms, behavioral traits may be considered outputs arising from systemic, energetic-values-based processing of environmental inputs that mediate between systemic 'needs' and the wider environment. In humans, personal values form a motivational system that influences individual perceptions, judgement, decision-making, and behavior in relation to desirable goals and needs (Schwartz, 1992). For example, an individual with a motivational system in which the values of curiosity and creativity (part of self-direction) are the most important is more likely to find a wide range of information interesting, and so is more likely to absorb it and link it to creative outputs, than someone for whom these values are relatively unimportant (e.g., Lebedeva, et al., 2019). As such, it is apparent the role of personal values is not only comparable to the selective role of orbital energy values of electrons, but fundamentally reliant on it.

The action of photons on atoms, through their electrons, motivates them to occupy locations and form relationships that best satisfy the MTPEP in the context of the greater systems of which they are part. The behavioral traits of atoms mediate between them and their molecular environment. The traits of molecular genes mediate between them and the environment of the genotype, the traits of which are expressed in phenotypes, which mediate between organisms and their environments. All these systemic interactions are driven toward energy-efficiency in accordance with the MTPEP; the most energy-efficient being those favored by natural selection; i.e., those that maximise survival and reproductive outputs/returns per unit input cost.

Making sense of evolving complexity

The behavior of relatively simple physical systems may be predictable, but the precise behavior of their component electrons and photons is not (Heisenberg, 1927). The predictability of simple systems agrees with the averaging out of probabilistic quantum events (Feynman & Hibb's, 1965), but still quantum uncertainty (Heisenberg, 1927) may contribute toward the chaotic, apparently non-deterministic behavior we associate with personality in macroscopic CAS (Brun, 1995).

The behaviors of CAS components change in response to those of others to which they are systematically networked (their environment). In large complex systems the number of components and possible interactions - including recurrent feedback loops - is so great as to render conventional analysis impractical (Miller & Page, 2007). In computer based evolutionary models of CAS algorithms may be run cyclically to affect all components in ways that mimic intergenerational genetic processes, including the potential for the algorithm to mutate. Each iterative running of the algorithm motivates the evolution of the system. The states of individual 'cells' within a CAS are determined by the algorithm with reference to the states of proximate cells. In organisms, Hox genes rely on comparable programming: responding conditionally to location-sensitive cues to 'switch off' specific genes; the effect of which is to delineate and define new rules for the development of different somatic regions (e.g., Lemons, 2006). Emergent patterns in the behavior of cell populations in CAS can be considered in terms of resistance to being overtaken by alternative developmental schemata (i.e., relative stability), and whether such change is cooperative (coordinated and orderly) or competitive (chaotically disruptive) (Kauffman, 1995).

The relationship between cooperative and competitive schemata, or strategies, can be explored with the Prisoner's Dilemma. This product of game theory was developed from the work of Flood &

Dresher (Poundstone, 1993) to represent interactions in which the destiny of two players is determined by a co-dependent decision each makes without knowledge of how the other will decide. Axelrod and Hamilton (1981) were the first to use iterated versions of the Prisoner's Dilemma game, involving multiple players and competing strategies, to illustrate how cooperative strategies – i.e., those targeted at optimising joint benefits – could outcompete competitive strategies – i.e., those seeking to maximise their advantage over other players. Axelrod (1997) went on to relate this work to complex, agent-based models of competition and cooperation, and to incorporate insights from the Prisoner's Dilemma into the study of Holland's (1975) genetic algorithms and CAS.

The binary option before players in The Prisoner's Dilemma is whether to cooperate or defect (i.e., compete). The game, which may be played over many rounds, may be scored in accordance with the matrix shown in figure 1.

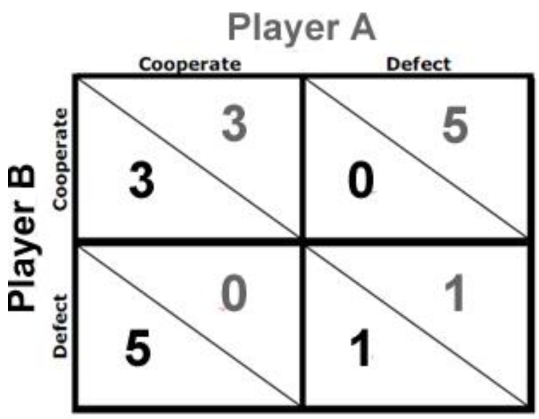


Figure 1. Prisoner's Dilemma Scoring Matrix

In the single round version of the game an attractive strategy is to always defect (compete), because it offers the opportunity to score the maximum 5 points and cannot be beaten by the other player. However, in iterated versions of the game it is better to cooperate by default but retaliate to punish a competitor (Axelrod & Hamilton, 1981). Unless competitive players can exploit a limitless resource of players pursuing 'always cooperate' strategies, they will likely encounter repeated rounds of costly conflict in which they score only 1 point. This illustrates the relative advantages of competitive and cooperative strategies. In the short-term, competition offers the greatest potential for personal gain and minimises the potential for personal loss relative to one's opponent, but, in the long-term, against a rational or otherwise adaptive opponent, it is suboptimal. In the long-term, cooperation offers the greatest potential for gains, both personally and collectively.

If points are taken to represent energy, the pattern of pay offs in the Prisoner's Dilemma can be used to model the interaction of natural systems. If two systems combine to maximise local energy conservation (3 + 3 = 6), this may be taken to represent cooperation. The combination of two oxygen atoms to form an O_2 molecule achieves a comparable outcome. If the two compete, much energy may be lost from their conjoined system (6 – (1 + 1) = 4), leaving each (if they survive) with a much-reduced share of residual energy (2/2 = 1). This might be considered comparable to such violent interactions as that between potassium and water. If one component quickly overpowers the other this may be considered equivalent to the compete/cooperate combination, in which one system consumes the other (leaving it with 0 points – 'the sucker's pay-off') and less energy (1 point) is lost in conflict, leaving a greater residual (6 – 1 = 5). A planet absorbing the energy from a meteorite might be considered representative of this. In all these examples, unlike in Prisoner's Dilemma gameplay, in the absence of intent, 'strategies' may be deemed cooperative or competitive dependent on their ability to conserve energy in the environment in which they play out.

Trivers (1971) was among the first to associate the principles of the Prisoner's Dilemma with the evolution of reciprocal altruism (cooperation) in organisms. Unlike point scoring in the Prisoner's Dilemma, organisms interact such that accumulated energy is available to influence future 'rounds of play'. Therefore, cooperating systems may gain power and competitive advantage over equivalents playing competitive strategies.

While it may be possible for systems using competitive strategies to inflict successive 'sucker's payoffs' on components of larger cooperative systems, providing cooperative systems retaliate with targeted, subservient competitive strategies, their greater resources may allow them to overcome and eliminate competitors and remain relatively stable. This is effectively how organisms fight infection. Organisms' cells and cellular systems are programmed to play cooperative strategies that benefit the whole organism, yet have subordinate immune systems programmed to seek out and destroy bacteria, viruses, and other competitors (Nowak and Highfield, 2012).

Nowak and Highfield (2012) illustrated the limitations of unmoderated competitive strategies within a system with reference to cancer cells. The mutated genetic programming of cancer cells effectively causes them to defect and deliver successive sucker's payoffs to other cells: multiplying at their expense until the cooperative systems on which they and the host organism is dependent break down; bringing about their mutual destruction.

When considering the evolution of cell populations in CAS, it is apparent that the interaction of two factors is involved: (1) propensity to change, and (2) the strategy by which change is transacted – cooperation or competition. These correspond to the axes of the Schwartz (1992) system of values: (1) conservation to openness to change, and (2) self-enhancement (competition) to self-transcendence (cooperation). The universe, earth's ecosystem, humanity, individual humans, and neural systems responsible for generating our system of values are CAS with a shared ancestry. Accordingly, this coincidence of structure suggests their co-evolution might be considered in relation to a universal equivalent of Schwartz's (1992) circle (UESC).

For any system to attain equilibrium and stability it must have minimized its total potential energy locally. Its components must have achieved a cooperative state in which energy is conserved. All such stable systems can therefore be mapped in the conservation/cooperation quadrant of the circle, as illustrated in figure 2.

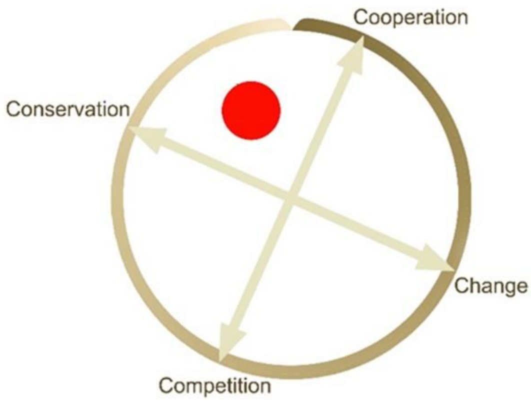


Figure 2. The red marker represents the location of a unified strategy (or averaged combination of component strategies) of any stable system in relation to a universal motivational map with a structure equivalent to that of the Schwartz (1992) circle (UESC)

Stable local systems (such as atoms of carbon and hydrogen) with motivational value-equivalents mapping in the conservation/cooperation quadrant may be driven together by electromagnetic and/or gravitational attraction to interact on terms defined by what may be considered a universal motivational algorithm (UMA) comprising all universal physical laws. The collision between them changes their momentum and releases kinetic energy, which becomes available as activation energy (Tolman, 1977). If this exceeds a certain threshold it will destabilize them, opening the system to the competitive dynamism of the universal system; related 'strategies' of which may be associated with the other quadrants of the UESC. Such collisions potentiate both the destruction of the systems and the creation of a new system or systems. The potential energy of each system increases temporarily to a transition state, before settling into a new stable state, or, if divided, stable states (as illustrated in figures 3 and 4). This will only result in increased complexity if the more complex configuration is more energy-efficient than the other possibilities given environmental constraints.

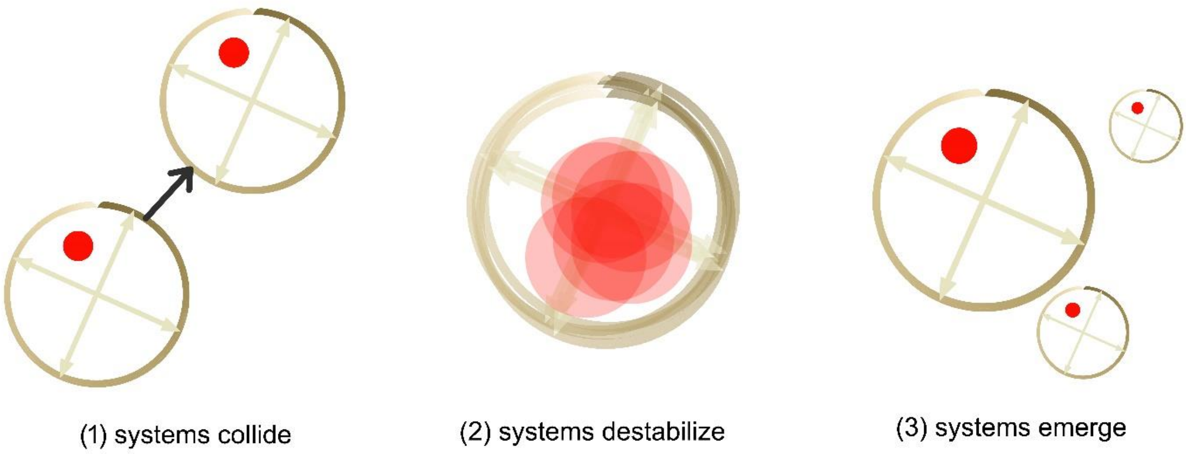


Figure 3. Value-equivalents of colliding and emerging systems in relation to the UESC

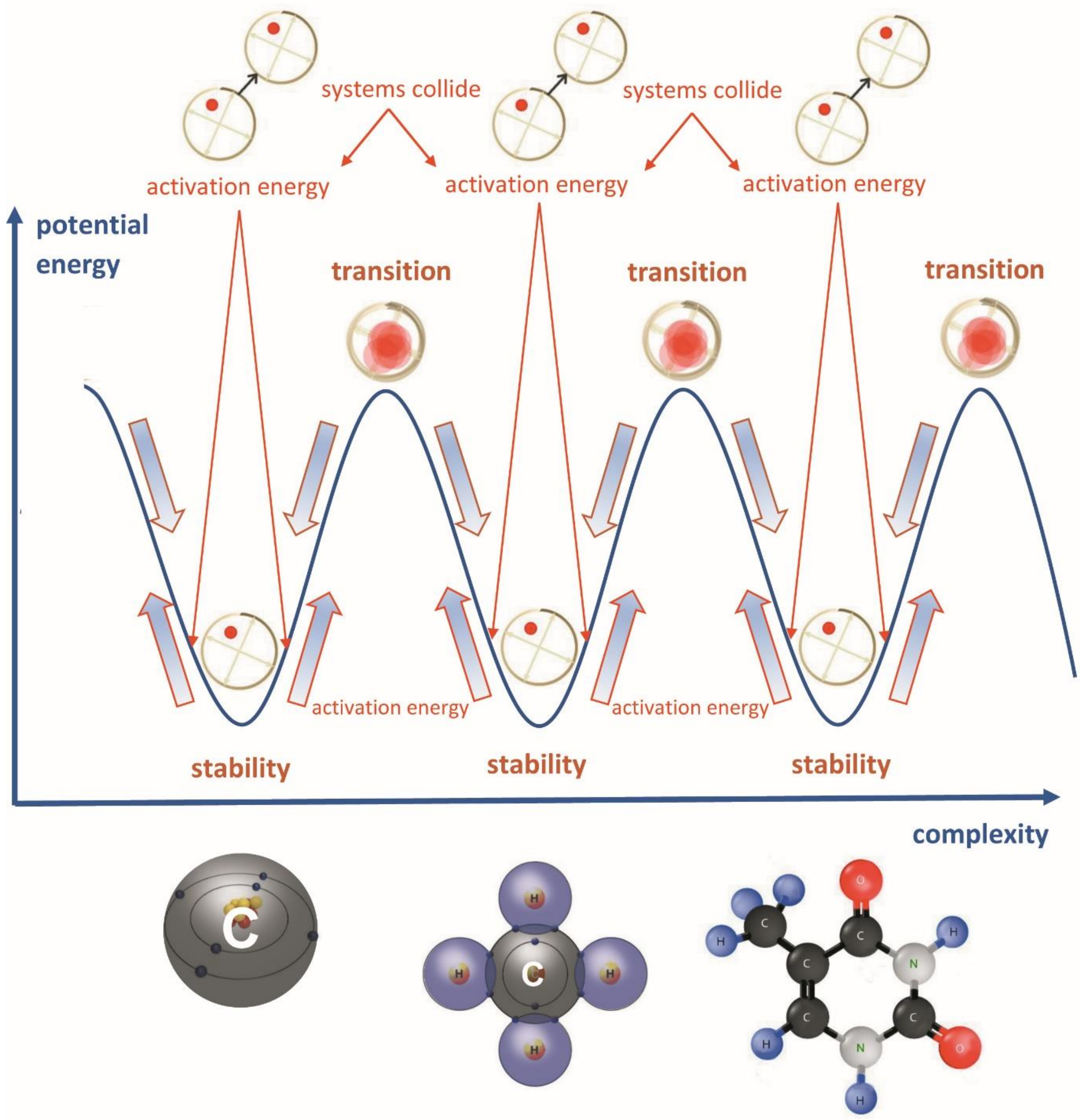


Figure 4. Systemic evolution in relation to potential energy and the UESC, potentiating the emergence of increasingly complex systems.

In accordance with the second law of thermodynamics, the universe evolves toward ever greater entropy. However, due to its complexity and the uneven distribution of its matter, chaotic patterns of attraction and repulsion give rise to localised oscillations that appear to defy the second law (Parunak, et al., 2001). The emergent order associated with galaxies, stars, and their sub-systems, including humanity, being examples.

The evolution of local systems can be considered over many epochs: from the Planck epoch of cosmology, measured in parts of a second (Faber, 2012), to Earth's geological epochs measured in millions of years. Over this time larger and more complex systems evolved: from plasma to quarks, to protons and neutrons, to atomic nuclei, to atoms, to simple molecules, to stars, to heavy atomic elements, to more complex molecules, to self-replicating molecules, and to organisms (e.g., Gustan, et al., 2019; Heylighen, et al., 1999).

Personal values, universal equivalence, and the evolution of human personality

As previously discussed, the process by which atoms 'decide' whether their electrons will emit or absorb photons is effectively mirrored in that by which neurons 'decide' to fire, and humans decide to act. Consistent with Gell-Mann's (1994) description of how CAS may evolve to replicate schemata in the greater system of which they are part, and Simon's (1995, p.26) description of CAS as "sets of boxes nesting within sets of boxes", it seems reasonable to suggest the Schwartz system of values may be a replication of a universal schema, i.e., the UESC. If, as we suggest, it is possible to locate all evolutionary strategies somewhere in the UESC, equivalents of Schwartz's values may be interpreted as representations of umbrella strategies for all such subordinate strategies. So, while human values may manifest themselves in memes[1] subject to cultural selection (Dawkins, 1978), it may be possible to infer pre-existing physical and biological value-equivalents for particle-based and genetic schemata subject to natural selection.

We propose it is useful to consider the evolution of stable and increasingly dynamic yet sustainable complex systems in four phases associated with the progressive internalization of motivational equivalents of values situated in the four quadrants of the UESC (as shown in figure 5). (1) stable systems located in the conservation/cooperation quadrant, (2) autocatalyzing, dynamically stable living systems with equivalents in the conservation/competition quadrant, (3) living systems with enhanced capabilities for internally generated change associated with equivalents in the

[1] units of cultural information

competition/change quadrant, and (4) intelligent living systems capable of self-directing their evolution (humanity), in which values are realized from pre-existing equivalents, including those in the change/cooperation quadrant. In each phase 'strategies' that evolved in previous phases are carried forward and supplemented by motivational factors internalized from the universal system. These sequentially facilitate greater efficiency, dynamism, and adaptability, and so are preferred by natural selection.

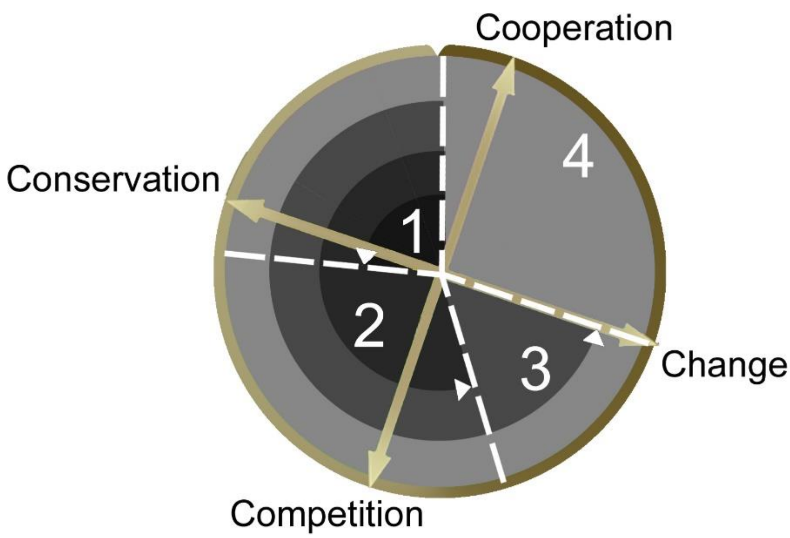


Figure 5. Four phases of evolution in relation to the UESC

The Schwartz (1992) System and the UESC

The Schwartz system of values is the leading cross-cultural values model. Its values serve as criteria by which individuals decide what is good, desirable, interesting or not (Schwartz, 1992). Based on correlations between the relative importance individuals attach to 56 component values such as ambition, honesty, and creativity, ten zonal values have been identified to describe a circular map (as shown in figure 6). These zonal super-values represent useful but arbitrary divisions of a continuous motivational construct. Their relative locations reflect systematic relationships between the needs they serve and the attitudes and behavior they promote, according to whether they promote or inhibit change (openness to change/conservation) toward competitive or cooperative ends (self-enhancement/self-transcendence) (e.g., Bardi & Schwartz, 2003; Doran, 2009; Sagiv & Schwartz, 1995).

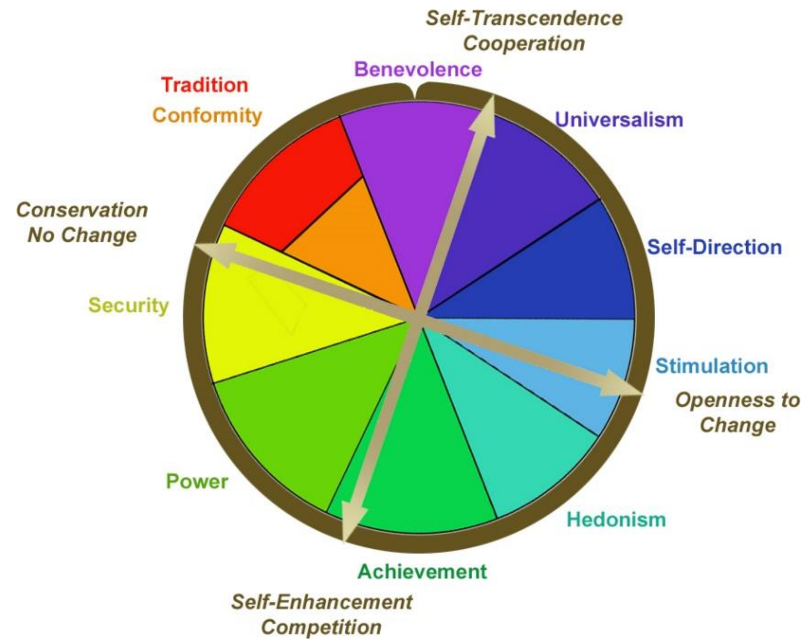


Figure 6. The Schwartz (1992) Values Circle

Once considered simply cultural adaptations, values are now known to be heritable (Twito & Knafo-Noam, 2020; Zacharopoulos, et al., 2016). They share a common genetic root with personality traits (Schermer, et al., 2011) and are similarly stable (see review in Schuster, et al., 2019). An individual's value priorities may change as their needs, physical state, or environment changes (e.g., Bardi, at al., 2014; Vecchione, et al. 2019).

Given all values have some importance to all individuals, it is their relative importance one to another that differentiates individuals through their influence on perceptions, decision-making, and behavior. For example, as social animals, humans share instincts relating to belonging and continuity that manifest themselves in the values of benevolence, tradition, conformity, and security, that together promote in-group cooperation and adherence to tribal norms and rules (Schwartz, 1992). However, those for whom the value of self-direction (that promotes independent thought and action) is relatively more important will be inclined to override such instincts when personal circumstances, knowledge, and rational assessment favor an alternative course of action. This is not to suggest strongly self-directed individuals are so nonconformist as to reject all social norms, but rather that they are more likely to recognize and pursue alternative options where available. This is key to understanding the function and evolution of values. While they may end up promoting conflicting beliefs, self-enhancing, openness to change, and self-transcending values should be considered supplements, rather than opponents, to the conservation values. For example, even strongly self-directing individuals are likely to abide by such social conventions as living in houses and working with others; differing only in how they do so: preferring urban and mixed housing (Jansen, 2014) and self-management (Hall, at al., 2018)

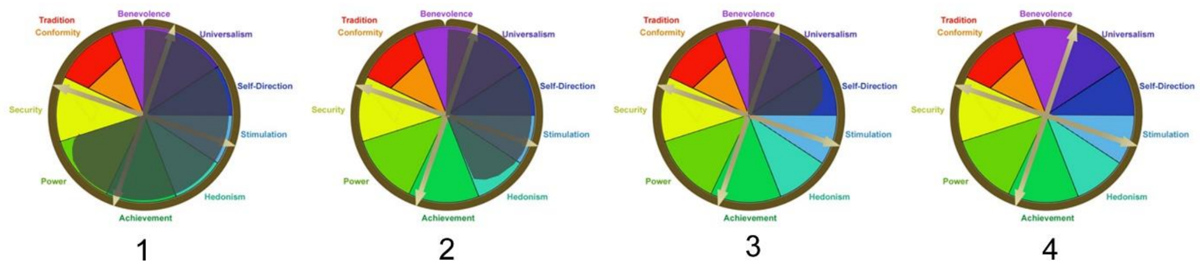


Figure 7. Four phases of evolution in which equivalents to Schwartz's (1992) values are internalised by increasingly complex adaptive systems.

Phase 1 - Equivalents of the conservation values and a related equivalent of benevolence

Stable pre-biotic systems such as atoms and molecules form. In phase 1 local systems have no means to initiate change internally but may resist it. They maintain stability through quantum mechanical balancing mechanisms such as those involved in photon absorption and emission.

The personal value of benevolence facilitates in-group cooperation through, for example, honesty, forgiveness, and helpfulness. Fundamental to the stability of any system is cooperation between its components. Therefore, an equivalent of benevolence may be inferred in stable systems. All physical systems are 'honest' in that they have no ability to conditionally manipulate the gravitational and electromagnetic information they broadcast.

The value of tradition facilitates the replication and continuity of customs across time. Stable systems such as hydrogen and helium atoms have persisted in the same form for 13.8 billion years.

The value of conformity facilitates replication across space by encouraging conformist behavior. Atoms of hydrogen and other elements, as well as molecular combinations of these encountered in one location tend to be indistinguishable from those in another.

The value of security regulates change in relation to localised boundaries and rules in the interests of safety and stability. Social rules and boundaries such as those prescribed in ‘the ten commandments’, national statute books, and, informally, in quasi-tribal customs are intended to protect and differentiate ‘us’ from ‘them’. While specific rules and boundary definitions apply to each, all tend to serve similar goals related to the maintenance of order and the protection of the local systems of which people are part: e.g., family, friendship, village, national, social, religious, and ethnic groups (e.g., Lamont & Molnár, 2002). Universal equivalents may be inferred in the elemental systems of atoms, with electrons abiding by localised rules and boundaries determined by their nuclei according to universal laws.

One may infer an equivalent of the power value operating in basic prebiotic systems only insofar as their constituents exert influence on each other; e.g., atomic nuclei influencing and controlling orbiting electrons, and the electromagnetic and gravitational influences they exert on external systems. However, the former is balanced cooperatively between components and the latter is not harnessed for the benefit of the local system itself. Indeed, the power endowed upon local systems by the universal system threatens their stability by bringing them into competition with each other. For non-living systems, an equivalent of the achievement value can be inferred as being imposed upon them in arriving at and maintaining a stable physical form in the competitive environment of the universal system. As such, equivalents of power and achievement relate less to localised, system-specific motivations than external factors.

Systemic instability arising from components engaged in competitive activity may be tolerated in systems such as radioactive elements for limited periods, but consequent energy loss continually depletes and destabilizes them. Other systems, such as Benard cells that form when certain oils are heated, may persist in 'far from equilibrium' states (Kondepudi & Prigogine, 1998), but these are not self-sustaining. They endure by the absorption and dissipation of energy but cannot orchestrate its acquisition.

Stars, which first evolved around 100,000 years after Big Bang (Larson & Bromm, 2009) are also dynamic systems that persist in far from equilibrium states. However, like radioactive elements, rather than extracting energy from their environment, they exploit and deplete internal nuclear energy stores. The enormous gravitational forces they generate disrupt the internal cooperation of hydrogen atoms, releasing energy as their nucleons and electrons compete for locations in more energy-efficient systems of helium atoms. This competition eventually brings about the exhaustion of the star's hydrogen fuel, its collapse, and a final burst of energy that forces helium atoms into even more energy efficient systems, such as the heavier elements of carbon, oxygen, and nitrogen (Hoyle, 1946 & 1954). The energy radiated by second generation stars such as the Sun, and the concentration of these heavier elements in orbiting planets such as the Earth, potentiated the second phase of evolution.

Phase 2 - Equivalents to the competitive values of power and achievement

The complement of elements essential to organisms on Earth are associated with third generation star systems such as our own, which date from 6.5 to 7.3 billion years ago (Lineweaver, 2001). The environment on Earth was conducive to the formation of the complex molecular systems from which the first organisms evolved (e.g., Sousa, et al., 2013). The emergence of organisms, running 'algorithms' written into their DNA, RNA and/or proteins, represents the emergence of local systems capable of autocatalyzing sustainable internal change (e.g. Mossel & Steel, 2005) and dynamic stability (England, 2015). Sustainability in this context requires coordination between cooperative and competitive strategies. Stable systems in perfect equilibrium, by definition, cannot evolve. Living systems exist in far from equilibrium states (e.g., Ornes, 2017) but, unlike Benard cells and stars, actively import and process energy to sustainably harness the disruptive potential of competitive strategies in metabolisms and defence mechanisms.

The power value relates to desires to influence and control. The influence and control exerted by atomic nuclei over the electrons responsible for the chemical properties of elements in phase 1 is mirrored in phase 2 by the influence and control of genetic material in chromosomes and cellular nuclei over somatic functioning and phenotypes. Over generations these evolve in ways that seek to increase or protect the influence and control organisms have over their environment. This environment includes other organisms, which may be parasites, predators, prey, competitors for a shared resource, or potential mates.

The achievement value relates to the pursuit and advertisement of success in relation to widely accepted standards. For genes and organisms natural selection effectively sets these standards according to the second law of thermodynamics (Kaila & Annila, 2008), favoring genes that promote: success in survival and reproduction; fitness indicators that advertise such capabilities; and capabilities to recognise, distinguish between, and act upon reliable indicators in others. In phase 2 natural selection's universal equivalent of an achievement drive appears to have been internalised in the genetic programming of organisms. Rather than leaving survival to the whim of external factors, evolution equips organisms with ever improving physical and behavioral traits to deceive, evade, and overpower competitors and attract potential co-operators. As such, competition between genes and organisms appears to exert a progressive influence.

Energy-efficient mechanisms that enable organisms to recognise and respond to threats and opportunities in complex environments evolve through an equivalent of satisficing (Simon, 1956); i.e., they are good enough given prevailing environmental conditions. Because they are not perfect, competition between organisms gives rise to selection pressure on genes that exploit deficiencies by encouraging the evolution of deceptive traits. These may serve to impress a potential mate, evade detection by a predator (by camouflage for example), or otherwise mislead competitors to better secure a share of a scarce resource. As such, the internalization of equivalents to power and achievement potentiated an opposition between the honesty associated with benevolence and a facility for dishonesty associated with equivalents of the self-enhancing values.

In phase 2 equivalents to the conservation values prevail, albeit modified by the progressive influence of equivalents of the self-enhancing, competitive values. For example, tradition and conformity may be inferred in meiosis and mitosis: the processes by which genes are copied from one generation to the next and across organisms in concurrent generations, and security in the ways nucleotide pairs observe molecular rules, genes observe chromosome boundaries, and phenotypes observe genetic instruction. As pre-existing (traditional) traits are modified by genetic mutation and environmental change, they may be replaced by new enduring traits that effectively become new traditions.

Perversely, and as discussed previously, the most cooperative systems have the potential to be the most competitive, and the systems best able to satisfy the MTPEP may accumulate the greatest potential energy and power. Evolution of complex organisms by natural selection proceeds on this basis over the long-term: lowering the entropy of organisms (Sabater, 2006) as a consequence of a universal trend toward greater entropy. Systems/organisms able to process the largest quantity of energy – i.e. absorb and dissipate it – become better adapted to their environment (England, 2015), and so will tend to be favoured by natural selection. The associated accumulation and throughput of energy increase the ability of the system to perform work. The more this contributes to greater efficiency-enhancing cooperation within the organism’s immediate and extended local systems, the better adapted the system/organism will become. In this context it is apparent that competition serves the equivalent of a waste management function in dynamic systems: removing that which undermines cooperative efficiency, e.g., outdated, relatively inefficient traits.

However, by weeding out the genes of organisms with traits least well-adapted to their environment, natural selection tends to reduce the variance necessary to sustain evolution (Dawkins, 1978). Without the mutational effects of quantum uncertainty (e.g., Slocombe, at al., 2021) and environmental interactions with genes, natural selection would have no variation on which to act. In computer models of CAS, which map the evolution of systems in relation to fitness landscapes[2], it has been found that evolutionary systems without mutation-mimicking algorithms tend to get stuck on suboptimal peaks. If they are to evolve toward higher peaks, it is necessary to endow gene-mimicking algorithms with the ability to generate destabilizing random elements (Kaufmann, 1995).

Phase 3 – Equivalents to the progressive values of hedonism and stimulation

Identifying universal equivalents for progressive values demands that we look beyond anthropocentric terminology to the purpose they serve. Hedonism concerns fun and enjoyment. Stimulation concerns excitement, novelty, and adventure. As such, they relate to behavior that appears not fully functional (Burghardt, 2005); i.e., it seems to offer no immediate survival or reproductive benefit. From the perspective of an organism seeking to maximise its fitness in a competitive environment, such behavior is risky. From the perspective of a stable system, behaviors that do other than maintain equilibrium threaten to destablize and destroy it. Yet without the mutation of stable genetic systems, the variation on which evolution by natural selection depends would disappear. This provides a clue to the likely purpose of these values and how they evolved.

Humans are not alone in our capacity for playful and adventurous activity. Apes (Pellegrini, at al., 2007), octopi (Zylinski, 2015), dolphins (Kuczaj & Eskelinen, 2014), and dogs (Bekoff, 2015) are among those that have been studied. Most usually these traits are associated with invertebrates with brains large enough to support complex behaviors and cognitive abilities (Graham & Burghardt,

[2] Three dimensional representations of the relative abilities of algorithmic quasi-genetic strategies to outcompete others to maximise their frequency in successive generations, in which relative success is represented as height on the z-axis of a virtual landscape.

2010; Zylinski, 2015). That all activities incur time- and energy-related costs, and natural selection favors genes that increase efficiency over those failing to provide a competitive return on investment, suggests genes promoting these activities have been selected for the survival and/or reproductive benefits they bestow. That such behavior tends only to be exhibited by animals in the absence of threats to fitness (e.g., Burghardt, 2005, Dawkins, 2006), suggests the fitness-enhancing purposes served relate to secondary, less urgent needs. Some may better prepare animals for threats and opportunities they may face in later life in dynamic and uncertain environments (Held & Spinka, 2011). A capacity for such behavior suggests the availability of energy reserves that may, when circumstances allow, be invested for potential long-term benefit. That such activity is not usually associated with organisms with little or no intelligence, and seems to become more frequent and pronounced in intelligent animals, suggests its fitness-enhancing potential is a function of intelligence. This fits with the case made for a link between playfulness and creativity, and between propensities for these and fitness (Bateson, 2014). Creativity precedes innovation and requires a different approach to learning and applying a new skill (Bateson, 2014) than the linear, goal-related approach we associate with the value of achievement.

While intelligence may be a significant factor in promoting playfulness and other behavior apparently serving no immediate survival or reproductive benefit, to cope with unpredictability in the CAS of their environments, all organisms must tolerate at least short periods during which they are not engaged in immediately productive survival-related or reproductive activity. The greater the resources available to them the greater this tolerance is likely to be. However, natural selection ensures that the return on energy invested in such ‘unproductive’ activity cannot escape being judged in terms of indirect effects on survival and reproduction. Accordingly, this investment of energy effectively represents the organism’s research and development budget. The greater the eventual return from consequent innovations, the greater the selection pressure that will likely come to bear on genes facilitating it.

Early genetic ‘innovations’ may have included the production of a protein that served no immediate purpose but perhaps benefitted its host organism when unusually stressed. Over time ‘research and development’ related innovations clearly evolved to find expression in morphogenetic mechanisms. For example, the microtubules that make up cellular cytoskeletons randomly grow outward from nuclei and frequently fail to make a connection with cell membranes, whereupon they shrink back to be replaced by new ones growing in different directions. Only when certain structural goals/needs/values have been satisfied does the cell assume a stable form best adapted to its environment (Kirschner & Mitchison, 1986). Comparable experimental behaviour, in which variation and selection are in evidence, can be seen in the chaotic distribution of plant seeds by air, water, and animals. An example of similar exploratory behavior can be seen in the ‘Levy flight’ of animals (Mandelbrot, 1982, p.289): a randomised foraging pattern shown to be effective in locating food in uncertain and dynamic environments (e.g., Reynolds & Rhodes, 2009).

If trait innovation is primarily reliant on genetic mutation, it is apparent the cutting edge of organismic achievement is honed by genetic accidents: copying errors caused by interference from invasive particles from the external environment (e.g., Lodish, et al., 2000), or factors related to quantum uncertainty. In both one can infer equivalents of change-inducing, progressive values. In the former they are external but in the latter they appear to have been internalized. However, since quantum uncertainty underlies all systems, this cannot be a unique feature of organic systems, let alone of organisms that have internalised capabilities for randomised, experimental, or creative behaviour.

The ‘innovations’ enabled by the largely random genetic experimentation of mutation come at the cost of many ‘failed experiments’ that disadvantage or kill organisms (e.g., Keightley & Eyre-Walker, 2010). Experimentation can be more productive and less costly when supported by abilities to recall, recognise, and accumulate information that may be useful in, for example, directing future foraging (Johnson, at al., 2012). When aided by brains capable of replicating environmental schemata that may serve as internal reference models for their cognitive systems, organisms such as rats have evolved memory assisted visio-spatial capabilities that enable them to successfully navigate mazes (Vorhees & Williams 2014). Evolved abilities to memorise and learn appear to have accelerated the internalization of equivalents to the values of hedonism and stimulation, particularly those in which playful and adventurous exploratory behavior are related to positive affect (Panksepp, 2011).

Phase 4 – The evolution of personal values from universal equivalents

Other animals' capabilities to explore, discover, and instigate change pale against those of neurologically advanced humans. Equipped with brains capable of more sophisticated information storage (memory) and processing (intelligence), humans can instigate change in ways that suggest far greater levels of autonomy. The human brain is a CAS that has evolved to become capable of modelling, and feeding back to affect, not only the somatic system of which it is part and its immediate environment, but, increasingly, the universal system beyond (Simon, 1995). In creating a virtual representation of the sometimes-chaotic behavior of external environmental systems, rather than evolving only in response to involuntary interactions with these, the evolution of human consciousness has enabled us to initiate virtual interactions in our heads. Abilities to visualise and distinguish between the characteristics of things, and conduct physical experiments based on more energy-efficient thought experiments, enable us to innovate and effectively self-direct our evolution, so internalizing corresponding schemata from the universal system.

Regardless of where it originates, information relating to opportunities and threats arrives in a stream of photons in a manner analogous to morse code. The ability to process, coordinate, and extract meaning from it, as many intelligent organisms seem able to do, requires some level of multi-functionality. However, it is apparent the human brain offers computational advantages over other organisms analogous to those of computers over single purpose devices such as typewriters, telephones, and calculators. The evolution of the complex genetic system that facilitated such processing capability (e.g., Plomin & Deary, 2015) may have been a gateway event (Morowitz, 1999) that gave our ancestors an enduring competitive advantage over other organisms. The more complex the interaction of genes, phenotypes, and environment required to facilitate such processing, the less likely it would have been that selection pressure on random gene mutations in competing organisms would have given rise to combinations capable of facilitating effective counter measures. If this cut the genome of our ancestors some slack from the pressures of natural selection, potentially costly genetic mutations offering no immediate competitive advantage, that would otherwise have been eliminated, would more likely have been tolerated, passed on, and made available for future environmental testing. This may have been sufficient to allow the evolution of greater propensities for experimental behavior associated with hedonism and stimulation, and greater tolerance for failure and unproductive lines of enquiry.

If the playful behaviour associated with hedonism represents ‘purposeless’ activity, including involuntary experimentation, and the adventurous behavior associated with stimulation represents more directed forms of experimentation, self-direction can be considered as the motivation and related capability to act purposefully with reference to memorised and processed information. This may be used to make better decisions as to how invest one’s energy in any given environment (independent thought and action), including how to better target experimental and information gathering activity (curiosity). While some highly intelligent organisms such as dolphins and chimpanzees have enhanced abilities to self-direct (e.g., Morrison & Reiss, 2018), humanity appears unique in its capacity for independent thought and action.

Deutsche (Deutsch, 2011, p59) describes humans as universal constructors: “factories for transforming anything into anything”. Turing (1950) talked of a learning machine capable of mirroring the principles of evolution. Not only has humanity created such machines in computers running CAS simulations, but it is apparent the human brain responsible for designing and building such machines is itself one: one that has used theory, observation, data, and technology to build an increasingly accurate model of its environment. The personal value of universalism promotes gaining an understanding of all people and of the greater natural system of which we are part.

The targeted learning and logical approach to problem-solving and decision-making facilitated by self-direction are readily associated with the concepts of elaborative interrogation and self-explanation identified by Dunlosky, et al. (2013) as facilitating an expanding knowledge base. A diverse and expanding knowledge base presents new learning opportunities as patterns within it are discovered and explored. When hitherto hidden connections are revealed, opportunities to acquire deeper levels of understanding present themselves. The feedback loop of inquiry-discovery-knowledge-inquiry potentiates an individual building an increasingly large and accurate virtual model of the universal system of which he or she is part. Other organisms may have functionally effective, if constrained, models of their environment, but that of humanity appears closest to universality.

As a conscious awareness of self and the environment evolved in humanity, so would an appreciation of the unconsciously acquired habits of cooperation and their benefits. In so doing, the pre-existing equivalent of benevolence, that we take to represent the motivational basis of all stable systems, and therefore tied to equivalents of tradition and conformity, began its close association with conscious universalism. As such, it complements self-direction, facilitating a shared approach to learning that accelerates the acquisition of universal knowledge. All of which is reflected in its location between tradition/conformity and universalism in the Schwartz system.

An individual lacking a universalist outlook seems likely to express their benevolence most in the context of localised in-groups and quasi-tribal beliefs associated with tradition. Such benevolence is comparable to that encouraged by genetic relatedness – most pronounced in social insects (e.g., Hamilton, 1972) - and the reciprocal altruism exhibited by other species such as rats (e.g., Dolivo, et al., 2016). So, while equivalents to benevolence are to be found in all organisms, only in humans can benevolence be rationally derived from and supported by universalism. Universalist expressions of benevolence include the expenditure of personal resources (time, money, and energy) for the benefit of people, other organisms, and parts of the natural environment with which one has no close proximate relationship. As such, while an individual may receive direct emotional benefits from acts of benevolence, tangible reciprocal benefits are realized indirectly from being part of the same system as the direct beneficiaries.

In the context of local systems, an equivalent of benevolence is manifest in MTPEP related cooperative stability associated with the second law of thermodynamics. A universal equivalent of benevolence is manifest in the first law and its associated principle of conservation of energy. Considered as such, a universalist approach treats the benevolent investment of energy by local systems such as individuals, groups, or nation states as stability-enhancing distributions of energy across the greater system, rather than as stability-threatening losses to the local system.

Without wishing to explore potential resonance with panpsychism, panprotopsychism, and related notions of universal consciousness, it is possible to infer a pre-existing equivalent of universalism arising from universally inescapable electromagnetic and gravitational fields and related physical laws. That all things in the universe behave in accordance with the latter and are connected and bound by the former implies that all things are universally 'knowledgeable', in that they receive information from all other things and 'know' how to respond. Similarly, a pre-existing equivalent of self-direction may be inferred in the apparent autonomy of the universal system and its entropic directedness in the direction of time's arrow.

According to our evolutionary theory of universal values, the Schwartz system of personal values represents the replication of a system of pre-existing universal equivalents in the CAS of the human mind. While equivalents to all ten values have been internalized, the process by which higher values gain importance continues to evolve. The somatic systems of organisms internalized equivalents of values as described in phases 2 and 3 in ways that maintained dynamic stability by limiting the influence of progressive value-equivalents on their conservative counterparts. Similarly, while the evolution of the human brain facilitated further progressive influences through independent thought and action and the accumulation of knowledge, given the brain evolved from pre-existing somatic control systems, it is to be expected that, initially at least, these conservative influences continued to dominate.

Given that motivational instincts related to basic survival and reproductive behavior pre-date the evolution of the human brain, it is likely that whatever control the brain now exerts over these functions evolved from more direct forms of genetic instruction. For example, sexual arousal is associated with the hypothalamus, ansa lenticularis, pallidum, and septal regions of the subcortex, as well as the frontal, parietal, and temporal lobes of the cortex (Baird, et al., 2007). This spread of functions across primitive, sub-cortical areas responsible for automated, unconscious processes, and more recently evolved, higher-functioning regions of the cortex illustrates how the evolution of the human brain has facilitated humans gaining greater executive control over need satisfaction (e.g., Deeke, 2012). Given our values affect conscious and unconscious decision-making (Bardi & Schwartz, 2003), and it is our contention that their equivalents affect all unconscious 'decision-making', together they may be taken to affect all human decision-making and behavior. Rational, system 2 thinking (Kahneman, 2003; Stankovich & West, 2000) requires the independent thought associated with self-direction. However, when lessons have been learned through effortful thought and the experience of repeated action, decision-making may be delegated to intuitive (system 1) thinking (e.g., Matzler, et al., 2005). This is an energy-efficiency seeking mechanism that mimics the evolution of the human brain itself (e.g., Balasubramanian, 2015).

Matzler, et al., (2005, p.14) state "people who have acquired deep wells of knowledge and experience — through their curiosity, openness and propensity to seize opportunities — are able to reach good 'intuitive' decisions much more frequently than people who possess a relatively limited sphere of experience". Curiosity and openness are aspects of self-direction and other openness to change values. Accordingly, these progressive values seem to affect the evolution of brain function in a single lifetime in ways that mimic the intergenerational, evolutionary updating of pre-existing 'traditional', genetically programmed 'decision-making' strategies by their pre-existing universal equivalents. When a capacity for self-directed, independent thought first evolved, it seems reasonable to assume its influence was like that we associate with these pre-existing value-equivalents, i.e., sufficient to exert a small progressive influence, but too small to destabilize the long-established cooperative functioning of the system. However, once established, intelligent self-direction potentiated the internalization and acceleration of the previous, inter-generational equivalent of learning through natural selection, with memes gradually replacing genes as the principal agents of humanity's evolution.

Although an advantageous 'innovative' trait arising from a genetic mutation (associated with universal equivalents to hedonism and stimulation) will be preferred by natural selection in ways analogous to an achievement drive (i.e., motivation associated with the value of achievement), it may take a great many generations before it becomes widespread in a population. In the meantime, from the perspective of a species, there will be a lag between the initial adoption of the improved trait and the final replacement of the 'traditional' trait. This gives rise to an apparent hierarchical, developmental relationship between the value-equivalents of achievement and tradition. Similarly, when the values of self-direction, universalism, and related benevolence became the primary motivators of human innovation, this created tension between the progressive values at the top of the hierarchy and conservative values at the bottom. Unproven, potentially destabilizing changes may be resisted by all individuals, but change-resistant conservatives are the most likely to reject them. Some innovations, such as mobile phones, may go on to almost universal adoption (O'Dea, 2022), and so become new traditions, whereas others, such as evolutionary theories that dispel the need for a supreme being, are more stubbornly resisted (Miller, et al,. 2006).

When innovations gain acceptance, they generate trickle down benefits for those motivated by lower values. They may give rise to novelties that appeal to those with a stimulation drive, and opportunities for enjoyment for those driven by hedonism. As innovations become more widely adopted, and/or prove their worth, they become attractive to achievement-driven individuals seeking a competitive advantage, and then to power-driven individuals seeking to increase or protect their status and influence. Eventually, they may become so widely adopted they become safe options for security-driven conformists wishing to avoid social exclusion, and finally to all but the most extreme traditionalists.

Evidence consistent with values having a complementary hierarchical structure

Self-directed thought, an increasing knowledge base, and shared learning through benevolent cooperation potentiate an exponential growth in innovation, especially as advances in information technology (from language itself to the Internet) increase the rate at which information can be shared. In modern times this is reflected in Moore's (1965) 'law' and Kurzweil's (2001) law of accelerating returns. It seems reasonable to consider that related principles gave, and continue to give rise to, both genetic and cultural selection pressure favoring neural systems that promote these values. Given that intelligence is essential to self-direction, the Flynn (1987) effect – the apparent increasing intelligence of individuals – may reflect this.

Dependent on factors such as competition between social groups, rates of genetic mutation, neural plasticity, geography, and abilities to communicate (related to language and technology), there will tend to be a lag between innovations being made available to and embraced by early adopters and others. The pattern of this seems likely to follow the pattern of Rogers' (1995) adoption curve as illustrated in figure 8. Given the alignment between Schwartz's values and Maslow's (1943) hierarchy of needs described in the next section of this paper, this would be consistent with the sequential adoption of innovations by motivational types investigated by Singh & Holmstrom (2015).

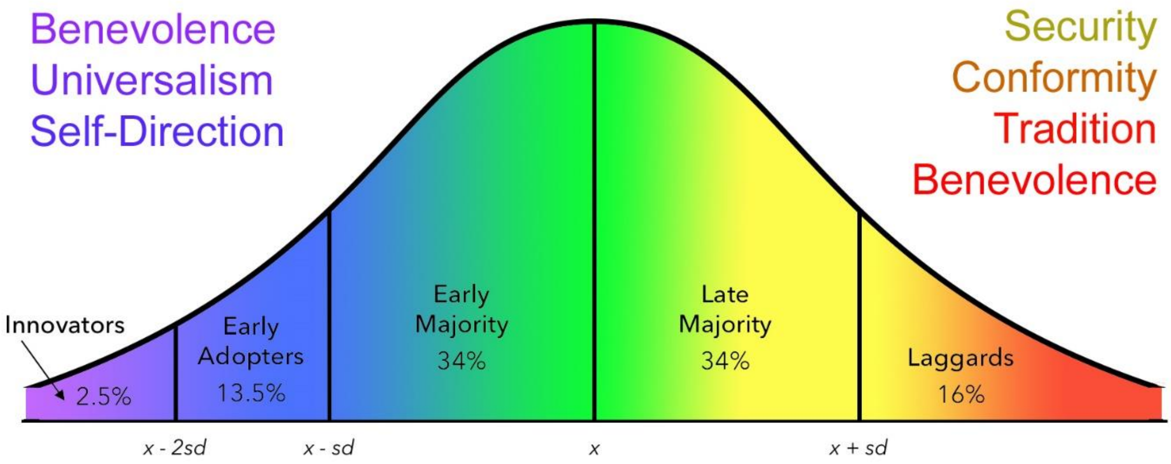
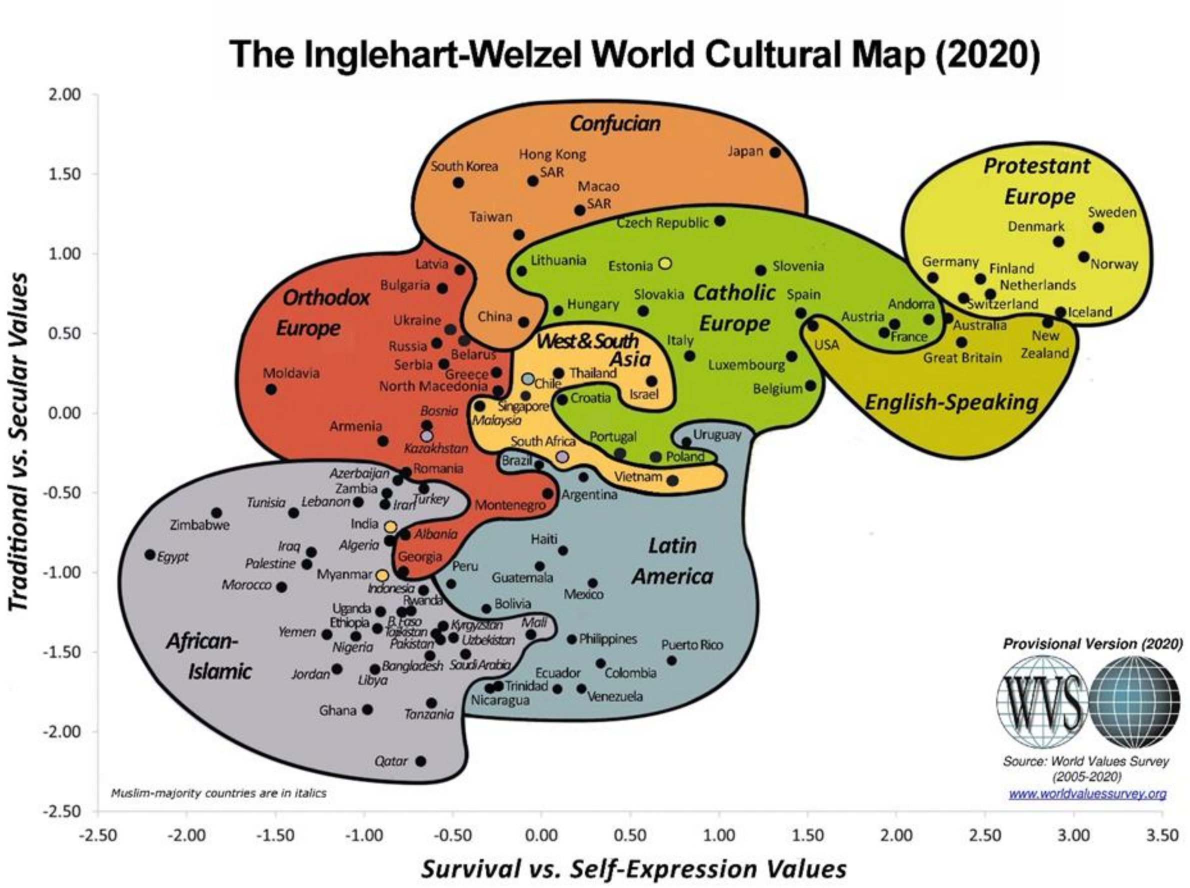


Figure 8 Relationship between types of adopters classified by innovativeness, their location on Rogers (2003) the adoption curve, and related values.

Evolutionary logic related to natural selection suggests decision-making mechanisms evolve to better satisfy the needs of organisms in prevailing environmental conditions. It is reasonable to consider that emotions evolved to facilitate fast intuitive decision-making in complex, information rich environments (e.g., Keltner & Gross, 1999; Naqvi, at al., 2006). Their intrinsic and dynamic coupling to brain and body (Critchley, at al., 2013) hints at a direct evolutionary link to the pre-existing decision-making mechanisms of organisms without brains. Resonating with the binary nature of the fundamental 'decision-making' of atoms and neurons described previously, emotions can be considered either broadly positive or negative: fight or flight, approach or avoid, etc. (Keltner & Gross, 1999). Positive emotions, such as sexual ecstasy, love of one's own children, and the enjoyment of good food, likely evolved to encourage activity likely to help satisfy our ancestors' survival and reproductive needs, just as negative emotions such as fear of spiders and disgust at rotting flesh encourage the avoidance of potential threats (e.g., Ekman, 1992; Tooby & Cosmides, 1990). Given a correlation between positive emotions and life-satisfaction (Kuppens, at al., 2008), it seems reasonable to consider that the happiness of individuals may broadly represent the quality of their decision-making. If so, comparison of the World Values Survey (WVS, 2020)[3] and the World Happiness Report (WHR, 2021)[4], suggests a link between values and happiness consistent with our proposed hierarchical evolutionary structure. Those nations having the most self-expressive/secular-rational values (top right in figure 9) rank amongst the happiest in the WHR: Sweden 7th, Norway 6th, Denmark 2nd, Finland 1st, and the Netherlands 5th, whereas those with the most survival/traditional values (bottom left in figure 9) ranked among the least happy: Jordan 127th (of 149), Yemen 141st, Zimbabwe 148th Morocco 106th, and Ghana 95th. Self-direction and universalism correspond with self-expressive/secular-rational values (Inglehart & Oyserman, 2004) measured in the WVS, and conservation values with survival/traditional values.



[3] A periodic international survey of the values of representative samples of adults conducted by a global cooperative of social scientists. The most recent 7th wave covers the years 2017-2020 drawing from data collected from over 120,000 individuals in 79 nations.

[4] An annual survey of representative samples of 1,000 to 3,000 adults per nation conducted by Gallup and published by the United Nations Sustainable Development Solutions Network. Respondents are asked to rate their current happiness with their lives on a scale of 0 (worst possible life) to 10 (best possible life).

Figure 9. Inglehart–Welzel cultural map, World Values Survey (2020)

To explore expectations associated with this evolutionary theory of universal values, we researched values-related decision-making biases using Kahneman and Tversky (1984) based questions and intelligence and creativity tests. A pre-print of our findings (reference withheld for blind review) reveals coincidental circular and hierarchical patterns of correlations in respect of all the tests, consistent with theoretical expectations. The linear hierarchical components were dominant in respect of the intelligence and creativity tests.

Fit with existing psychological theory

Correspondence between characteristics from different theoretical models based on identical terminology, such as achievement (value), achievement (motive) and achievement-seeking (trait), tends to be reflected in imperfect correlations (Bilsky, 2006). However, imperfect alignment should not undermine common sense confidence as to the likely relationships between them. Bilsky (2006, p.4) addresses this issue, explaining that it is the "overall pattern of contingencies and not the single bivariate correlation which is important for the identification of structural relationships". The Schwartz 'system' of values is just that, i.e., an interconnected group of things that operate as a whole. Therefore, to understand the role of one value one must also consider its systematic interactions with all others. It is also universal, in that no motive or behavior can escape being associated with its capacity to bring about change, let alone the cooperative/competitive, energy-efficiency-related mode of this change. Therefore, comparison between Schwartz's values and concepts from other constructs that use identical terminology, but are neither systematic nor universal, such as the Big Five (Block, 2010), or are not part of a congruent system, may not yield strong correlations.

Furthermore, while the Schwartz system has been thoroughly tested and repeatedly validated (e.g., Bardi & Schwartz, 2003; Bilsky, et al., 2010; Schwartz & Boehnke, 2004), the data upon which it is based, in common with all self-reporting measures, is unlikely to yield perfectly accurate information concerning the things it seeks to measure. As abstract concepts concerned with morality (Sverdlik & Rechter, 2019), which is associated with complex patterns of neural activity in many areas of the brain (Fumagalli & Priori, 2012), values are difficult to pin down, let alone measure accurately. The theory being advanced here is not reliant on the precise description of human values provided by Schwartz, but rather a broad correspondence between the general structure of the Schwartz system and the idealized version presented by the UESC. Therefore, in much of the following, rather than allowing imperfect correlations between concepts from different models to substantiate doubts as to their shared identity, we are taking the view that 'If it looks like a duck, swims like a duck, and quacks like a duck, then it probably is a duck'.

Maslow's Hierarchy of Needs

While evidence showing that Maslow's (1943) 'higher' needs operate independently of his 'lower' needs (e.g., Wahba & Bridwell, 1976) appeared to undermine the hierarchy, Maslow (1987) maintained his suggested developmental progression up the hierarchy was never intended to preclude the co-existence of multiple need states. Tay & Diener (2011) have since identified tendencies for these needs to be fulfilled in hierarchical order. Further support for the model comes from Singh & Holmstrom (2005), who found a sympathetic correspondence between the needs of individuals and their adoption of innovations, and the positive impact of Transformational Leadership[5] (Bass & Riggio, 2005) on intrapreneurship (Moriano, et al., 2015), leadership-member relationships (Li & Hung, 2009), and organizational commitment, innovation, and performance (García-Morales, et al., 2008; Thamrin, 2012).

Comparison between the values Maslow (1987) associated with each level of his hierarchy and those of the Schwartz system shows a broad sequential alignment, as shown in Figure 10.

[5] based on Maslow's (1965) concept of eupsychian management, i.e., management based on self-actualizing principles

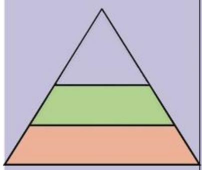
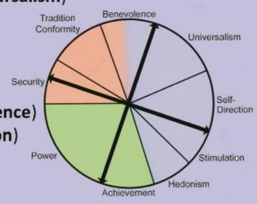
Maslow Need Type	**Maslow Values/Qualities**	**Schwartz Values**
Self-Actualization	Wholeness	inner harmony, unity with nature (**universalism**)
(B-Values)	Perfection (balance and harmony)	.. ..
	Completion	.. .. , wisdom, world at peace (**universalism**)
	Justice	social justice, equality (**universalism**) 
	Simplicity	honesty (**benevolence**)
	Liveliness (spontaneity)	exciting life (**stimulation**)
	Beauty	world of beauty (**universalism**)
	Goodness (benevolence)	helpful, forgiving, honest, loyal, etc. (**benevolence**)
	Uniqueness (individuality)	independence, setting own goals (**self-direction**)
	Playfulness	creativity, freedom (**self-direction**)
		enjoying life (**hedonism**)
	Truth (reality)	honesty (benevolence) wisdom (**universalism**)
	Autonomy	independence, setting own goals (**self-direction**)
	Meaningfulness	meaning in life (**benevolence**)
	Close Friendships	true friendship (**benevolence**)
	Curiosity & Knowledge	curiosity (**self-direction**), wisdom (**universalism**)
Esteem	Self-Respect	self-respect (**achievement**)
(D-Values)	Competence	capable (**achievement**)
	Reputation and Appreciation & Recognition	preserving public image (**power**), social recognition (**power** and **achievement**)
	Status and Dominance	social power (**power**)
	Achievement	**achievement**
	Mastery	success, capable (**achievement**)
Love & Belonging	Friendship	reciprocation of favours (**security**), true friendship (**benevolence**)
(D-Values)	Belonging	associated with **benevolence, tradition, conformity & security**
Safety	Safety	healthy, clean (**security**)
(D-Values)	Law & Order	honouring parents & elders (**conformity**), social order (**security**)
	Security	family security, national security (**security**)

Figure 10 Comparison of Maslow's (1987) hierarchy of needs and Schwartz's (1992) values

If Maslow's 'safety' and 'love and belonging' needs are considered as one, their associated values correspond with Schwartz's conservation values and some benevolence values. To place conservative safety needs below (i.e., to consider them more fundamental than) cooperative love and belonging needs fails to recognise the latter as preconditions for safe physiological existence: cooperation between gametes being fundamental to the existence of every human life, and cooperation between family and tribe members being fundamentally important to humanity (Boyd & Richerson, 2009). Maslow's (1987) esteem needs correspond with the values of power and achievement, and his self-actualization needs principally to self-direction, universalism, and the remaining benevolence values. One can also link the hedonism value of 'enjoying life' and the stimulation value of 'exciting life' with Maslow's self-actualizing values of playfulness and liveliness.

The co-existence of multiple need states needn't undermine the developmental structure of the hierarchy. If, as seems likely, humanity has largely freed itself from the effects of genetic selection pressure arising from competing macroscopic organisms (Vatsiou, at al., 2015), and global culture is sufficiently cooperative that wealth, education, healthcare, and innovations such as computer technology and the Internet are (at least to some extent) shared, there is arguably insufficient competition between individuals to give rise to intense selection pressure on values. Logically, in a highly competitive environment, selection pressure would give rise to the evolution of highly energy-efficient motivational systems. Given that adjacent values in the Schwartz system serve sympathetic needs, these would be characterised by individuals with dominant suites of sympathetic values: ideally self-direction, universalism, and benevolence. However, research data[6] shows individuals are frequently subject to internal values conflicts, in addition to there being wide ranging differences between individuals. Conflicts arise when an individual's dominant values oppose each other, e.g., self-direction and conformity. Rather than addressing sympathetic needs, conflicting values may compete, giving rise to mixed emotions and related stress in decision-making (Hanselmann & Tanner, 2008). Given the heritability of value priorities (e.g., Knafo & Spinath, 2011; Schermer, et al., 2008), such conflicts would be consistent with the shuffling of supportive genes in meiosis.

Not only is cultural selection pressure insufficient to eliminate value conflicts in and between individuals, but it is also apparent that global culture is subject to similar conflicts. This is illustrated in figure 9 by the spread of values in the WVS (2020), and implicit in the disparity between the ever-increasing pace of innovation (Kurzweil, 2001) and the enduring influence of the relatively narrowly-framed beliefs associated with conservative and self-enhancing values (Ipsos, 2011). Religious conservatism remains a dominant influence in such nations as the USA, Brazil and Turkey, and Russia (Ipsos, 2011), all of which have elected power-driven nationalist 'strong men' as leaders promoting regressive, conservative agendas in recent years (Ben-Ghiat, 2020). In business too, despite the advantages of Transformational Leadership, in accordance with pressures toward person-organization fit (e.g., O'Reilly, Chatman, & Caldwell, 1991), competitive environments are conducive to nurturing power- and achievement-driven leaders inclined toward pursuing narrowly-framed goals. A procession of corporate scandals (Hail, et al, 2019), including widely reported fraudulent

[6] In the supplementary materials we have provided examples of individual motivational systems taken from values data collected from 1317 individuals participating in research into values related decision-making biases.

activities at Enron, Waste Management, Lehman Brothers, VW, etc., have borne testament to the susceptibility of commercial organizations to the self-interested competitive strategies of their leaders. These may offer short-term benefits to those involved but at the expense of others: conflicting with the interests of customers, employees, the wider economy, and society, and damaging or destroying their organizations in the longer term.

Other Motivational Theories

McClelland's (1961) theory describes three motivational needs common to all people: achievement, power, and affiliation, later supplemented with intimacy (McAdams, 1980). The terminology and definitions associated with this 'Big 3' very close match those associated with values. Power and achievement are nominally identical, and affiliation motivations related to being accepted as members of a group and adhering to cultural norms closely match the goals of conformity. Intimacy relates to a closeness and deep connections with others based on honesty, warmth, openness, and self-disclosure (Sokolowski,2008). These qualities relate to the value of benevolence through its components of honesty, true friendship, and mature love. As noted by Bilsky (2006), while there is considerable overlap between values and 'Big 3' motives, the latter represent only the self-enhancement vs. self- transcendence dimension of the Schwartz system, and make no allowance for motives associated with curiosity, play, and order associated with the openness to change vs. conservation dimension.

Bilsky (2006) further tested relationships between values and the 14 motives (achievement, affiliation, aggression, dominance, endurance, exhibition, harmavoidance, impulsivity, nurturance, order, play, social recognition, succorance, and understanding) covered by the German Personality Research Form (PRF; Stumpf, at al., 1985). Finding close structural relationships between value dimensions and motives, Bilsky (2006) concluded that the Schwartz system of values provided a parsimonious taxonomy for classifying motives.

Reiss (2004) sought to provide a more comprehensive list of motivations (see in figure 11), providing an evolutionary context with examples of associated animal behaviors. Unlike the PRF, the list includes motives relating to survival and reproductive needs. Reiss (2004) acknowledged that all these basic motives corresponded with all 10 of Schwartz's values. However, Reiss's matching of vengeance to conformity is inappropriate, as 'getting even' in this context relates not to conforming but to inflicting power-related, retaliatory harm on an individual or group. In figure 11 we have amended and supplemented Reiss's declared correspondences with our own, including value-equivalents for motives primarily associated with survival and reproduction. We also did this for 'social contact', as this relates to a more basic motivation: cooperation between social animals. While Reiss links tranquillity to stimulation by inverting the purpose of the latter, security and conformity more directly address his stated aims of safety and the avoidance of anxiety. As such, his 16 fundamental motives make no provision for stimulation's pursuit of novelty, adventure, and excitement.

Motive Name	**Motive – *basic purpose/intrinsic feeling***	**Value (*or Equivalent*)**
Idealism	Desire to improve society (including altruism, justice) *compassion*	Universalism & **Benevolence**
Curiosity	Desire for knowledge	**Self-Direction**
Independence	Desire to be autonomous	Self-Direction
Social contact	Desire for peer companionship (desire to play) *fun*	Hedonism & *Benevolence, Tradition & Conformity*
Vengeance	Desire to get even (including desire to compete, to win)	**Power & Achievement**
Power	Desire to influence (including leadership; related to mastery)	Power & Achievement
Status	Desire for social standing (including desire for attention)	Power
Order	Desire to organize (including desire for ritual) *health & stability*	**Power** & Security
Tranquility	Desire to avoid anxiety – *safety*	**Security** (opposite of Stimulation)
Saving	Desire to collect – *frugality & ownership*	**Security**
Acceptance	Desire for approval – *self-confidence*	**Conformity, Power & Achievement**
Honor	Desire to obey a traditional moral code – *loyalty*	Tradition
Family	Desire to raise own children - *love*	Benevolence & Tradition *Power & Achievement > Tradition & Conformity*
Physical exercise	Desire to exercise muscles (vitality)	*Power & Achievement > Tradition & Conformity*
Romance	Desire for sex (including courting)	*Power & Achievement > Tradition & Conformity*
Eating	Desire to eat - *survival*	*Power & Achievement > Tradition & Conformity*

Figure 11 Relating Reiss's (2004) fundamental motives to Schwartz (1992) values or their equivalents (values in plain text indicate matches declared by Reiss, those in **bold** are our suggested matches, and those in *italics* are equivalent values)

Given the correspondence between Schwartz's values and these fundamental motives, it seems reasonable to consider Bilsky's (2006) conclusion concerning the relative parsimony of the Schwartz model applies as much to Reiss's list as it does to PRF. Indeed, if all motives can be located somewhere on a two-dimensional model, it is inconceivable that one could be more parsimonious than that of Schwartz or the UESC.

Personality Traits

There is a tendency for considerations of personality to focus solely on traits. For example, for a paper intended to close the debate on whether birth-order affects personality development, Damian and Roberts (2015) chose the title of 'Settling the debate on birth order and personality' despite seeking to do so only with reference to Big Five related trait-based findings. Given McAdams (1995) declared thoughts and feelings to be inaccessible to the Big Five, this is a telling oversight. Thoughts and feelings are subject to the influence of values (Schwartz, 1992). While privately experienced, they are expressed in ways that enable people who know each other well to read them as accurately as personality traits (Dobewall, et al.. 2014).

According to McCrae and Costa (1999), individuals are predisposed to exhibit traits such as curiosity and self-discipline without necessarily considering the corresponding values important. However, individuals tend to exhibit behavior consistent with their most important values (e.g., Bardi & Schwartz, 2003; Skimina, at al., 2018). As previously stated, traits mediate the interaction of individuals with their environment (Sih, et al., 2011) toward meeting their needs (McEwen & Wingfield, 2003). Given the direct relationship between needs and values, this implies traits are the product of values-environment interactions. Some behaviors seem to be strongly influenced by certain values, e.g., the apparent influence exerted by universalism on the purchase of ethical goods (Doran, 2009). However, it is apparent the consistent influence of particular values may give rise to different traits in different environments. For example, in common with the 'allegiance fickleness' of chimpanzees (Nishida, 1983), a person strongly motivated by power might pursue different behavioral strategies to improve or maintain their status, influence, and control in different contexts. Behavior consistent with the Big Five trait of agreeableness might be useful in winning trust and gaining influence with those one seeks to impress, while disagreeable, dismissive, threatening, and controlling behavior may be preferred when overthrowing, warding off, or subordinating perceived competitors. Such patterns of behavior would be consistent with known susceptibilities for environment-sensitive trait adaptation (e.g., Ellis, et al., 2001) and the if/then conditionality of trait expression described by Mischel (2004). The potential for similar value priorities to promote different traits in different environments may help explain why popular beliefs concerning the greater self-centeredness of only-children are supported by differences in the importance given to the values of power and benevolence (Griffiths, et al., 2021), but are only weakly reflected in differences in traits (Stronge, et al., 2019).

Traits, whether psychological, behavioral, or physical, and whether ours or of others, interact with, and so become environmental inputs to be processed with our values. Personal values tend to be trans-situationally stable, but may evolve over time (Gouveia, et al., 2017) and with respect to significant life changes (Bardi, et al., 2009), including those related to education, whether self-chosen or not (Bardi, et al., 2014). Relatively stable environments promote trait stability (Briley & Tucker-Drob, 2014), with similar inputs being processed to elicit consistent patterns of output behavior. Over time, behaviors initiated in relation to specific goals may become habitual, i.e., persist independently of such goals (Wood & Rünger, 2016), and so become characteristic traits. The establishment and reinforcement of supportive neural pathways, limited availability of resources to develop and maintain alternatives, and the brain's systemic drive toward energy-efficiency (Laughlin & Sejnowski, 2003) encourage automated behavioral responses to environmental triggers, even when these relate to new challenges for which other responses might better serve goal fulfilment (Wood & Rünger, 2016). Just as behaviors known to improve health and attractiveness (e.g., Tovee, et al., 1998) may become habitual (Bandura, 2004) by the consolidation of supportive neural pathways (e.g., Yin et al., 2009), when fitness-enhancing traits first emerged and endured, the genes promoting them likely become subject to selection pressure. Over many generations this would tend to spread the apparently 'habitual' traits of one individual across an entire population, so contributing to consistent environmental changes to which values and their equivalents must adapt; albeit traits may be processed differently by different individuals (Molden & Dweck, 2006), with different value systems, cognitive abilities, and experiences. Accordingly, whether traits are derived from environmental interactions with values or pre-existing value-equivalents, all are bound together in patterns of cyclical feedback.

Such complexity of interaction presents difficulties to researchers seeking to understand the relationship between traits and values. Vecchione, et al. (2019) found that values did not predict traits, but high levels of agreeableness and openness exerted an influence over the development of benevolence and self-direction respectively. However, in a previous study, Vecchione, et al. (2016) found the values of children more predictive of behavior than traits were of values; albeit they acknowledged a reciprocal relationship between the two seemed to be operating.

Despite this, patterns of correlations between the five trait dimensions of the Big Five and the sixth dimension of HEXACO (Ashton, et al., 2014) and Schwartz's values betray predictable influences of values over traits. Parks-Leduc, et al (2015) found openness to experience traits correlated positively with values populating the openness to change half of the circle, and negatively with those on the conservation half. Agreeableness (i.e., behavior that minimises the potential for conflict) correlated positively with values populating the cooperative (self-transcending) half of the circle, and negatively with those on the competitive (self-enhancing) half. Extraversion (i.e., outgoing behavior that likely increases the imposition of an individual's personality on others and their environment) correlated positively with values in the competitive half, and negatively with those in the cooperative half. Conscientiousness (dutiful compliance and attentiveness in relation to a task) correlated positively with all the values on the conservation half, and negatively with the progressive values of hedonism and stimulation. The high pole of the sixth honesty/humility dimension of HEXACO correlates strongly with the cooperative value of benevolence (which includes the component value of honesty) and its low pole with the opposing competitive value of power (Anglim, et al., 2017).

The exceptional trait in terms of its relationships with values is neuroticism, in respect of which correlations are practically non-existent (Parks-Leduc, et al., 2015). Given that people are happier and more content when they live in accordance with their values (e.g., Michelson, et al., 2011), and people's choices are influenced by their values (Feather, 1995), it may be that relationships between neuroticism and values are particularly dependent on the alignment (cooperation) or misalignment (competition) between values and environment. The values on the conservation half of the circumplex have been associated with anxiety (Schwartz, 2010), and trait facets such as anger/hostility and vulnerability are readily relatable to the frustration of/threats to the value of power. However, the unease or lack of contentment that one associates with neuroticism could arise from a lack of alignment between any value (or set of values) important to an individual and their environment. Such misalignments effectively create competition between values and the environmental systems in which an individual would otherwise seek to express them. It is perhaps worth adding that cooperation between values and environment is not restricted to cooperative (self-transcending) values. The performance, psychological, and physical well-being contributions of person-environment fit seem to relate to values-congruence in general (Bouckenooghe, et al., 2004; Bretz & Judge, 1994; Meglino, et al., 1989). Also, given every value contributes to the motivational environment in which other values operate, lack of alignment and consequent emotional instability may also arise in those who attach similarly high levels of importance to conflicting values (e.g., Sverdlik, 2012), regardless of the wider environment in which they find themselves.

Beyond the Big Five and HEXACO traits lie the Dark Triad (Paulhus and Williams, 2002) traits of narcissism, Machiavellianism, and psychopathy. The competitive and self-enhancing nature of the aggression, violence, coercive behavior, low affective empathy, selfish attitudes to power, money, sex, and infidelity associated with these suggest a linkage with self-enhancing values. Kajonius, et al. (2015) found power and achievement exhibited the strongest positive correlations, but strong systematic relationships between all values and Dark Triad traits were found, with the opposing values of universalism and benevolence showing the strongest negative correlations.

In the Schwartz system, there are no 'anti-values' such as dishonesty or desire to cause harm. Instead, motives for immorality are attributed to the relative dominance of power and achievement values over the moral, self-transcending values of benevolence and universalism, including honesty, helpfulness, and social justice.

Evolutionary Theories

The evolutionary roots of morality are the subject of Moral Foundations Theory (MFT; Graham, et al., 2013; Haidt, 2001, 2007, & 2012). In line with the systematic relationships previously described between values and the morality-related aspects of motives and traits, we would suggest the five foundations of MFT: care/harm; fairness/cheating; loyalty/betrayal; authority/subversion; and sanctity/degradation can be fully accounted for by systematic relations between personal values, and between their pre-existing equivalents. Care/harm, fairness/cheating, and loyalty/betrayal transparently relate to the self-enhancement/self-transcendence dimension of the Schwartz system and the UESC; examples of which are highlighted by Kajonius, et al. (2015) and Griffiths, et al., (2021), which relate to Dark Triad traits and the relatively greater selfishness of only-children respectively. Both poles of authority/subversion relate to power: the former arising from the assertion of status, influence, and control; the latter being a reciprocal strategy by which to improve one's relative standing by undermining the status, influence, and control of another; as per allegiance fickleness. In this context, the aim of the power-driven is to subdue others into accepting and abiding by their authority, whether by security-related rules and boundaries, or conformist obedience. The poles of the sanctity/degradation foundation effectively represent the preservation and promotion of that which sustains the cooperative functioning of a system, and the avoidance, rejection, and repulsion of that which threatens it. As such, its roots can be traced to the initial internalization and sub-ordination of competitive value-equivalents in the first organisms. The physiological strategies associated with these relate to equivalents of benevolence and power. Those, such as salivation and emetic triggering, that have become innate, genetically automated traits (Wooley & Wooley, 1973; Yates, et al., 2014), can now be related to an equivalent of tradition. While many sanctity-preserving (conservative) traits such as temperance, chastity, and piety may be associated with the personal value of tradition, others, such as cleanliness and racism, may better relate to the value of security (Schwartz, 1992).

A simple division of evolutionary psychologists might pit those who consider the human brain to comprise systems of genetically derived domain-specific modules, as per Fodor (1983), against those who emphasize the importance of culturally-derived, domain-general developmental processes, as per Heyes (2019). The evolutionary theory of universal values sees both the genetic bases and neurological functioning of the brain as having evolved in accordance with the value-equivalents of the UESC, with higher functions continuing to evolve in sympathy with the values of the Schwartz system. Both the UESC and the Schwartz system are domain-general, insofar as we propose the former guides the evolution of all systems, and the values of the latter serve as a form of psychological currency in which the relative benefits of disparate concepts may be evaluated and compared on a like for like basis (Brosch & Sander, 2013). If, as we suggest, it was the genetically derived multifunctionality of brain function that proved to be a gateway event (Morowitz, 1999) that gave our ancestors an evolutionary advantage humanity never surrendered, why wouldn't domain-generality continue to reign? Also, even though localized specialisations clearly exist within the brain (Kanwisher, 2010), given all information arrives in streams of photons, few of which are likely to be unique to any frequently encountered source, domain-specificity is perhaps best considered in relative terms.

Testing and Applying the Theory

As stated previously, our preliminary research (citation withheld for review) identified patterns of values-related decision-making biases consistent with the developmental and evolutionary hierarchical structure we propose. These suggest values affect both intuitive, system 1, and rational, system 2 thinking in accordance with both the circular pattern of the Schwartz model and the hierarchical pattern associated with this theory. They also suggest that those most subject to values conflicts are more likely to experience intuitive dilemmas and so engage system 2 to resolve them.

If as we suggest there is a hierarchical influence of values on morality, intelligence, and creativity, given that it is possible to develop people's values (Bardi, et al, 2014), further research replicating and extending our findings could pave the way for a range of potentially transformative initiatives in psychology, sociology, ecology, economics, education, and organizational development.

Given the abstract nature of values and their equivalents, concrete evidence to support historical aspects of this theory may be difficult to find. No matter how plausible it is, and how much evidence is found to support its developmental hierarchy, like values themselves, it may remain a high-level, abstract conceptualisation of more fundamental mechanisms. It seems likely the systematic relationships between values and their pre-existing equivalents can only be inferred from patterns of behavior, i.e., the physical activity of people and their neurons. As such, values are unlikely to be found residing in specific areas of the brain or being generated by specific genes or simple combinations thereof. Accordingly, it is perhaps a theory best judged by the utility of the predictions it facilitates, i.e., those related to the hierarchical influence of values on decision-making. Given the immense global challenges presented by, for example, global warming, the rise of populist nationalist leaders, social inequality, and the increasing influence of artificial intelligence and associated potential for human redundancy, there is a pressing case to be made for the testing of initiatives designed to promote the values of self-direction, universalism, and benevolence. If we are to maximise the potential for individuals, organizations, and societies to achieve higher levels of personal wellbeing, social harmony, and environmental sustainability, the more knowledge that can be shared and understood by individuals capable of independent thought and action, and the less we are constrained by habitual practices and narrow frames of reference, the better.

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References

Adami, C., Ofria, C., & Collier, T. C. (2000). Evolution of biological complexity. *Proceedings of the National Academy of Sciences of the United States of America*, *97*, 4463–4468. https://doi.org/10.1073/PNAS.97.9.4463

Alves, J., Combes, F., Ferrara, A., Forveille, T., & Shore, S. (2016). Planck 2015 results. *Astronomy and Astrophysics*, *594*. https://doi.org/10.1051/0004-6361/201629543

AMOLF. (2017). Personality and Mood Swings in Bacteria. Retrieved October 27, 2020, from Phys.Org. website: https://phys.org/news/2017-12-personality-mood-bacteria.html

Anglim, J., Knowles, E. R. V, Dunlop, P. D., & Marty, A. (2017). HEXACO personality and Schwartz's personal values: A facet-level analysis. *Journal of Research in Personality*, *68*, 23–31. https://doi.org/https://doi.org/10.1016/j.jrp.2017.04.002

APA. (2022). Personality. Retrieved Mar 18, 2022, from APA website: http://www.apa.org/topics/personality/

Ashton, M. C., Perugini, M., De Vries, R. E., Boies, K., Lee, K., Szarota, P., de Vries, R.E., Di Blas, L., Boies, K., & De Raad, B. (2004). A Six-Factor Structure of Personality-Descriptive Adjectives: Solutions from Psycholexical Studies in Seven Languages. *Journal of Personality and Social Psychology*, *80*, 356–366. https://doi.org/10.1037/0022-3514.86.2.356

Axelrod, R. M. (1997). *The Complexity of Cooperation: Agent-based Models of Competition and Cooperation*. Princeton University Press.

Axelrod, R. M., & Hamilton, W. D. (1981). The Evolution of Cooperation. *Science*, *211*, 1390–1396. https://doi.org/10.1126/science.7466396

Baird, A. D., Wilson, S. J., Bladin, P. F., Saling, M. M., & Reutens, D. C. (2007). Neurological control of human sexual behaviour: Insights from lesion studies. *Journal of Neurology, Neurosurgery and Psychiatry*, *78*, 1042–1049. https://doi.org/10.1136/jnnp.2006.107193

Balasubramanian, V. (2015). Heterogeneity and Efficiency in the Brain. *Proceedings of the IEEE*, *103*, 1346–1358. https://doi.org/10.1109/JPROC.2015.2447016

Bandura, A. (2004). Health Promotion by Social Cognitive Means. *Health Education & Behavior*, *31*, 143–164. https://doi.org/10.1177/1090198104263660

Bardi, A., Buchanan, K. E., Goodwin, R., Slabu, L., & Robinson, M. (2014). Value stability and change during self-chosen life transitions: Self-selection versus socialization effects. *Journal of Personality and Social Psychology*, *106*, 131–147. https://doi.org/10.1037/a0034818

Bardi, A., Lee, J. A., Hofmann-Towfigh, N., & Soutar, G. (2009). The structure of intraindividual value change. *Journal of Personality and Social Psychology*, *97*, 913–929. https://doi.org/10.1037/a0016617

Bardi, A., & Schwartz, S. H. (2003). Values and behavior: Strength and structure of relations. *Personality and Social Psychology Bulletin*, *29*, 1207–1220. https://doi.org/10.1177%2F0146167203254602

Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.. (1992). *The adapted mind: Evolutionary psychology and the generation of culture.* Oxford University Press.

Bass, B., & Riggio, R. E. (2005). *Transformational Leadership* (2nd ed.). https://doi.org/https://doi.org/10.4324/9781410617095

Bateson, P. (2014). Play, Playfulness, Creativity and Innovation. *Animal Behavior and Cognition*, *2*, 99. https://doi.org/10.12966/abc.05.02.2014

Bekoff, M. (2015). Playful fun in dogs. *Current Biology*, *25*, R4–R7. https://doi.org/10.1016/j.cub.2014.09.007

Bethe, H. A., & Bacher, R. F. (1936). Nuclear Physics: A. Stationary States of Nuclei. *Review of Modern Physics*, *8*, 1–225. https://doi.org/10.1103/RevModPhys.8.82

Ben-Ghiat, R. (2020). *Strongmen: How They Rise, Why They Succeed, How They Fall*. Profile

Bianconi, E., Piovesan, A., Facchin, F., Beraudi, A., Casadei, R., Frabetti, F., Vitale, L., Pelleri, M.C., Tassani, S., Piva, F., Perez-Amodio, S., Strippoli, P., &, Canaider, S. (2013). An estimation of the number of cells in the human body. *Annals of Human Biology*, *40*, 463–471. https://doi.org/10.3109/03014460.2013.807878

Bilsky, W. (2006). On the structure of motives: Beyond the “Big Three.” In M. Braun & P. P. H. Mohler (Eds.), *Beyond the horizon of measurement: Festschrift in honor of Ingwer Borg* (pp. 73–84). Mannheim: GESIS-ZUMA.

Bilsky, W., Janik, M., & Schwartz, S. H. (2010). The Structural Organization of Human Values-Evidence from Three Rounds of the European Social Survey (ESS). *Journal of Cross-Cultural Psychology*, *42*, 759–776. https://doi.org/10.1177/0022022110362757

Block, J. (2010). The Five-Factor Framing of Personality and Beyond: Some Ruminations. *Psychological Inquiry*, *21*, 2–25. https://doi.org/10.1080/10478401003596626

Bohr, N. (1913). On the constitution of atoms and molecules. *Philosophical Magazine Series 6*, *26*, 857–875. https://doi.org/10.1080/14786441308635031

Boyd, R., & Richerson, P. J. (2009). Culture and the evolution of human cooperation. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *364*, 3281–3288. https://doi.org/10.1098/rstb.2009.0134

Bouckenooghe, D., Buelens, M., Fontaine, J., & Vanderheyden, K. (2005). The Prediction of Stress by Values and Value Conflict. *The Journal of Psychology*, *139*, 369–384. https://doi.org/10.3200/JRLP.139.4.369-384

Briley, D. A., & Tucker-Drob, E. M. (2014). Genetic and environmental continuity in personality development: a meta-analysis. *Psychological Bulletin*, *140*, 1303–1331. https://doi.org/10.1037/a0037091

Bretz Robert D., J., & Judge, T. A. (1994). Person–Organization Fit and the Theory of Work Adjustment: Implications for Satisfaction, Tenure, and Career Success. *Journal of Vocational Behavior*, *44*, 32–54. https://doi.org/https://doi.org/10.1006/jvbe.1994.1003

Brosch, T., & Sander, D. (2013). Neurocognitive Mechanisms Underlying Value-Based Decision-Making: From Core Values to Economic Value. *Frontiers in Human Neuroscience, 7*. https://doi.org/https://doi.org/10.3389/fnhum.2013.00398

Brown, J. H. (1995). Organisms and Species as Complex Adaptive Systems: Linking the Biology of Populations with the Physics of Ecosystems. In C. G. Jones & J. H. Lawton (Eds.), *Linking Species & Ecosystems.* https://doi.org/10.1007/978-1-4615-1773-3_2

Brun, T. A. (1995). An example of the decoherence approach to quantum dissipative chaos. *Physics Letters A*, *206*, 167–176. https://doi.org/10.1016/0375-9601(95)00605-3

Burghardt, G. M. (2018). The Genesis of Animal Play. In *The Genesis of Animal Play*. https://doi.org/10.7551/mitpress/3229.001.0001

Carmichael, T., & Hadzikadic, M. (2019). The Fundamentals of Complex Adaptive Systems. In *Complex Adaptive Systems* (pp. 1–16). https://doi.org/10.1007/978-3-030-20309-2_1

CERN. (2020). Why Should I Car About The Higgs Boson? Retrieved October 29, 2020, from CERN website: https://cms.cern/news/why-would-i-care-about-higgs-boson

Cloninger, C. R. (2004). *Feeling good: the science of well-being.* New York: Oxford University Press.

Critchley, H. D., Eccles, J., & Garfinkel, S. N. (2013). Interaction between cognition, emotion, and the autonomic nervous system. *Handbook of Clinical Neurology*, *117*, 59–77. https://doi.org/10.1016/B978-0-444-53491-0.00006-7

Curtis, H. D. (1988). Novae in Spiral Nebulae and the Island Universe Theory. *Publications of the Astronomical Society of the Pacific*, *100*, 6. https://doi.org/10.1086/132128

Damian, R. I., & Roberts, B. W. (2015). Settling the debate on birth order and personality. *Proceedings of the National Academy of Sciences*, *112*, 14119–14120. https://doi.org/10.1073/pnas.1519064112

Dawkins, M. S. (2006). A user's guide to animal welfare science. *Trends in Ecology & Evolution*, *21*, 77–82. https://doi.org/10.1016/j.tree.2005.10.017

Dawkins, R. (1978). *The Selfish Gene*. Oxford: Oxford University Press.

Deutsch, D. (2011). *The Beginning Of Infinity*. Penguin.

Deecke, L. (2012). There are conscious and unconscious agendas in the brain and both are important-Our will can be conscious as well as unconscious. *Brain Sciences*, *2*, 405–420. https://doi.org/10.3390/brainsci2030405

DeWeerdt, S. (2019). How to map the brain. Retrieved October 27, 2020, from Nature website: https://www.nature.com/articles/d41586-019-02208-0

Dobewall, H., Aavik, T., Konstabel, K., Schwartz, S. H., & Realo, A. (2014). A comparison of self-other agreement in personal values versus the Big Five personality traits. *Journal of Research in Personality*, *50*, 1–10. https://doi.org/10.1016/j.jrp.2014.01.004

Doherty, M. (2008). Theory of Mind: How Children Understand Others' Thoughts and Feelings. *Theory of Mind: How Children Understand Others' Thoughts and Feelings*, 1–247. https://doi.org/10.4324/9780203929902

Dolivo, V., Rutte, C., & Taborsky, M. (2016). Ultimate and proximate mechanisms of reciprocal altruism in rats. *Learning & Behavior*, *44*, 223–226. https://doi.org/10.3758/s13420-016-0236-z

Doran, C. J. (2009). The role of personal values in fair trade consumption. *Journal of Business Ethics*, *84*, 549–563. https://doi.org/10.1007/s10551-008-9724-1

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques: Promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, Supplement*, *14*, 4–58. https://doi.org/10.1177/1529100612453266

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*, 169–200. https://doi.org/10.1080/02699939208411068

Ellis, B. J., Boyce, W. T., Belsky, J., Bakermans-Kranenburg, M. J., & Van Ijzendoorn, M. H. (2011). Differential susceptibility to the environment: An evolutionary-neurodevelopmental theory. *Development and Psychopathology*, *23*, 7–28. https://doi.org/10.1017/S0954579410000611

England, J. L. (2015). Dissipative adaptation in driven self-assembly. *Nature Nanotechnology*, *10*, 919–923. https://doi.org/10.1038/nnano.2015.250

Faber, S. M. (2012). *Nearly Normal Galaxies: From the Planck Time to the Present.* New York.: Springer.

Fang, T. (2005). From “Onion” to “Ocean”: Paradox and Change in National Cultures. *International Studies of Management & Organization*, *35*, 71–90. https://doi.org/10.1080/00208825.2005.11043743

Feather, N. T. (1995). Values, valences, and choice: The influences of values on the perceived attractiveness and choice of alternatives. *Journal of Personality and Social Psychology*, *68*, 1135–1151. https://doi.org/10.1037/0022-3514.68.6.1135

Feynman, R. P., & Hibbs, A. R. (1965). *Quantum Mechanics and Path Integrals*. New York, NY: McGraw-Hill.

Flynn, J. R. (1987). Massive IQ gains in 14 nations: What IQ tests really measure. *Psychological Bulletin*, *101*, 171–191. https://doi.org/10.1037/0033-2909.101.2.171

Fodor, J. A. (1983). *The Modularity of Mind: An Essay on Faculty Psychology* (Vol. 94). MIT Press.

Fumagalli, M., & Priori, A. (2012). Functional and clinical neuroanatomy of morality. *Brain*, *135*, 2006–2021. https://doi.org/10.1093/brain/awr334

García-Morales, V. J., Matías-Reche, F., & Hurtado-Torres, N. (2008). Influence of transformational leadership on organizational innovation and performance depending on the level of organizational learning in the pharmaceutical sector. *Journal of Organizational Change Management*, *21*, 188–212. https://doi.org/10.1108/09534810810856435

Gell-Mann, M. (1994). *The Quark and the Jaguar*. London, UK: Little, Brown and Company.

Glansdorff, N., Xu, Y., & Labedan, B. (2008). The Last Universal Common Ancestor: emergence, constitution and genetic legacy of an elusive forerunner. *Biology Direct*, *3*, 29. https://doi.org/10.1186/1745-6150-3-29

Gouveia, V. V., Vione, K. C., Milfont, T. L., & Fischer, R. (2015). Patterns of Value Change During the Life Span: Some Evidence From a Functional Approach to Values. *Personality and Social Psychology Bulletin*, *41*, 1276–1290. https://doi.org/10.1177/0146167215594189

Graham, K. L., & Burghardt, G. M. (2010). Current perspectives on the biological study of play: Signs of progress. *Quarterly Review of Biology*, *85*, 393–418. https://doi.org/10.1086/656903

Graham, J., Haidt, J., Koleva, S., Motyl, M., Iyer, R., Wojcik, S. P., & Ditto, P. H. (2013). Moral Foundations Theory: The Pragmatic Validity of Moral Pluralism. In *Advances in Experimental Social Psychology* (1st ed., Vol. 47). https://doi.org/10.1016/B978-0-12-407236-7.00002-4

Greene, B. (2004). *The Fabric of the Cosmos*. London, UK: Penguin.

Gregory, T. R. (2008). The Evolution of Complex Organs. In *Evolution: Education and Outreach,* 1. https://doi.org/10.1007/s12052-008-0076-1

Griffiths, N. L., Thomas, K., Dyer, B., Rea, J., & Bardi, A. (et al.(a)) (2021). The values of only-children: Power and benevolence in the spotlight. *Journal of Research in Personality*, *92*, 104096. https://doi.org/10.1016/j.jrp.2021.104096

Güsten, R., Wiesemeyer, H., Neufeld, D., Menten, K. M., Graf, U. U., Jacobs, K., … Stutzki, J. (2019). Astrophysical detection of the helium hydride ion HeH+. *Nature*, *568*, 357–359. https://doi.org/0.1038/s41586-019-1090-x

Haidt, J. (2001). The emotional dog and its rational tail: A social intuitionist approach to moral judgment. Psychological Review, 108, 814–834. https://doi.org/10.1037/0033-295x.108.4.814.

Haidt, J. (2007). The new synthesis in moral psychology. Science, 316, 998–1002. https://doi.org/10.1126/science.1137651

Haidt, J. (2012). The righteous mind: Why good people are divided by politics and religion. New York: Pantheon.

Hail, L., Tahoun, A., & Wang, C. (2018). Corporate Scandals and Regulation. *Journal of Accounting Research*, *56*, 617–671. https://doi.org/10.1111/1475-679X.12201

Hall, D. T., Yip, J., & Doiron, K. (2018). Protean Careers At Work. *Annual Review of Organizational Psychology and Organizational Behavior*, *5*, 129–158. https://doi.org/https://doi.org/10.1146/annurev-orgpsych-032117-104631

Hamilton, W. D. (1972). Altruism and Related Phenomena, Mainly in Social Insects. *Annual Review of Ecology and Systematics*, *3*, 193–232. https://doi.org/10.1146/annurev.es.03.110172.001205

Hanselmann, M., & Tanner, C. (2008). Taboos and conflicts in decision making: Sacred values, decision difficulty, and emotions. *Judgment and Decision Making*, *3*, 51–63.

Heisenberg, W. (1927). Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. *Zeitschrift Fur Physik*, *43*, 172–198. https://doi.org/https://doi.org/10.1007%2FBF01397280

Held, S. D. E., & Špinka, M. (2011). Animal play and animal welfare. *Animal Behaviour*, *81*, 891–899. https://doi.org/10.1016/j.anbehav.2011.01.007

Henning, T., & Salama, F. (1998). Carbon in the universe. *Science*, *282*, 2204–2210. https://doi.org/10.1126/science.282.5397.2204

Herz, D. M., Zavala, B. A., Bogacz, R., & Brown, P. (2016). Neural Correlates of Decision Thresholds in the Human Subthalamic Nucleus. *Current Biology*, *26*, 916–920. https://doi.org/10.1016/j.cub.2016.01.051

Heyes, C. (2012). New thinking: The evolution of human cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*, 2091–2096. https://doi.org/10.1098/rstb.2012.0111

Heyes, C. (2019). Précis of Cognitive Gadgets : The Cultural Evolution of Thinking. *Behavioral and Brain Sciences*, *42*, 1–58. https://doi.org/10.1017/S0140525X18002145

Heylighen, F., Bollen, J., & Riegler, A. (Eds)(1999). *The evolution of complexity: the violet book of "Einstein meets Magritte",* Netherlands: Springer

Holland, J. (1975). *Adaptation in Natural and Artificial Systems.* Minnesota: The MIT Press.

Hoyle, F. (1946). The Synthesis of the Elements from Hydrogen ⋆. *Monthly Notices of the Royal Astronomical Society*, *106*, 343–383. https://doi.org/10.1093/mnras/106.5.343

Hoyle, F. (1954). On Nuclear Reactions Occuring in Very Hot Stars. 1. The Synthesis of Elements from Carbon to Nickel. *Astrophysical Journal Supplement*, *1*, 121–146. https://doi.org/10.1086/190005

Inglehart, R., & Oyserman, D. (2004). Individualism, Autonomy, and Self-Expression: The Human Development Syndrome, in H. Vinken, J. Soeters, and P. Ester (Eds.), *Comparing Cultures, Dimensions of Culture in a Comparative Perspective.*, 74–96. Leiden, The Netherlands: Brill

Ipsos. (2011). Global share of people who believe in God or a supreme being, by country, as of 2010. Retrieved April 26, 2022, from Statista website: https://www.statista.com/statistics/273004/global-belief-in-god-or-a-supreme-being/

Jansen, S. J. T. (2014). Different Values, Different Housing? Can Underlying Value Orientations Predict Residential Preference and Choice? *Housing, Theory and Society*, *31*, 254–276. https://doi.org/10.1080/14036096.2013.867279

Johnson, A., Varberg, Z., Benhardus, J., Maahs, A., & Schrater, P. (2012). The hippocampus and exploration: Dynamically evolving behavior and neural representations. *Frontiers in Human Neuroscience*, *6*, 1–17. https://doi.org/10.3389/fnhum.2012.00216

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, *58*, 697–720. https://doi.org/10.1037/0003-066X.58.9.697

Kahneman, D., & Tversky, A. (1984). Choices, Frames and Values. *American Psychologist*, *39,* 341–350. https://psycnet.apa.org/doi/10.1037/0003-066X.39.4.341

Kaila, V. R. I., & Annila, A. (2008). Natural selection for least action. *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *464*, 3055–3070. https://doi.org/10.1098/rspa.2008.0178

Kajonius, P. J., Persson, B. N., & Jonason, P. K. (2015). Hedonism, Achievement, and Power: Universal Values that Characterize the Dark Triad. *Personality and Individual Differences VO - 77*, 173. https://doi.org/10.1016/j.paid.2014.12.055

Kanwisher, N. (2010). Functional specificity in the human brain: A window into the functional architecture of the mind. *Proceedings of the National Academy of Sciences of the United States of America*, *107*, 11163–11170. https://doi.org/10.1073/pnas.1005062107

Kauffman, S. (1995). *At Home In The Universe*. Penguin.

Keegstra, J. M., Kamino, K., Anquez, F., Lazova, M. D., Emonet, T., & Shimizu, T. S. (2017). Phenotypic diversity and temporal variability in a bacterial signaling network revealed by single-cell FRET. *ELife*, *6*, e27455. https://doi.org/10.7554/eLife.27455

Keightley, P. D., & Eyre-Walker, A. (2010). What can we learn about the distribution of fitness effects of new mutations from DNA sequence data? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*, 1187–1193. https://doi.org/10.1098/rstb.2009.0266

Keltner, D., & Gross, J. J. (1999). Functional Accounts of Emotions. *Cognition and Emotion*, *13*, 467–480.

Khriachtchev, L., Pettersson, M., Runeberg, N., Lundell, J., & Räsänen, M. (2000). A stable argon compound. *Nature*, *406*, 874–876. https://doi.org/10.1038/35022551

Kirschner, M., & Mitchison, T. (1986). Beyond self-assembly: From microtubules to morphogenesis. *Cell*, *45*, 329–342. https://doi.org/https://doi.org/10.1016/0092-8674(86)90318-1

Knafo, A., & Spinath, F. M. (2011). Genetic and environmental influences on girls' and boys' gender-typed and gender-neutral values. *Developmental Psychology*, *47*, 726–731. https://doi.org/10.1037/a0021910

Kondepudi, D., & Prigogine, I. (1998). Far-From Equilibirum Systems. In *Modern Thermodynamics - from Heat Engines to Dissapative Structures* (p. 409). New York, NY: John Wiley and Sons.

Kuczaj, S. A., & Eskelinen, H. C. (2014). Why do Dolphins Play? *Animal Behavior and Cognition*, *2*, 113. https://doi.org/10.12966/abc.05.03.2014

Kuppens, P., Realo, A., & Diener, E. (2008). The Role of Positive and Negative Emotions in Life Satisfaction Judgment Across Nations. *Journal of Personality and Social Psychology*, *95*, 66–75. https://doi.org/10.1037/0022-3514.95.1.66

Kurzweil, R. (2001). The Law of Accelerating Returns. Retrieved July 18, 2016, from Kurzweil Tracking the acceleration of intelligence website: http://www.kurzweilai.net/the-law-of-accelerating-returns

Lamont, M., & Molnár, V. (2002). The study of boundaries in the social sciences. *Annual Review of Sociology*, *28*, 167–195. https://doi.org/10.1146/annurev.soc.28.110601.141107

Larson, R. B., & Bromm, V. (2009). The First Stars in the Universe. *Scientific American*. Retrieved from https://www.scientificamerican.com/article/the-first-stars-in-the-un/

Laughlin, S. B., & Sejnowski (2003). Communication in Neuronal Networks. *Science*, *301*, 1870–1874. https://doi.org/10.1126/science.1089662

Lebedeva, N., Schwartz, S. H., van de Vijver, F. J. R., Plucker, J., & Bushina, E. (2019). Domains of everyday creativity and personal values. *Frontiers in Psychology*, *9*, 1–16. https://doi.org/10.3389/fpsyg.2018.02681

Lemons, D. (2006). Genomic Evolution of Hox Gene Clusters. *Science*, *313*, 1918 LP – 1922. https://doi.org/10.1126/science.1132040

Li, C.-K., & Hung, C.-H. (2009). The influence of transformational leadership on workplace relationships and job performance. *Social Behavior & Personality*, *37*, 1129–1142. https://doi.org/https://doi.org/10.2224/sbp.2009.37.8.1129

Lineweaver, C. H. (2001). An Estimate of the Age Distribution of Terrestrial Planets in the Universe: Quantifying Metallicity as a Selection Effect. *Icarus*, *151*, 307–313. https://doi.org/https://doi.org/10.1006/icar.2001.6607

Lodish, H., Berk, A., & Zipursky, S.L., et al. (2000). Mutations: Types and Causes. In *Molecular Cell Biology.* (4th ed.). Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK21578/

Mandelbrot, B. B. (1982). *The Fractal Geometry of Nature (Updated and augmented ed.)*. New York: W. H. Freeman.

Maslow, A. H. (1943). A Theory of Human Motivation. *Psychological Review*, *50*, 370–396. https://psycnet.apa.org/doi/10.1037/h0054346

Maslow, A. H. (1965). *Eupsychian Management*. Homewood, IL: Irwin Inc.

Maslow, A. (1987). *Motivation and Personality* (3rd ed.). Addison-Wesley Educational Publishers.

Matzler, K., Bailom, F., & Mooradian, T. A. (2007). Intuitive decision making. *MIT Sloan Management Review*, *49*. https://doi.org/10.4135/9781452276090.n139

Mayer, J. D. (2007). Asserting the Definition of Personality. Retrieved April 11, 2022, from The Online Newsletter for Personality Science website: https://www.personality-arp.org/html/newsletter01/jdm.pdf

McAdams, D. P. (1980). A thematic coding system for the intimacy motive. *Journal of Research in Personality*, *14*, 413–432. https://doi.org/10.1016/0092-6566(80)90001-X

McAdams, D. P. (1995). What Do We Know When We Know a Person? *Journal of Personality*, *63*, 365–396. https://doi.org/10.1111/j.1467-6494.1995.tb00500.x

McCrae, R. R., & Costa, P. T. (1999). A five-factor theory of personality. In *Handbook of Personality: Theory & Research* (pp. 139–153). New York: Guilford Press.

McEwen, B. S., & Wingfield, J. C. (2003). The concept of allostasis in biology and biomedicine. *Hormones And Behavior*, *43*, 2–15. https://doi.org/10.1016/s0018-506x(02)00024-7

McClelland, D. C. (1961). *The Achieving Society*. Free Press.

Meglino, B. M., Ravlin, E. C., & Adkins, C. L. (1989). A Work Values Approach to Corporate Culture: A Field Test of the Value Congruence Process and Its Relationship to Individual Outcomes. *Journal of Applied Psychology*, *74*, 424–432. https://doi.org/10.1037/0021-9010.74.3.424

Michelson, S. E., Lee, J. K., Orsillo, S. M., & Roemer, L. (2011). The role of values-consistent behavior in generalized anxiety disorder. *Depression and Anxiety*, *28*(5), 358–366. https://doi.org/10.1002/da.20793

Miller, J. D., Scott, E. C., & Okamoto, S. (2006). Supporting Online Material for Public Acceptance of Evolution. *Science (New York, N.Y.)*, *313*, 2005–2006. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16902112

Miller, J. H., & Page, S. E. (2007). *Complex Adaptive Systems: an introduction to computational models of social life*. New Jersey: Princeton University Press.

Mischel, W. (2004). Toward an integrative science of the person. *Annual Review of Psychology*, *55*, 1–22. https://doi.org/10.1146/annurev.psych.55.042902.130709

Molden, D. C., & Dweck, C. S. (2006). Finding “meaning” in psychology: A lay theories approach to self-regulation, social perception, and social development. *American Psychologist*, *61*, 192–203. https://doi.org/10.1037/0003-066X.61.3.192

Moore, G. E. (1965). Cramming more components onto integrated circuits. *Electronics Magazine*. Retrieved from https://newsroom.intel.com/wp-content/uploads/sites/11/2018/05/moores-law-electronics.pdf

Moriano, J. A., Molero, F., Topa, G., & Lévy Mangin, J. P. (2014). The influence of transformational leadership and organizational identification on intrapreneurship. *International Entrepreneurship and Management Journal*, *10*, 103–119. https://doi.org/10.1007/s11365-011-0196-x

Morowitz, H. J. (1999). A theory of biochemical organization, metabolic pathways, and evolution. *Complexity*, *4*, 39–53. https://doi.org/10.1002/(SICI)1099-0526(199907/08)4:6<39::AID-CPLX8>3.0.CO;2-2

Morrison, R., & Reiss, D. (2018). Precocious development of self-awareness in dolphins. *PLoS ONE*, *13*, 1–12. https://doi.org/10.1371/journal.pone.0189813

Mossel, E., & Steel, M. (2005). Random biochemical networks: the probability of self-sustaining autocatalysis. *Journal Of Theoretical Biology*, *233*, 327–336. https://doi.org/10.1016/j.jtbi.2004.10.011

National Research Council (US) (1989). The Nervous System and Behavior. In *Opportunities in Biology*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK217810/

Naqvi, N., Shiv, B., & Bechara, A. (2006). The role of emotion in decision making: A cognitive neuroscience perspective. *Current Directions in Psychological Science*, *15*, 260–264. https://doi.org/10.1111/j.1467-8721.2006.00448.x

Newcomb, T. M. (1960). Varieties of interpersonal attraction. In Cartwright & Zander (Eds.), *Group dynamics: Research and theory* (2nd ed., pp. 104–119). Harper & Row.

Nishida, T. (1983). Alpha status and agonistic alliance in wild chimpanzees (Pan troglodytes schweinfurthii). *Primates*, *24*, 318–336. https://doi.org/10.1007/BF02381978

Nowak, M. A., & Highfield, R. (2012). *Super Cooperators: Beyond the Survival of the Fittest: why Cooperation, Not Competition, is the Key of Life*. Canongate.

O'Dea, S. (2022). Number of smartphone subscriptions worldwide from 2016 to 2027. Retrieved April 25, 2022, from Statista website: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Okasha, A. (2005). Mental health in Egypt. *The Israel Journal of Psychiatry and Related Sciences*, *42*, 116–125.

O'Reilly, C. A., Chatman, J., & Caldwell, D. F. (1991). PEOPLE AND ORGANIZATIONAL CULTURE: A PROFILE COMPARISON APPROACH TO ASSESSING PERSON-ORGANIZATION FIT. *Academy of Management Journal*, *34*, 487–516. https://doi.org/10.5465/256404

Ornes, S. (2017). How nonequilibrium thermodynamics speaks to the mystery of life. *Proceedings of the National Academy of Sciences of the United States of America*, *114*, 423–424. https://doi.org/10.1073/pnas.1620001114

Panksepp, J. (2011). The basic emotional circuits of mammalian brains: Do animals have affective lives? *Neuroscience and Biobehavioral Reviews*, *35*, 1791–1804. https://doi.org/10.1016/j.neubiorev.2011.08.003

Parks-Leduc, L., Feldman, G., & Bardi, A. (2015). Personality Traits and Personal Values: A Meta-Analysis. *Personality and Social Psychology Review*, *19*, 3–29. https://doi.org/10.1177/1088868314538548

Parunak, H. V. D., Box, P. O., & Arbor, A. (2001). Entropy and Self-Organization in Multi-Agent Systems. *Proceedings of the International Conference on Autonomous Agent*, (Agents), 124–130. https://doi.org/10.1145/375735.376024

Paulhus, D. L., & Williams, K. M. (2002). The dark triad of personality: Narcissism, machiavellianism, and psychopathy in everyday life. *The Dark Triad of Personality: Narcissism, Machiavellianism, and Psychopathy in Everyday Life*, *36*, 556–563. https://doi.org/10.1016/C2017-0-01262-4

Pellegrini, A. D., Dupuis, D., & Smith, P. K. (2007). Play in evolution and development. *Developmental Review*, *27*, 261–276. https://doi.org/https://doi.org/10.1016/j.dr.2006.09.001

Plomin, R., & Deary, I. J. (2015). Genetics and intelligence differences: five special findings. M*olecular Psychiatry*, *20*, 98–108. https://doi.org/10.1038/mp.2014.105

Poundstone, W. (1993). *Prisoner's Dilemma*. Oxford University Press.

Preciadoa, P., Snijdersb, T. A. B., Burkc, W. J., Stattind, H., & Kerrd, M. (2012). Does Proximity Matter? Distance Dependence of Adolescent Friendships. *Social Networks*, *34*, 18–31. https://doi.org/10.1016/j.socnet.2011.01.002.

Ramstead, M. J. D., Badcock, P. B., & Friston, K. J. (2018). Answering Schrödinger's question: A free-energy formulation. *Physics of Life Reviews*, *24*, 1–16. https://doi.org/10.1016/j.plrev.2017.09.001

Reiss, S. (2004). Multifaceted nature of intrinsic motivation: The theory of 16 basic desires. *Review of General Psychology*, *8*, 179–193. https://doi.org/10.1037/1089-2680.8.3.179

Reynolds, A. M., & Rhodes, C. J. (2009). The Lévy flight paradigm: random search patterns and mechanisms. *Ecology*, *90*, 877–887. https://doi.org/https://doi.org/10.1890/08-0153.1

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York: Free Press.

Sabater, B. (2006). Are organisms committed to lower their rates of entropy production? Possible relevance to evolution of the Prigogine theorem and the ergodic hypothesis. *BioSystems*, *83*, 10–17. https://doi.org/10.1016/j.biosystems.2005.06.012

Sagiv, L., & Schwartz, S. H. (1995). Value Priorities and Readiness for Out-Group Social Contact. *Journal of Personality and Social Psychology*, *69*, 437–448. https://doi.org/10.1037/0022-3514.69.3.437

Schermer, J. A., Vernon, P. A., Maio, G. R., & Jang, K. L. (2011). A Behavior Genetic Study of the Connection between Social Values and Personality. *Twin Research and Human Genetics, 14*, 233. https://doi.org/https://doi.org/10.1375/twin.14.3.233

Schuster, C., Pinkowski, L., & Fischer, D. (2019). Intra-individual value change in adulthood: A systematic literature review of longitudinal studies assessing Schwartz's value orientations. *Zeitschrift Für Psychologie*, *227*, pp. 42–52. https://doi.org/10.1027/2151-2604/a000355

Schwartz, S. H. (1992). Universals in the content and structure of values: Theory and empirical tests in 20 countries. *Advances in Experimental Social Psychology*, *25*, 1–65. https://doi.org/doi.org/10.1016/s0065-2601(08)60281-6

Schwartz, S. H. (2010). Basic values: How they motivate and inhibit prosocial behavior. In P. Shaver & M. Mikulincer (Eds.), *Prosocial motives, emotions, and behavior: The better angels of our nature.* (pp. 221–241). https://doi.org/10.1037/12061-012

Schwartz, S. H., & Boehnke, K. (2004). Evaluating the structure of human values with confirmatory factor analysis. *Journal of Research in Personality*, *38*, 230–255. http://dx.doi.org/10.1016/S0092-6566(03)00069-2

Sih, A., Ferrari, M. C. O., & Harris, D. J. (2011). Evolution and behavioural responses to human-induced rapid environmental change. *Evolutionary Applications*, *4*, 367–387. https://doi.org/10.1111/j.1752-4571.2010.00166.x

Simon, H. A. (1956). Rational Choice and the Structure of the Environment. *Psychological Review*, *63*, 129–138. https://doi.org/https://doi.org/10.1037/h0042769

Simon, H. A. (1995). Near decomposability and complexity: How a mind resides in a brain. In *The Mind, The Brain And Complex Adaptive Systems* (pp. 25–43). Reading, MA.: Addison-Wesley Educational Publishers.

Singh, V., & Holmstrom, J. (2015). Needs and technology adoption: Observation from BIM experience. *Engineering, Construction and Architectural Management*, *22*, 128–150. https://doi.org/10.1108/ECAM-09-2014-0124

Skimina, E., Cieciuch, J., & Strus, W. (2018). Traits and values as predictors of the frequency of everyday behavior: Comparison between models and levels. *Current Psychology*, 1–21. https://doi.org/10.1007/s12144-018-9892-9

Slocombe, L., Al-Khalili, J. S., & Sacchi, M. (2021). Quantum and classical effects in DNA point mutations: Watson-Crick tautomerism in at and GC base pairs. *Physical Chemistry Chemical Physics*, *23*, 4141–4150. https://doi.org/10.1039/d0cp05781a

Smith, S. E. (2019). Is Evolutionary Psychology Possible? *Biological Theory*, *15*, 39–49. https://doi.org/10.1007/s13752-019-00336-4

Sokolowski, K. (2008). Social Bonding: Affiliation motivation and intimacy motivation. In H. Heckhausen & J. Heckhausen (Eds.), *Motivation and action* (2nd ed., pp. 184–201). New York, NY: Cambridge University Press.

Sousa, F. L., Thiergart, T., Landan, G., Nelson-Sathi, S., Pereira, I. A. C., Allen, J. F., … Martin, W. F. (2013). Early bioenergetic evolution. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *368*, 20130088. https://doi.org/10.1098/rstb.2013.0088

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences*, *23*, 645–726. https://doi.org/10.1017/S0140525X00003435

Stronge, S., Shaver, J. H., Bulbulia, J., & Sibley, C. G. (2019). Only children in the 21st century: Personality differences between adults with and without siblings are very, very small. *Journal of Research in Personality*, *83*. https://doi.org/doi.org/10.1016/j.jrp.2019.103868

Stumpf, H., Angleitner, A., Wieck, T., Jackson, D. N., & Beloch-Till, H. (1985). *Deutsche Personality Research Form Handanweisung*. Göttingen: Hogrefe International.

Sverdlik, N. (2012). The Content of Internal Conflicts: A Personal Values Perspective. *European Journal of Personality*, *26*, 30–44. https://doi.org/http://dx.doi.org/10.1002/per.814

Sverdlik, N., & Rechter, E. (2020). Religiosity and the value of being moral: Understanding the meaning of morality through a personal values perspective. *European Journal of Social Psychology*, *50*, 406-421. https://doi.org/10.1002/ejsp.2627

Tanabashi, M., et al. (Particle Data Group). (2018). RPP-21. Big-Bang Cosmology, Review of Particle Physics. *Physical Review D*, *98*, 030001. https://doi.org/10.1103/PhysRevD.98.030001

Tay, L., & Diener, E. (2011). Needs and Subjective Well-Being Around the World. *Journal of Personality and Social Psychology*, *101*, 354–365. https://doi.org/10.1037/a0023779

Thamrin, H. M. (2012). The Influence of Transformational Leadership andOrganizational Commitment on Job Satisfaction and Employee Performance. *International Journal of Innovation, Management and Technology*, *3*. https://doi.org/10.7763/ijimt.2012.v3.299

Tolman, C. A. (1977). Steric effects of phosphorus ligands in organometallic chemistry and homogeneous catalysis. *Chemical Reviews*, *77*, 313–348. https://doi.org/10.1021/cr60307a002

Tooby, J., & Cosmides, L. (1990). On the universality of human nature and the uniqueness of the individual: the role of genetics and adaptation. Special issue: biological foundations of personality: evolution, behavioral genetics, and psychophysiology. *Journal of Personality*, *58*, 17–67. https://doi.org/10.1111/j.1467-6494.1990.tb00907.x

Tovee, M. J., Reinhardt, S., Emery, J. L., & Corneilssen, P. L. (1998). Optimum body-mass index and maximum sexual attractiveness. *Lancet*, *352*, 548. https://doi.org/10.1016/s0140-6736(05)79257-6

Trivers, R. L. (1971). The Evolution of Reciprocal Altruism. *The Quarterly Review of Biology*, *46*, 35–57. https://doi.org/10.1086/406755

Turing, M. (1950). Computing Machinery and Intelligence. *Mind*, (October), 433–460. https://doi.org/https://doi.org/10.1093/mind/LIX.236.433

Twito, L., & Knafo-Noam, A. (2020). Beyond culture and the family: Evidence from twin studies on the genetic and environmental contribution to values. *Neuroscience and*

Biobehavioral Reviews, *112*, 135–143. https://doi.org/10.1016/j.neubiorev.2019.12.029

Vatsiou, A. I., Bazin, E., & Gaggiotti, O. E. (2016). Changes in selective pressures associated with human population expansion may explain metabolic and immune related pathways enriched for signatures of positive selection. *BMC Genomics*, *17*, 1–11. https://doi.org/10.1186/s12864-016-2783-2

Vecchione, M., Alessandri, G., Roccas, S., &, & Caprara, G. V. (2019). A look into the relationship between personality traits and basic values: A longitudinal investigation. *Journal of Personality*, *87*, 413–427. https://doi.org/doi.org/10.1111/jopy.12399

Vecchione, M., Döring, A. K., Alessandri, G., Marsicano, G., & Bardi, A. (2016). Reciprocal Relations across Time between Basic Values and Value-expressive Behaviors: A Longitudinal Study among Children. *Social Development*, *25*, 528–547. https://doi.org/10.1111/sode.12152

Vorhees, C. V., & Williams, M. T. (2014). Assessing spatial learning and memory in rodents. *ILAR Journal*, *55*, 310–332. https://doi.org/10.1093/ilar/ilu013

Wahba, M. A., & Bridwell, L. G. (1976). Maslow Reconsidered: A Review of Research on the Need Hierarchy Theory. *Organizational Behavior & Human Performance*, *15*, 212–240. https://doi.org/https://doi.org/10.1016/0030-5073(76)90038-6

Weiss, M. C., Sousa, F. L., Mrnjavac, N., Neukirchen, S., Roettger, M., Nelson-Sathi, S., & Martin, W. F. (2016). The physiology and habitat of the last universal common ancestor. *Nature Microbiology*, *1*, 1–8. https://doi.org/10.1038/nmicrobiol.2016.116

Wheaton, B. R. (2009). Photoelectric Effect BT - Compendium of Quantum Physics. In D. Greenberger, K. Hentschel, & F. Weinert (Eds.), *Compendium of Quantum Physics* (pp. 472–475). https://doi.org/10.1007/978-3-540-70626-7_143

Wolf, M., & Weissing, F. J. (2012). Animal personalities: Consequences for ecology and evolution. *Trends in Ecology and Evolution*, *27*, 452–461. https://doi.org/10.1016/j.tree.2012.05.001

Wood, W., & Rünger, D. (2016). Psychology of Habit. *Annual Review of Psychology*, *67*, 289–314. https://doi.org/10.1146/annurev-psych-122414-033417

Wooley, S. C., & Wooley, O. W. (1973). Salivation to the sight and thought of food: A new measure of appetite. *Psychosomatic Medicine*, *35*, 36–142. https://doi.org/10.1097/00006842-197303000-00006

World Happiness Report. (2021). World Happiness Report. Retrieved March 19, 2021, from https://worldhappiness.report/ed/2021/

World-Values-Survey. (2020). World Values Survey. Retrieved October 24, 2021, from World Values Survey website: http://www.worldvaluessurvey.org/WVSContents.jsp

Yates, B. J., Catanzaro, M. F., Miller, D. J., & McCall, A. A. (2014). Integration of Vestibular and Emetic Gastrointestinal Signals that Produce Nausea and Vomiting: Potential Contributions to Motion Sickness Bill. *Experimental Brain Research*, *27*, 1–19. https://doi.org/10.1007/s00221-014-3937-6.Integration

Yerkes, R. M. (1933). Concerning the anthropocentrism of psychology. *Concerning the Anthropocentrism of Psychology.*, *40*, 209–212. https://doi.org/https://psycnet.apa.org/doi/10.1037/h0072301

Yin, H. H., Mulcare, S. P., Hilário, M. R. F., Clouse, E., Holloway, T., Davis, M. I., … Costa, R. M. (2009). Dynamic reorganization of striatal circuits during the acquisition and consolidation of a skill. *Nature Neuroscience*, *12*, 333–341. https://doi.org/10.1038/nn.2261

Zacharopoulos, G., Lancaster, T. M., Maio, G. R., & Linden, D. E. J. (2016). The genetics of neuroticism and human values. *Genes, Brain and Behavior*, *15*, 361–366. https://doi.org/10.1111/gbb.12286

Zhu, S., Zhu, M., Knoll, A. H., Yin, Z., Zhao, F., Sun, S., … Liu, H. (2016). Decimetre-scale multicellular eukaryotes from the 1.56-billion-year-old Gaoyuzhuang Formation in North China. *Nature Communications*, *7*, 11500. https://doi.org/10.1038/ncomms11500

Yates, B. J., Catanzaro, M. F., Miller, D. J., & McCall, A. A. (2014). Integration of Vestibular and Emetic Gastrointestinal Signals that Produce Nausea and Vomiting: Potential Contributions to Motion Sickness Bill. *Experimental Brain Research*, *27*, 1–19. https://doi.org/10.1007/s00221-014-3937-6.Integration

Zacharopoulos, G., Lancaster, T. M., Maio, G. R., & Linden, D. E. J. (2016). The genetics of neuroticism and human values. *Genes, Brain and Behavior*, *15*, 361–366. https://doi.org/https://doi.org/10.1111/gbb.12286

Zylinski, S. (2015). Fun and play in invertebrates. *Current Biology*, *25*, R10–R12. https://doi.org/10.1016/j.cub.2014.09.068