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Daniel Nettle

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Synonyms

Cost and benefit trade-off; Daniel Nettle; Evolutionary personality psychology; Five-factor model

Definition

Daniel Nettle's proposal of a cost and benefit trade-off framework in personality entails that investment toward any personality domain is rarely fully adaptive or costly in the evolutionary paradigm and the optimum personality value is contingent on the varying adaptive problems present in each relevant ecology. Nettle's contribution to evolutionary personality psychology had since provided researchers a direction toward the development of an evolutionary model of personality.

Introduction

Daniel Nettle's research spans across a vast range of fields such as health psychology, individual differences and personality, and evolutionary sciences as well as in topics such as social inequality, cooperation, deprivation, and biological aging. Among these include a series of studies leading up to Nettle's influential paper, "The Evolution of Personality Variation in Humans and Other Animals," which facilitated the progress of the academic study in personality within the evolutionary paradigm. This entry reviews the different theories that have been proposed to explain variations in personality and highlights how Nettle's work has contributed to the field of evolutionary personality psychology.

Explanations for Personality Variation

Since the conceptualization of the five-factor model (FFM), FFM taxonomies have demonstrated strong predictive abilities across various domains such as academic performance (Chamorro-Premuzic and Furnham 2003a, b; Poropat 2009, 2014), work-related performance (Barrick and Mount 1991; Barrick et al. 2001; Salgado 1998; see also Schmitt 2014, for a review), motivation (Judge and Ilies 2002),

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romantic partnership (Figueredo et al. 2006), and parenting style (Huver et al. 2010). Despite the breadth of its robust application, FFM and other forms of personality taxonomy remain largely descriptive and, by itself, cannot offer any explanation to the origin of personality variation.

Natural Selection

The process of natural selection favors traits that offer evolutionary advantages and creates selective pressure against those that do not. Accordingly, natural selection should eventually remove all but the highest-fitness variant at a particular locus (Fisher 1930; Tooby and Cosmides 1990), creating homogeneity in species-typical traits. Within this natural selection framework, individual differences were thought to originate from random sources and are irrelevant to the basic functioning of the universal psychological machinery – much like the colors of different wires in a car engine – and hence lacked adaptive significance (Tooby and Cosmides 1990). Variances in traits persist because they are invisible to the selective forces of natural selection – a core proposition of selective neutrality.

Selective Neutrality

Selective neutrality proposes that trait variance results from the accumulation of fitness-neutral mutations, which are mutations that have no net effect on survival or reproductive success, averaged across all environments (Kimura 1983). In this view, being extraverted or introverted would not confer any fitness benefit nor impose any fitness loss on an individual in all environments. However, given the diverse evidence of personality traits influencing fitness-related outcomes such as life expectancy (Chapman et al. 2011), mating and relationship, and health (Ozer and Benet-Martínez 2006), selective neutrality is unlikely to explain the source of differences observed in personality.

Mutation-Selection Balance, Balancing Selection, and Nettle's Trade-Offs

Trait variance is influenced by two opposing forces: one being selection, which reduces variance, and the other being mutation, which increases variance. Since personality traits are consequential to fitness, according to the mutation-selection balance framework, variance in traits is therefore a result of the rate of mutation matching the rate at which natural selection takes place (Keller and Miller 2006; Lande 1975; Zhang and Hill 2005). Humans possess a relatively high mutation load (Eyre-Walker and Keightley 1999), and carrying non-neutral mutations tends to be harmful (Ridley 2000; Tooby and Cosmides 1990). While dominant deleterious mutations are often weeded out by selection, mutations carried by recessive genes persist over time (Zhang and Hill 2005). A mutation load of mostly recessive genes exists in an individual at any point in time (Penke et al. 2007). This mutation load may, therefore, account for the variation observed in fitness-related traits (Keller and Miller 2006; Zhang and Hill 2005) and personality (Lewis 2015; Verweij et al. 2012).

Where both selective neutrality and mutation-selection balance frameworks suggest that trait variance is maintained due to the lack of selective power to eliminate variance (traits either have no fitness impact or that new mutations are continuously introduced), the balancing selection framework postulates a mechanism in which trait variance is selected for (Penke et al. 2007). In this framework, trait variance is maintained when different levels of traits are optimal under different environmental conditions; selective pressures from different physical environments favor different levels of a trait (Buss 2009; Penke et al. 2007).

Nettle's contribution took into account the key pointers of both mutation selection and balancing selection; he recognized mutation as the process that produces differential traits and creates genetic polymorphism; this variance is then maintained

by fluctuating environmental conditions (Nettle 2006a, 2011). Expanding on MacDonald's (1995) proposal that any normative range of observed personality variation represents a continuum of viable behavioral strategy, Nettle proposed a framework that alludes the concepts of trade-offs and demonstrates its application to the context of personality with the Big Five.

Origins of Personality and the Big Five

Nettle's approach to personality focuses on the fitness costs and benefits of possessing varying levels of each personality dimension such that these trade-offs shape personality variation. The benefits of possessing a particular trait depend on the adaptive problem the personality trait is designed to solve and how effective this trait is in circumventing the adaptive problem. The cost of a personality trait can arise from the cost intrinsic to the behavioral tendency as a result of possessing the personality trait or from opportunity cost where an individual would have benefitted if the individual had behaved differently.

Agreeableness

Agreeableness refers to the behavioral tendencies characterized by friendliness, consideration, modest behavior, and propensity for nurturance. Its facets include trust, straightforwardness, altruism, compliances, modesty, and tender-mindedness (Costa and McCrae 1992). High scorers on agreeableness are more likely to be able to empathize with others (Nettle 2007), cooperate and engage in collective action (Denissen and Penke 2008), be accepted by peers and form friendships (Jensen-Campbell et al. 2002), share common resources, and thrive in joint cooperative ventures (Koole et al. 2001). Collectively, these findings seem to suggest that agreeableness serves an adaptive function of forming coalition and alliances that facilitate the cooperative task for the benefit of the collective.

Inasmuch as agreeableness facilitates social exchanges, being agreeable exposes one to social exploitation. Individuals high in agreeableness invest attention in the interests of others, to the detriment of their own, and, therefore, are vulnerable to social exploitation (Judge et al. 2012). When the majority of the population consists of individuals high in agreeableness and cooperation is widespread, cheaters and sociopaths may have considerable advantages to gain through their exploits (Nettle 2011). Hence, based on the trade-off principle, high agreeableness is favored when people live in small isolated groups that demand cooperative effort, whereas low agreeableness is favored when people live in loose social formation or when environment encourages solitary foraging (Nettle 2006b).

This trade-off principle can also be observed in intersexual dimorphism in agreeableness, where women are found to be significantly more agreeable than men (Costa et al. 2001; Schmitt et al. 2008). Women, who bear more childbearing fitness cost than men, often relied on social support and therefore stood to benefit more by better integration into their social network (Campbell 1999). Hence, the fitness benefits women have gained over human's evolutionary history by being agreeable, as opposed to men (Nettle 2011; Nettle and Liddle 2008), have been selected for and maintained.

Conscientiousness

Conscientiousness underlines orderliness, ownership of responsibility, and self-discipline characterized by the facets of competence, order, dutifulness, achievement-striving, self-discipline, and deliberation (Costa and McCrae 1992). Being conscientious allows individuals in the modern context to excel in academic and work performance (Barrick and Mount 1991). Conscientiousness also enables individuals to delay immediate gratification in favor of longer-term benefits. In our ancestral condition, conscientiousness may benefit individuals facing tasks where adherence to repetitive schedules, forethoughts, or procedures is required to achieve the optimal outcome.

Despite the substantial benefits of high conscientiousness, individuals in the upper limits of conscientiousness incur opportunity cost by forgoing opportunistic situations in favor of their

preferred routine. Conscientious individuals, held back by their inhibition and their avoidance of risky sexuality, have less short-term mates (Schmitt 2004). Certain circumstances in our ancestral condition may also be difficult to predict (e.g., unanticipated attack or opportunistic hunting), and failure to seize or act upon these scenarios would have led these individuals to incur fitness costs (i.e., failure to instinctively respond to survival threat or lower food resource; Nettle 2011).

Extraversion

Extraversion refers to the disposition toward social-seeking behavior and is characterized by the facets of warmth, gregariousness, assertiveness, activity, excitement-seeking, and positive emotions (Costa and McCrae 1992). Given extraverts' tendency to seek a variety of social partners, it comes at no surprise that there is a wealth of empirical evidence on the positive association of extraversion with the number of sexual partners (Alvergne et al. 2010; Heaven et al. 2000; Nettle 2005). Extraverts are more likely to engage in polygamy and partner switching, which suggests that there are more opportunities for them to acquire a higher-quality mate than introverts who tend to be more faithful toward a single mate (Nettle 2005). Extroverts are also more likely to initiate social behavior (Buchanan et al. 2005), engage in self-disclosure (Franken et al. 1990), and are more physically active (Kirkcaldy and Furnham 1991). On the flip side, in their quest to seek sexual diversity and physical activities, extraverts are more prone to injuries and accidents (Marusic and Musek 2001; Nettle 2005). They are also more likely to incite competitions and conflicts (Lund et al. 2007) and to be involved in criminal activities (Ellis 1987).

Extraversion is a behavioral strategy that is generally risky in nature; individuals with better physical attributes (e.g., attractiveness, formidability, and immunity function) are more likely to be able to bear the cost of an extraversion strategy going wrong (Nettle 2011). Hence, the optimum fitness values of extraversion are more likely to be observed in healthier individuals, an association that Lukaszewski and Roney (2011) support – attractiveness and strength predicted extraversion. Optimum fitness values of extraversion are also dependent on the ecological context. When social structures are fluid and the habitat is unfamiliar, there are considerable benefits to gain by being sociable. Extraversion would enhance group living that would aid survival and facilitate exploratory behaviors, which would allow one to achieve mastery over the new environment. In ecologies where stable and saturated social hierarchies with known environmental hazards exist, it may be more optimal to exercise caution instead (Nettle 2011). The fact that the long allele of the D4DR gene, which is associated with behaviors related to extraversion (Ebstein 2006), is more prominent among nomadic or migratory human populations (Chen et al. 1999) provides evidence to illustrate how the different local ecology produces variance in extraversion by selecting for varying optimum fitness value of extraversion.

Neuroticism

Neuroticism, the tendency to experience negative emotions, is characterized by its facets of anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability (Costa and McCrae 1992). High neuroticism predisposes individuals to anxiety disorders as neurotic behaviors are manifested as a preventive strategy that keeps one from facing and challenging their irrational fears from ambiguously threatening stimuli (Lommen et al. 2010). In general, high neuroticism is a risk factor for several psychopathologies, such as depression (Claridge and Davis 2001), schizophrenia (Van Os and Jones 2001), post-traumatic stress disorder (van Zelst et al. 2003), and eating disorders (Cervera et al. 2003). Individuals with high levels of neuroticism tend to experience chronic negative affect, as a result of their less adaptive coping strategies (Gunthert et al. 1999), and chronic stress, which subsequently leads to poor physical health, marital instability and dissatisfaction (Kelly and Conley 1987), and sexual dissatisfaction (Fisher and McNulty 2008).

Given the well-detailed literature of the negative outcomes experienced by those high in neuroticism, its prevalence is paradoxical because high neuroticism would have been selected against and yet palpable variation is maintained. According to Nettle (2011), a potential explanation lies in the error management theory (EMT; Haselton and Buss 2000; Haselton and Nettle 2006) wherein the evolved decision-making psychological mechanism is selected to be biased toward the least costly error when the fitness cost of false-positive and false-negative errors was asymmetrical over evolutionary history. When the principle of EMT is applied to explain neuroticism, failure to detect threat in the social (e.g., mate rivalry) or physical environment (e.g., predator) would directly jeopardize reproductive odd and survival. Therefore, it is plausible that in ancestrally high-threat environment, bias toward a false positive (and therefore high neuroticism) is favored, and vice versa (Nettle 2011). High neuroticism in this view serves an adaptive function in threat detection, facilitating vigilance in threatening or competitive environments.

Openness to Experience

Openness, characterized by the cognitive disposition to creativity and aesthetics, comprises the primary facets of fantasy, aesthetics, feelings, actions, ideas, and values (Costa and McCrae 1992). Openness is positively related to artistic creativity (McCrae 1987), and creativity itself is consequential to fitness as it reflects problem-solving ability. High openness to experience also appears to be a protective factor against age-related cognitive decline (Sharp et al. 2010) and memory impairment in multiple sclerosis (Leavitt et al. 2017). Individuals higher in openness are more actively engaged in cognitively enriching activities, combating decline and impairment with stimulation. Yet, high scorers of openness to experience are also more prone to psychosis and typically have an increased level of paranormal beliefs (McCreery and Claridge 2002; Thalbourne 2000; Thalbourne and Delin 1994), which may implicate fitness costs.

The distinction between the pathological and benign outcome of high openness to experience is not well understood; poets and artist have levels of openness as high as a schizophrenic individual but display no negative symptoms such as anhedonia and social withdrawal (Nettle 2006b). Nettle (2011) speculated that psychotic disorders might be the product of the interaction of a particular cognitive style with adverse general developmental conditions. In this case, openness is not so much selected by the different environment, but rather the optimum fitness value of openness may be contingent on other characteristics of the individual.

Conclusion

At present, although personality psychology has produced successful taxonomies capable of predicting several outcomes, the fundamental question of the origin of personality remains an unsettled science. Nettle's proposal outlined how each individual weights the cost and benefit of a personality strategy, which has fluctuating optimum values based on the local ecology of the individual. The cost and benefit trade-off principle is well supported by the proximate observation in both animals and humans (e.g., Boudreau et al. 2001; Friedman et al. 1995; Haselton and Miller 2006; Jensen-Campbell et al. 2002; Koole et al. 2001; Lukaszewski and Roney 2011; Nettle 2005; O'Steen et al. 2002) and is cited as the core conceptual pillar of recent personality models (the condition-dependent, adaptationist model of personality; see Lewis 2015). Nettle's overall argument presents itself as a unitary force that brings together seemingly dichotomous concept that extends to the distinction between the genetic and environmental influence of personality.

In the 2011 reiteration of his proposal, Nettle turns toward an additional element in the discussion of cost and benefit trade-off: developmental plasticity. Nettle's case of developmentally induced individual variation is consistent with Buss and Greiling's (1999) concept of early environmental calibration, which states that individuals with a common evolved psychology can experience different development events that

channel them into adopting different behavioral strategies. Given that it is not probable for a phenotype to be optimally adaptive in all ecological context and that it is costly to achieve complete plasticity in adulthood (Nettle 2011; Nettle et al. 2013), it is likely that individuals adopt behavioral strategies based on their formative experiences. Developmentally induced variations are either evolutionary responsiveness to specific early environmental cues available during ontogeny to forecast future ecological condition which facilitates the development of phenotypes adaptive in the anticipated ecology or a functional feature of an adaptive response to negative somatic state incurred with early life adversity (Nettle et al. 2013).

In essence, Nettle's framework postulates that each differential trait induced developmentally by environmental conditions has a cost and benefit value that differs cross ecology, and experiential factors funnel development toward a more ecologically beneficial level of a quantitative trait. It is this concept of trade-offs that is central to study of evolutionary personality psychology as it implies that trait variance is selected for; otherwise, natural selection would have selected for a specific value of the trait and reduced personality variance into a species-typical trait. The concept of cost and benefit trade-off in personality presents itself as a viable step toward the advancement of evolutionary personality psychology.

Cross-References

- Big Five Model of Personality
- Charles Darwin: Theory of Natural Selection
- Evolutionary Personality Psychology
- Personality
- Personality Development

References

Alvergne, A., Jokela, M., & Lummaa, V. (2010). Personality and reproductive success in a high-fertility human population. *Proceedings of the National Academy of Sciences, 107*(26), 11745–11750. https://doi.org/10.1073/pnas.1001752107.

Barrick, M. R., & Mount, M. K. (1991). The Big Five personality dimensions and job performance: A meta-analysis. *Personnel Psychology, 44*(1), 1–26. https://doi.org/10.1111/j.1744-6570.1991.tb00688.x.

Barrick, M. R., Mount, M. K., & Judge, T. A. (2001). Personality and performance at the beginning of the new millennium: What do we know and where do we go next? *International Journal of Selection and Assessment, 9*(1 & 2), 9–30. https://doi.org/10.1111/1468-2389.00160.

Boudreau, J. W., Boswell, W. R., & Judge, T. A. (2001). Effects of personality on executive career success in the United States and Europe. *Journal of Vocational Behavior, 58*(1), 53–81. https://doi.org/10.1006/jvbe.2000.1755.

Buchanan, T., Johnson, J. A., & Goldberg, L. R. (2005). Implementing a five-factor personality inventory for use on the internet. *European Journal of Psychological Assessment, 21*(2), 115–127. https://doi.org/10.1027/1015-5759.21.2.115.

Buss, D. M. (2009). How can evolutionary psychology successfully explain personality and individual differences? *Perspectives on Psychological Science: A Journal of the Association for Psychological Science, 4*(4), 359–366. https://doi.org/10.1111/j.1745-6924.2009.01138.x.

Buss, D. M., & Greiling, H. (1999). Adaptive individual differences. *Journal of Personality, 67*(2), 209–243. https://doi.org/10.1111/1467-6494.00053.

Campbell, A. (1999). Staying alive: Evolution, culture, and women's intrasexual aggression. *The Behavioral and Brain Sciences, 22*(2), 203–252.

Cervera, S., Lahortiga, F., Angel Martínez-González, M., Gual, P., de Irala-Estévez, J., & Alonso, Y. (2003). Neuroticism and low self-esteem as risk factors for incident eating disorders in a prospective cohort study: Neuroticism. *International Journal of Eating Disorders, 33*(3), 271–280. https://doi.org/10.1002/eat.10147.

Chamorro-Premuzic, T., & Furnham, A. (2003a). Personality traits and academic examination performance. *European Journal of Personality, 17*(3), 237–250. https://doi.org/10.1002/per.473.

Chamorro-Premuzic, T., & Furnham, A. (2003b). Personality predicts academic performance: Evidence from two longitudinal university samples. *Journal of Research in Personality, 37*(4), 319–338. https://doi.org/10.1016/S0092-6566(02)00578-0.

Chapman, B. P., Roberts, B., & Duberstein, P. (2011). Personality and longevity: Knowns, unknowns, and implications for public health and personalized medicine. *Journal of Aging Research, 2011*, 1–24. https://doi.org/10.4061/2011/759170.

Chen, C., Burton, M., Greenberger, E., & Dmitrieva, J. (1999). Population migration and the variation of dopamine D4 receptor (DRD4) allele frequencies around the globe. *Evolution and Human Behavior, 20*(5), 309–324. https://doi.org/10.1016/S1090-5138(99)00015-X.

Claridge, G., & Davis, C. (2001). What's the use of neuroticism? *Personality and Individual Differences, 31*(3), 383–400. https://doi.org/10.1016/S0191-8869(00)00144-6.

Costa, P. T., & McCrae, R. R. (1992). *Revised NEO personality inventory (NEO PI-R) and NEP five-factor inventory (NEO-FFI): Professional manual*. Odessa: Psychological Assessment Resources.

Costa, P. T., Terracciano, A., & McCrae, R. R. (2001). Gender differences in personality traits across cultures: Robust and surprising findings. *Journal of Personality and Social Psychology, 81*(2), 322–331. https://doi.org/10.1037/0022-3514.81.2.322.

Denissen, J. J. A., & Penke, L. (2008). Motivational individual reaction norms underlying the five-factor model of personality: First steps towards a theory-based conceptual framework. *Journal of Research in Personality, 42*(5), 1285–1302. https://doi.org/10.1016/j.jrp.2008.04.002.

Ebstein, R. P. (2006). The molecular genetic architecture of human personality: Beyond self-report questionnaires. *Molecular Psychiatry, 11*(5), 427–445. https://doi.org/10.1038/sj.mp.4001814.

Ellis, L. (1987). Relationships of criminality and psychopathy with eight other apparent behavioral manifestations of sub-optimal arousal. *Personality and Individual Differences, 8*(6), 905–925. https://doi.org/10.1016/0191-8869(87)90142-5.

Eyre-Walker, A., & Keightley, P. D. (1999). High genomic deleterious mutation rates in hominids. *Nature, 397*(6717), 344–347. https://doi.org/10.1038/16915.

Figueredo, A. J., Sefcek, J. A., & Jones, D. N. (2006). The ideal romantic partner personality. *Personality and Individual Differences, 41*(3), 431–441. https://doi.org/10.1016/j.paid.2006.02.004.

Fisher, R. A. (1930). *The genetical theory of natural selection*. Oxford, London: Clarendon Press. https://doi.org/10.5962/bhl.title.27468.

Fisher, T. D., & McNulty, J. K. (2008). Neuroticism and marital satisfaction: The mediating role played by the sexual relationship. *Journal of Family Psychology, 22*(1), 112–122. https://doi.org/10.1037/0893-3200.22.1.112.

Franken, R. E., Gibson, K. J., & Mohan, P. (1990). Sensation seeking and disclosure to close and casual friends. *Personality and Individual Differences, 11*(8), 829–832. https://doi.org/10.1016/0191-8869(90)90192-T.

Friedman, H. S., Tucker, J. S., Schwartz, J. E., Martin, L. R., Tomlinson-Keasey, C., Wingard, D. L., & Criqui, M. H. (1995). Childhood conscientiousness and longevity: Health behaviors and cause of death. *Journal of Personality and Social Psychology, 68*(4), 696–703. https://doi.org/10.1037/0022-3514.68.4.696.

Gunthert, K. C., Cohen, L. H., & Armeli, S. (1999). The role of neuroticism in daily stress and coping. *Journal of Personality and Social Psychology, 77*(5), 1087–1100.

Haselton, M. G., & Buss, D. M. (2000). Error management theory: A new perspective on biases in cross-sex mind reading. *Journal of Personality and Social Psychology, 78*(1), 81–91.

Haselton, M. G., & Miller, G. F. (2006). Women's fertility across the cycle increases the short-term attractiveness of creative intelligence. *Human Nature, 17*(1), 50–73. https://doi.org/10.1007/s12110-006-1020-0.

Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: An integrative evolutionary model of cognitive biases. *Personality and Social Psychology Review, 10*(1), 47–66. https://doi.org/10.1207/s15327957pspr1001_3.

Heaven, P. C. L., Fitzpatrick, J., Craig, F. L., Kelly, P., & Sebar, G. (2000). Five personality factors and sex: Preliminary findings. *Personality and Individual Differences, 28*(6), 1133–1141. https://doi.org/10.1016/S0191-8869(99)00163-4.

Huver, R. M. E., Otten, R., de Vries, H., & Engels, R. C. M. E. (2010). Personality and parenting style in parents of adolescents. *Journal of Adolescence, 33*(3), 395–402. https://doi.org/10.1016/j.adolescence.2009.07.012.

Jensen-Campbell, L. A., Adams, R., Perry, D. G., Workman, K. A., Furdella, J. Q., & Egan, S. K. (2002). Agreeableness, extraversion, and peer relations in early adolescence: Winning friends and deflecting aggression. *Journal of Research in Personality, 36*(3), 224–251. https://doi.org/10.1006/jrpe.2002.2348.

Judge, T. A., & Ilies, R. (2002). Relationship of personality to performance motivation: A meta-analytic review. *Journal of Applied Psychology, 87*(4), 797–807. https://doi.org/10.1037/0021-9010.87.4.797.

Judge, T. A., Livingston, B. A., & Hurst, C. (2012). Do nice guys – And gals – Really finish last? The joint effects of sex and agreeableness on income. *Journal of Personality and Social Psychology, 102*(2), 390–407. https://doi.org/10.1037/a0026021.

Keller, M. C., & Miller, G. (2006). Resolving the paradox of common, harmful, heritable mental disorders: Which evolutionary genetic models work best? *Behavioral and Brain Sciences, 29*(4), 385–404. https://doi.org/10.1017/S0140525X06009095.

Kelly, E. L., & Conley, J. J. (1987). Personality and compatibility: A prospective analysis of marital stability and marital satisfaction. *Journal of Personality and Social Psychology, 52*(1), 27–40. https://doi.org/10.1037/0022-3514.52.1.27.

Kimura, M. (1983). *The neutral theory of molecular evolution*. New York: Cambridge University Press.

Kirkcaldy, B., & Furnham, A. (1991). Extraversion, neuroticism, psychoticism and recreational choice. *Personality and Individual Differences, 12*(7), 737–745. https://doi.org/10.1016/0191-8869(91)90229-5.

Koole, S. L., Jager, W., van den Berg, A. E., Vlek, C. A. J., & Hofstee, W. K. B. (2001). On the social nature of personality: Effects of extraversion, agreeableness, and feedback about collective resource use on cooperation in a resource dilemma. *Personality and Social Psychology Bulletin, 27*(3), 289–301. https://doi.org/10.1177/0146167201273003.

Lande, R. (1975). The maintenance of genetic variability by mutation in a polygenic character with linked loci. *Genetical Research, 26*(3), 221–235. https://doi.org/10.1017/S0016672300016037.

Leavitt, V. M., Buyukturkoglu, K., Inglese, M., & Sumowski, J. F. (2017). Protective personality traits: High openness and low neuroticism linked to better memory in multiple sclerosis. *Multiple Sclerosis Journal, 23*(13), 1786–1790. https://doi.org/10.1177/1352458516685417.

Lewis, D. M. G. (2015). Evolved individual differences: Advancing a condition-dependent model of personality. *Personality and Individual Differences, 84*, 63–72. https://doi.org/10.1016/j.paid.2014.10.013.

Lommen, M. J. J., Engelhard, I. M., & van den Hout, M. A. (2010). Neuroticism and avoidance of ambiguous stimuli: Better safe than sorry? *Personality and Individual Differences, 49*(8), 1001–1006. https://doi.org/10.1016/j.paid.2010.08.012.

Lukaszewski, A. W., & Roney, J. R. (2011). The origins of extraversion: Joint effects of facultative calibration and genetic polymorphism. *Personality and Social Psychology Bulletin, 37*(3), 409–421. https://doi.org/10.1177/0146167210397209.

Lund, O. C. H., Tamnes, C. K., Moestue, C., Buss, D. M., & Vollrath, M. (2007). Tactics of hierarchy negotiation. *Journal of Research in Personality, 41*(1), 25–44. https://doi.org/10.1016/j.jrp.2006.01.002.

MacDonald, K. (1995). Evolution, the five-factor model, and levels of personality. *Journal of Personality, 63*(3), 525–567. https://doi.org/10.1111/j.1467-6494.1995.tb00505.x.

Marusic, M., & Musek, M. (2001). Injury proneness and personality. *Nordic Journal of Psychiatry, 55*(3), 157–161. https://doi.org/10.1080/08039480152036029.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*(6), 1258–1265. https://doi.org/10.1037/0022-3514.52.6.1258.

McCreery, C., & Claridge, G. (2002). Healthy schizotypy. *Personality and Individual Differences, 32*(1), 141–154. https://doi.org/10.1016/S0191-8869(01)00013-7.

Nettle, D. (2005). An evolutionary approach to the extraversion continuum. *Evolution and Human Behavior, 26*(4), 363–373. https://doi.org/10.1016/j.evolhumbehav.2004.12.004.

Nettle, D. (2006a). The evolution of personality variation in humans and other animals. *American Psychologist, 61*(6), 622–631. https://doi.org/10.1037/0003-066X.61.6.622.

Nettle, D. (2006b). Schizotypy and mental health amongst poets, visual artists, and mathematicians. *Journal of Research in Personality, 40*(6), 876–890. https://doi.org/10.1016/j.jrp.2005.09.004.

Nettle, D. (2007). Empathizing and systemizing: What are they, and what do they contribute to our understanding of psychological sex differences? *British Journal of Psychology, 98*(2), 237–255. https://doi.org/10.1348/000712606X117612.

Nettle, D. (2011). Evolutionary perspectives on the five-factor model of personality. In D. M. Buss & P. H. Hawley (Eds.), *The evolution of personality and individual differences* (pp. 5–28). New York: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195372 090.003.0001.

Nettle, D., & Liddle, B. (2008). Agreeableness is related to social-cognitive, but not social-perceptual, theory of mind. *European Journal of Personality, 22*(4), 323–335. https://doi.org/10.1002/per.672.

Nettle, D., Frankenhuis, W. E., & Rickard, I. J. (2013). The evolution of predictive adaptive responses in human life history. *Proceedings of the Royal Society B: Biological Sciences, 280*(1766), 20131343. https://doi.org/10.1098/rspb.2013.1343.

O'Steen, S., Cullum, A. J., & Bennett, A. F. (2002). Rapid evolution of escape ability in Trinidadian guppies (*Poecilia reticulata*). *Evolution, 56*(4), 776–784. https://doi.org/10.1111/j.0014-3820.2002.tb01388.x.

Ozer, D. J., & Benet-Martínez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology, 57*(1), 401–421. https://doi.org/10.1146/annurev.psych.57.102904.190127.

Penke, L., Denissen, J. J. A., & Miller, G. F. (2007). The evolutionary genetics of personality. *European Journal of Personality, 21*(5), 549–587. https://doi.org/10.1002/per.629.

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin, 135*(2), 322–338. https://doi.org/10.1037/a0014996.

Poropat, A. E. (2014). Other-rated personality and academic performance: Evidence and implications. *Learning and Individual Differences, 34*, 24–32. https://doi.org/10.1016/j.lindif.2014.05.013.

Ridley, M. (2000). *Mendel's demon: Gene justice and the complexity of life*. London: Weidenfeld & Nicolson.

Salgado, J. F. (1998). Big Five personality dimensions and job performance in Army and civil occupations: A European perspective. *Human Performance, 11*(2–3), 271–288. https://doi.org/10.1080/08959285.1998.9668034.

Schmitt, D. P. (2004). The Big Five related to risky sexual behaviour across 10 world regions: Differential personality associations of sexual promiscuity and relationship infidelity. *European Journal of Personality, 18*(4), 301–319. https://doi.org/10.1002/per.520.

Schmitt, N. (2014). Personality and cognitive ability as predictors of effective performance at work. *Annual Review of Organizational Psychology and Organizational Behavior, 1*(1), 45–65. https://doi.org/10.1146/annurev-orgpsych-031413-091255.

Schmitt, D. P., Realo, A., Voracek, M., & Allik, J. (2008). Why can't a man be more like a woman? Sex differences in Big Five personality traits across 55 cultures. *Journal of Personality and Social Psychology, 94*(1), 168–182. https://doi.org/10.1037/0022-3514.94.1.168.

Sharp, E. S., Reynolds, C. A., Pedersen, N. L., & Gatz, M. (2010). Cognitive engagement and cognitive aging: Is openness protective? *Psychology and Aging, 25*(1), 60–73. https://doi.org/10.1037/a0018748.

Thalbourne, M. A. (2000). Transliminality and creativity. *The Journal of Creative Behavior, 34*(3), 193–202. https://doi.org/10.1002/j.2162-6057.2000.tb01211.x.

Thalbourne, M. A., & Delin, P. S. (1994). A common thread underlying belief in the paranormal, creative personality, mystical experience and psychopathology. *Journal of Parapsychology, 58*(1), 3–38.

Tooby, J., & Cosmides, L. (1990). On the universality of human nature and the uniqueness of the individual: The role of genetics and adaptation. *Journal of Personality, 58*(1), 17–67.

Van Os, J., & Jones, P. B. (2001). Neuroticism as a risk factor for schizophrenia. *Psychological Medicine, 31*(6), 1129–1134. https://doi.org/10.1017/S0033291701004044.

van Zelst, W. H., de Beurs, E., Beekman, A. T. F., Deeg, D. J. H., & van Dyck, R. (2003). Prevalence and risk factors of posttraumatic stress disorder in older adults. *Psychotherapy and Psychosomatics, 72*(6), 333–342. https://doi.org/10.1159/000073030.

Verweij, K. J. H., Yang, J., Lahti, J., Veijola, J., Hintsanen, M., Pulkki-Råback, L., Heinonen, K., Pouta, A., Pesonen, A.-K., Widen, E., Taanila, A., Isohanni, M., Miettunen, J., Palotie, A., Penke, L., Service, S. K., Heath, A. C., Montgomery, G. W., Raitakari, O., … Zietsch, B. P. (2012). Maintenance of genetic variation in human personality: Testing evolutionary models by estimating heritability due to common causal variants and investigating the effect of distant inbreeding. *Evolution, 66*(10), 3238–3251. https://doi.org/10.1111/j.1558-5646.2012.01679.x.

Zhang, X.-S., & Hill, W. G. (2005). Genetic variability under mutation selection balance. *Trends in Ecology & Evolution, 20*(9), 468–470. https://doi.org/10.1016/j.tree.2005.06.010.