CHAPTER 17

Raymond B. Cattell: Bequeathing a Dual Inheritance to Life History Theory

1 The Half Has not Been Told

Raymond Bernard Cattell was born on the 20th of March 1905, amidst the waning inertia of Victorian culture and the waxing ethos of postmodern relativism. Raymond Cattell is featured alongside Gordon Allport and Hans Eysenck in introductory personality psychology textbooks as they provide historical background on the *lexical*[1] hypothesis from which the *five-factor model*[2] derives (Ryckman 2000). Cattell is equally likely to be identified for articulating the distinction between *crystallized intelligence*, defined as accumulated and stored knowledge, from *fluid intelligence*, understood as raw reasoning ability (Horn and Cattell 1966a). Like a South American temple lost in all but peak amidst the overgrowth of the surrounding jungle, one finds these two salient productions sitting on a broad base of intellectual output. For in truth, Cattell was prolific; possibly more prolific than any other social scientist featured in the present volume, having produced treatises, papers and books on leadership (1951), ethics (1948a), aging (Horn and Cattell 1966b), anxiety (Cattell and Scheier 1958), creativity (Drevdahl and Cattell 1958; Cattell and Drevdahl 1955), motivation (1966a), music (Cattell and Saunders 1954), biometrics (1965), temperament (1934), interest (1935), attitude (1950a), humor (Cattell and Luborsky 1947), status (1942), perseveration (1946), culture (1949), sex differences (1948b), syntality[3] (1948c, 1950b), heritability (1963), and complementarity (Cattell and Nesselroade 1967). Cattell even attempted to construct his own system

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of "scientific" religion in the form of *Beyondism*,[4] the purpose of which was to safeguard civilizations from existential "dysgenic threat" (Cattell 1972, 1987). Barring all exaggeration and overstatement, these are to name but a few of his manifold contributions.

Analytical rigor was brought to bear on these many topics. Perhaps extending from his research assistantship with Charles Spearman, who in turn was influenced by Karl Pearson and Sir Francis Galton[5] (Ryckman 2000), Cattell's career was empirically and statistically driven, exampled by his publications on orthogonality (Cattell and Tsujioka 1964), validity and reliability (1964), methodology (1988), ipsatization[6] (Horn and Cattell 1965), refraction factors (1961), the Cattellian data box (1966b) projective and personality assessment (1944), and, of course, factor analysis (1952, 1958).[7] However, one might be rewarded by the view of these individual stones of achievement, clearing the undergrowth more importantly reveals how all such works figure into the larger temple that Cattell built to his personal philosophy of science. Within that larger philosophical structure, Cattell's writings on intelligence and personality assume the relevance, without which they might become museum curios, picked up, admired, and replaced in reviewing the history of psychology.

2 Cattellian Conceptions of Intelligence and Personality

From an early phase of his career, Cattell is best known for his two-factor model of human intelligence (co-developed with John Horn), which posits that general intelligence, or *g*, can be delineated into two orthogonal domains—those of *fluid* and *crystallized* ability (following convention herein abbreviated to *gf* and *gc*, respectively). Fluid ability, or *gf*, enables the solving of abstract problems that are *culture reduced*. Culture reduced problems can be deciphered via the application of native ability, decontextualized with respect to culture, such that no cultural-idiosyncratic knowledge is needed. An example of a *gf* measure is the *Raven's Progressive Matrices* test, wherein inductive reasoning supplies the rules necessary for identifying the missing piece in a wallpaper-like mosaic from among various patterns and sequences. The ability to infer and utilize rules in solving these sorts of problems purportedly means that all individuals, irrespective of culture, can solve

them via the application of universal abstract reasoning mechanisms. By contrast, crystallized intelligence encompasses the ability to acquire and utilize knowledge in solving problems. This capacity is considered highly culturally relative, with different cultural systems imposing constraints on the sorts of knowledge that can be acquired. Relative to fluid intelligence, crystallized intelligence is theoretically more sensitive to exposure, education, and enrichment, even as natural ability will greatly influence the beneficial effects thereof.

Cattell began his career with a concentration in intelligence research (Tucker 2009) before being disoriented and derailed by detecting the *Flynn effect*, a point to which we later return.[8] Erroneously believing his ideas invalidated (Woodley of Menie et al. 2017c), Cattell turned personality researcher. In that capacity, Cattell was among the first to identify a five-factor structure among lexical personality adjectives and was also the first (although this is evidently very little known) to have identified a hierarchical (i.e., co-existing with lower-order factors) *Big Two* among the items comprising his personality inventory (Cattell 1973). The hierarchical Big Two were independently (re)discovered in the 1990s, firstly by Jerry Wiggins (1991) with his broad personological dimensions of *Agency* vs. *Passivity* and *Communion* vs. *Dissociation*. Wiggins (1968) was in fact the first to coin the term "Big Two" in relation to the early work of Hans Eysenck, who initially identified Neuroticism and Extraversion as the major dimensions of personality, before adding Psychoticism to the model, yielding the "Big Three" model for which Eysenck is most famous. John Digman (1997) identified two super factors, *Alpha* and *Beta*, lurking behind the *Big Five* advanced by Costa and McRae: *Openness to Experience*, *Conscientiousness*, *Extraversion*, *Agreeableness*, and *Neuroticism*. These broadly correspond to the conceptual coordinate system embodied in Wiggins' Big Two and were in turn subsequently renamed *Stability* and *Plasticity* by Colin DeYoung and colleagues (2002). Cattell's early advocacy for two factors is often overshadowed by his delineating these into sixteen, but at the same time, he continued to understand these sixteen as grounded within a smaller number of overarching factors. In the classic *lumping* and *splitting* debate in personality psychology, Cattell putatively comes down on the splitting side (Cattell 1943), but at the same time is sympathetic to lumping (Cattell 1945).

3 Embedding Cattellian Contributions Within Life History Theory

Cattell's contributions to intelligence research and personality theory are both advantageously treated in life history perspective, and so they will be, each in their turn. First, with respect to intelligence, Cattell (1950c) was himself among the first to notice the Flynn effect in his efforts to detect *dysgenic* effects on IQ performance, which, 14 years previously (Cattell 1936), he had predicted should be reducing IQ by between 1 and 1.5 points per decade. Disheartened by this seeming paradox, which would subsequently be termed *Cattell's Paradox* (Higgins et al. 1962), Cattell lost interest in the issue of dysgenics for many decades. Despite this, *Cattell's Paradox*, which has been solved via the *co-occurrence model* (Woodley of Menie et al. 2017b), coupled with Cattell's initial research on the Flynn effect, has led to novel thinking—thinking which ties the co-occurrence model in particular to life history via *Investment Theory* (Cattell 1957). Cattell's (1957) investment theory is based on the idea that there exists a relay between *gf* and *gc* in development, whereby *gf* regulates or gates the acquisition of knowledge or investments into *gc*. Cattell perceived an individual's level of *g* (i.e., the correlation between *gf* and *gc*) as being a consequence of this interplay in development between these two factors (Horn and Cattell 1966b). The investment model has been used to account for both the phenomenon of *ability tilts* (i.e., the tendency for one ability grouping to be overdeveloped relative to another, net of *g*) and also *differentiation-integration effects* (i.e., where abilities become more loosely or even more strongly correlated among themselves as a function of level of *g*, as is the case with certain personality traits and age) (Coyle 2016). In other words, general intelligence is not simply parsed into fluid and crystallized intelligences; rather, fluid intelligence constrains the scope and directs the content on which crystallized intellectual investments are made.[9]

Distal reformulation of investment within the rubric of life history theory was achieved using the *Cognitive Differentiation-Integration Effort* (CD-IE) model (Woodley 2011). This CD-IE model posits that, despite not having much of a main effect on *g*, life history speed should nevertheless influence the strength of the correlations among abilities. For instance, within the CD-IE model, the *sLH*-selected show a more thoroughly differentiated cognitive profile marked by specialized abilities; in contrast, the *fLH*-selected show a more uniform cognitive profile marked by general abilities. The degree of ability differentiation

has implications for adaptation. Specifically, the differentiated cognitive profiles common to highly *sLH*-selected individuals allow adaptation to highly specialized and stable niches within highly complex and stable environments. In contrast, the uniform cognitive profiles common to highly *fLH*-selected individuals facilitate adaptation to unpredictable environments. Thus, the *sLH*-selected are constrained specialists while the *fLH*-selected are obligate generalists. At the risk of belaboring the point, we state again, while *fLH*-selected generalists can contingently switch between unstable environment niches, the *sLH*-selected are ecological specialists, apt to divide labor within dense, stable environments; environments that on average pay returns to hard-won and long-deferred specialized somatic and educational attainments. There is no question of inferiority or superiority, only a matter of differential adaptation. This is part and parcel of the trade-offs integral to life history theory. To illustrate the point, we recall a lesson imparted by John Landers (2003) as he traduces the hard choices and trade-offs of the husbandman wherein maximizing yields was always pitted against mitigating risk. Sowing only a fickle, high-yield crop maximizes caloric returns per hectare at the cost of increasing the risk of crop failure and creating dependency on trade, whereas sowing a range of resilient, lower-yield crops fosters self-sufficiency and diversifies risk at the cost of reducing caloric returns per hectare. Accordingly, the differentiated *sLH*-selected cognitive profile renders the individual like a highly specialized part valued for its function in a complex machine, while the *fLH*-selected cognitive profile renders the individual a rudimentary machine unto itself. Embedding Cattell's investment model within life history theory, with its emphasis on trade-offs between specialized plasticity and generalized preparedness, furthermore advanced our causal understanding of the Flynn effect, which is itself a consequence of increasing levels of cognitive specialization associated in time with societal and demographic shifts betokening greater *sLH*-selection (Woodley 2012). What is more, in thus enveloping Cattell within the folds of life history theory, we better comprehend atoms of individual intellect as they interface with cultural systems.

We now turn from intelligence to personality. Amidst a landscape riddled with trait theorists converging toward a consensus, Cattell was at one and the same time sympathetic to more extreme lumping and splitting. In this way, Cattell stands apart for intelligently chaining lower-order to higher-order factors and for the implicit evolutionary savvy with which those lower-order factors were articulated. This is true for each level of hierarchical organization. Whether looking to his two

meta-traits, his five global factors, or his sixteen primary factors, we find Cattell intuitively *carving nature at its joints*. First, the lumping sympathies that impelled Cattell's two-factor solution have relevance to life history theory's *general factor of personality* (GFP), whereby all personality traits are loosely intercorrelated under the influence of relative life history speed (Figueredo et al. 2004; Musek 2017). Proving similarly applicable to life history theory are Cattell's five global factors.[10] Take for instance, the global factor of *Extraversion vs. Introversion,* connoting a general tendency for people to seek or to avoid affiliation with others. Especially when viewed alongside attachment theory (Bowlby 1969), the Extraversion vs. Introversion factor parses between fast and slow life histories as they, respectively, invest in exploitation or affiliation, short-term mutualisms or long-term bonds, mating effort or parental effort. Finally, in the capacity of splitter, Cattell articulated sixteen lower-order personality traits pertinent to the strategies employed at either end of the life history continuum. For instance, *Rule-Conscientiousness*[11] predicts moral, staid, and dutiful behavior on the high end, thus overlapping with *sLH*-selected behavior, while predicting expedience, libertinage, and self-indulgence on the low end, thus overlapping with *fLH*-selected behavior. Extremes foster antagonism. Highly rule-conscientious *sLH*-selected elements will impose order, laws, norms, precedents, and consequences to strategically interfere with *fLH*-selected elements and the stochasticity upon which they thrive (Woodley of Menie et al. 2017a).

4 Conclusions

Cattell gave little consideration to the distal antecedents underpinning variation in personality and intelligence. In other words, he expended little in the way of time or thought on questions of ultimate causation. In spite of this, the frameworks that he developed for understanding the structure and proximate origins of individual differences within the spheres of intelligence and personality readily map on to a life history evolutionary framework. With respect to Cattell's intelligence research, the investment model, when recast in terms of life history theory, yields insights into the evolutionary factors influencing the Flynn effect,[12] which appears to plausibly result from the increasing allocation of cognitive differentiation effort into the cultivation of ever more specialized abilities and skills, which, in turn, extends from life history slowing in both phylogenetic and ontogenetic time. Following from predictions of the CD-IE model,

genetic correlations between *g* and indicators of life history speed are small to zero in magnitude (Loehlin et al. 2015; Woodley of Menie and Madison 2015). Likewise following from predictions of the CD-IE model, trade-offs have been empirically validated, via studies of both student and national samples (Woodley et al. 2013). Further still, and more broadly, the trade-offs between specialized vs. generalized *behavioral* investments have also been demonstrated and have consequently been chained to environmental stability and predictability (Figueredo et al. 2013, 2015).

With respect to Cattell's personality research, his identification of higher-order factors among personality traits is consistent with theoretical predictions that life history variation should undergird covariation among such traits. This is so, up to and including the level of the superordinate GFP, which has been identified among Cattell's 16 personality factors, and has been found to correlate with other GFPs extracted from related personality inventories, indicating a fundamental homology among these various approaches to predicting and structuring personality variation. Indeed, several authors have found a GFP among Cattell's personality factors (Booth 2011; Loehlin 2012; Loehlin and Horn 2012).[13] Even while there is no evidence of his having heard of life history theory, Cattell's influence on the development of life history theoretic models of personality and cognition can therefore rightfully be considered substantive.

Notes

1. The lexical model uses language to search for personality. Instead of unrestrained theory, the lexical model looks to factor analytic surveys of adjectives that have been applied to human individual differences in order to specify personality traits.
2. The *Five-Factor Model* refers to factor analytic techniques producing five factors from a pool of adjectives, factors which are descriptive of human personality along the following dimensions: Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism.
3. Syntality refers to the personality trait, not of a person, but of a group.
4. Under the banner of *Beyondism*, Cattell gave thought as to how to create ecologically sustainable regimes of eugenic selection.
5. Edward Thorndike and William McDougall were among his later preceptors (Ryckman 2000). From McDougall, he gained a biological bent that worked its way into his personality framework.
6. Ipsatization refers to the process of subtracting an individual's mean rating across items from an item.

7. A student of his, Richard Gorsuch, would go on to become one of the foremost experts in factor analysis, advancing and refining many of Cattell's innovations (such as coarse-grained factor analysis) in the process (Gorsuch 1983).
8. The distinction between *gc* and *gf* originally made by Cattell and Horn has become a cornerstone of modern structural psychometrics. John Carroll (1993) demonstrated that these were the two most stable Stratum II factors that could be extracted from among a large array of batteries (Carroll's model also accommodated six additional Stratum II factors, along with numerous Stratum I factors, subordinate to these in his hierarchical model of *g*). Indeed, the model proposed by Carroll (1993) is termed the Cattell–Horn–Carroll (CHC) model. While certainly useful, not all of the original precepts of this model have remained intact. Cattell believed *gf* to be more heritable and cross-culturally stable than *gc* (Cattell 1980), which has been challenged recently with the identification of a *Heritability Paradox*—the apparent incongruity between the observation that it is the *least* culture-fair tests that are the most heritable (such as vocabulary) (Kan et al. 2013). This is further compounded with the *Mental Retardation Paradox*—the observation that the most culture fair and *gf* loaded ability measures (such as the Ravens) are also the most sensitive to the Flynn effect (the secular increase of on average 3 IQ points per decade), which means that nineteenth-century populations would have had IQs of between 50 and 70 compared with modern ones on these tests—yet clearly did not exhibit signs of mass intellectual disability (Flynn 2007). The first paradox can be solved by simply thinking about the effect of *g* on the environment in terms of *active gene environment correlations*. Individuals with high *g* seek out and expose themselves to environments (such as education) which facilitate their acquisition of knowledge. Thus, knowledge functions as part of an individual's extended phenotype, serving as a highly *ecologically valid* indicator of their underlying *g*. The second paradox can be solved via the observation that so-called culture-fair tests often rely on the detection of simple rules which are meant to generalize across populations, but can in fact be learned, either actively, via exposure to tests, or passively, via exposure to other media in which rule detection and following feature. The rule dependence of an IQ test positively correlates with its sensitivity to the Flynn effect (Armstrong and Woodley 2014). Furthermore, being "pre-equipped" with the expectation that rules need to be found and used in solving IQ tests alters the parameters that these tests measure over time—causing them to drift away from being strong measures of *g* (this being the failure of measurement invariance that is typical when the performance of cohorts from different time periods is compared on the same test; Fox

and Mitchum 2013; Wicherts et al. 2004). Very highly heritable and also *g* loaded *gc* measures, such as vocabulary knowledge, show the opposite pattern to the Flynn effect over time—performance (measured in terms of the *typical* utilization frequencies of high difficulty vocabulary across written texts sampled in Google Ngram Viewer) has been declining over time, since the 1850s (Woodley of Menie et al. 2015, 2017b). This pattern is consistent with the expectation that dysgenics (i.e., selection favoring the fitness of highly individually [as opposed to group] selected, and low *g* individuals) is causing *g* to decline over time, whereas the Flynn effect is restricted to specialized skills and narrow abilities, which can be improved via exposure to enriched environments and exhibit *discrete* heritabilities that are far lower than that of *g* (Carroll 1993). Hence, dysgenic declines in *g co-occur* with respect to gains in specialized skills and abilities, meaning that far from being intellectually disabled, Victorian populations likely had somewhat higher means of *g* than modern populations, but would have lacked any familiarity with rule-based tests, thus would have performed poorly on these relative to moderns (e.g., despite having on average richer vocabularies and faster reaction times).

9. The application of the investment model to understanding factors influencing the growth of abilities yields *proximate* explanations for these phenomena; that is, explanations that pertain to the action of factors acting on phenotypes arising from the environment in ontogenetic (developmental) time, such as education. The idea that humans invest effort into the acquisition of somatic capital (i.e., specialized knowledge and skills) has significant implications for life history models of human intelligence, which, however, historically have been unable to account for the extremely small magnitude observed bivariate correlation between *g* and behavioral life history inventories, such as the ALHB and Mini-K (the values of *Rho* range from .023 to .06 in meta-analyses; Figueredo et al. 2014; Woodley 2011), despite much stronger individual differences level positive correlations having initially been predicted on the basis that factors such as brain volume, which should capture somatic effort allocation, are positively associated with *g* (Rushton 1985, 2004).
10. Cattell's five global factors are as follows: Introversion/Extraversion; Low Anxiety/High Anxiety; Receptivity/Tough-Mindedness; Accommodation/Independence; and Lack of Restraint/Self-Control.
11. Factor *G* in the 16PF model.
12. In addition, this solved the paradox of a lack of a substantial main effect of *K* on *g* at the individual differences level (which was contrary to what had been predicted), via the development of the CD-IE model.
13. This has been found to correlate modestly with GFPs extracted from other personality batteries (MMPI $r = .49$; OutQ $r = .31$; Loehlin and Horn 2012, p. 660).

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