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Global behavioral variation: A test of differential-*K*

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ABSTRACT

Despite Rushton's path-breaking work into evolutionary forces affecting life history traits, not many attempts at operationalizing the differential-*K* spectrum at the level of countries or racial groups have been made so far. We report the construction of a "national *K*" factor from country-level behavioral variables. This *K* factor is closely related to country-level intelligence ("*g*"), operationalized by a composite score of IQ and scholastic achievement. We further demonstrate relationships of both *g* and *K* with measures of current environment and hypothesized evolutionary antecedents. Whereas *K* is predicted most powerfully by intelligence, log-transformed GDP (lgGDP) and skin reflectance, *g* is predicted by skin reflectance, lgGDP, cranial capacity, and a measure of evolutionary novelty.

1. Introduction

Among J.P. Rushton's contributions to psychology, his application of *r*-*K* theory to individual and group differences has been one of the most consequential and, in its application to race differences, the most controversial. The reason for the continuing strength of this theory can be summarized in one word: parsimony. Using a single theoretical construct, Rushton has provided an explanation for the co-occurrence of many seemingly unrelated traits both at the individual and the racial group levels.

r-*K* theory had been introduced into biology by MacArthur and Wilson (1967) to describe species differences in the allocation of resources to somatic effort, mating effort, and parenting effort. *K* stands for the carrying capacity of the environment, and *r* for the population's maximal growth rate. *K*-selected traits are thought to be favored by natural selection when the environment is stable and the population is close to the carrying capacity of the ecosystem. They include slow maturation, long life span, production of few offspring, and intensive parental care. The opposite, or *r*-selected strategy, is characterized by fast maturation, short life span, early and prolific reproduction, with little or no parental care. It was Rushton who first applied *r*-*K* theory to humans, calling it *differential-K*, owing to the fact that whilst all humans are relatively *K*-selected, some individuals and groups are more *K*-selected than others. He and his coworkers described several psychological traits as *K*-selected, including stable emotional attachments that lead to marital stability, the involvement of fathers in child rearing, future-orientation, and the propensity for long-term planning. Early sexual maturity, early reproduction, and a high incidence of externalizing disorders including antisocial personality are considered elements of an *r*-selected strategy (Bogaert & Rushton, 1989; Rushton, 1985, 2000). Many of the predictions made by Rushton and co-workers have been confirmed in subsequent work by A.J. Figueredo and colleagues, who have found significant common *genetic* variance amongst measures of personality, subjective wellbeing and a large array of *r*-*K* related behaviors (e.g. Figueredo & Rushton, 2009; Figueredo, Vásquez, Brumbach, & Schneider, 2004, 2007).

Importantly, differential-*K* (*r*-*K* applied to group differences) and life history theory (*r*-*K* applied to individual differences) are developmental as well as evolutionary theories of human behavior. Unstable environments are expected to favor fast (low-*K*) life history traits such as early puberty and a propensity for social deviance, and being raised in a stable family is expected to favor slow life history (high-*K*) traits (Ellis, Figueredo, Brumbach, & Schlomer, 2009).

Rushton insisted on the evolutionary-genetic origin of individual and especially group differences in differential-*K* related traits. Several objections have been raised against his theory. One is that each of the traits can be explained by environmental conditions, without the need to appeal to evolution (e.g. Lynn, 1989; Rushton, 1989). Slower life history traits can, on first sight, be identified as the typical traits of 'socially privileged' middle class people and prosperous countries, with faster life history traits being typical for low-SES people and for deprived societies and communities (Figueredo et al., 2007). This is consistent with the idea that life history theory comes in "weak" and "strong" forms (Figueredo et al., 2007). The weak form assumes that individual life history traits are not closely related mechanistically. For example early age at puberty and the tendency to engage in antisocial behaviors are influenced by different genes and vary independently at the individual level. However, they are genetically correlated at the

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population level because those populations that have experienced unstable environments in the past have been selected for both traits. Correlations between these traits at the individual level would result from developmental plasticity or "social privilege", with minimal genetic covariance. The strong form postulates the existence of regulatory genes and physiological mechanisms that coordinate the development of multiple related traits. This version of the theory predicts substantial genetic covariance at the individual-differences level, and is supported by twin studies (e.g. Figueredo & Rushton, 2009; Figueredo et al., 2004, 2007).

A second salient critique is Rushton's use of a crude tripartite system (Caucasoid, Mongoloid, Negroid) that is widely perceived as unsatisfactory for the classification of human population structure (e.g. Anderson, 1991). This critique is potentially obviated by using either more fine-grained racial taxonomies (e.g. Rushton, 2010), or by using continuously variable indicators of recent evolutionary history, such as skin reflectance as a measure of the extent to which the ancestors of an extant population have been exposed to non-tropical (low sunlight) climates with the need for heavy clothing. Relatively recent conditions, such as the presence of agriculture, should be considered because there is evidence for substantial changes in allele frequencies on this time scale (Cochran & Harpending, 2009; Meisenberg, 2008).

Another critique is that the concept of life history theory in humans is redundant because variations in life history traits are explained more parsimoniously by varying levels of intelligence. For example, at the individual level the propensity of marrying, which is a "classical" high-*K* trait in humans, is favored by high intelligence in societies as diverse as the United States (all races, see Meisenberg & Kaul, 2010) and the Caribbean (Meisenberg, Lawless, Lambert, & Newton, 2006). Rushton met this objection by including high intelligence among slow life history traits, along with rule following and sexual restraint. Whilst it could be argued that a slow life history requires foresight and long-term planning, it is not clear why intelligence should be less important for mate seeking than for parenting (Woodley, 2011a).

However, diverse measures of *K* (including measures of ecological preferences and two *K*-batteries including the Arizona Life History Battery and the 'Trifecta') do not usually correlate with *g* at the individual differences scale. A recent meta-analysis involving 12 effect sizes from ten studies found that the two correlate non-significantly ($\rho = .023$, $N = 2056$), and that the correlations exhibited significant heterogeneity (Woodley, 2011a). Woodley proposes an alternative conceptualization of the relationship between intelligence and *K* in the form of the Cognitive Differentiation-Integration Effort (CD-IE) hypothesis, which posits that whilst there is no main effect of *K* on *g*, *K* might affect the relationships among cognitive abilities hierarchically subordinate to *g*: those with high-*K* allocate effort to the cultivation of specialized abilities, whereas those with low-*K* will allocate effort into the development of a generalized ability profile. High-*K* cognitive specialists are capable of exploiting narrow social niches in stable and crowded environments, whereas low-*K* cognitive generalists acquire domain general skills that can be transferred between broader social niches as a buffer against environmental instability. Furthermore, cognitive generalism permits the creation of more 'multidimensional' mental fitness indicators to aid in short term mating.

CD-IE posits a strong variant of life history theory for explaining the covariance amongst personality, subjective wellbeing and other behavioral indicators of *K*, arguing that directional selection, historically operating on various polymorphisms, is sufficient to account for the existence of strong genetic correlations amongst these variables (Figueredo & Rushton, 2009). Furthermore it predicts the existence of genetic correlations between *K* and changes in the strength of the correlation amongst cognitive abilities. In line with Penke, Denissen, and Miller (2007), however, it argues that there are no genetic correlations of non-cognitive life history indicators with *g*, as variability in *g* is maintained within populations mainly via mutation-selection balance. It is posited therefore that *g* corresponds to general neural plasticity, efficiency and speed, which along with other indicators of general fitness, such as fluctuating asymmetry (Miller, 2000), constitutes a source of variance in individual differences genetically independent of *K*.

The present study is a preliminary investigation of the nature of *K* at the country level, including its operationalization via traits that have been included in the life history continuum by Rushton (1985, 1989, 2000, 2004), and especially in his work on race differences. Our focus is on advancing a more nuanced approach than that taken by Rushton, and in so doing special attention is given to the relationship of "national *K*" with "national *g*".

2. Methods

2.1. Elements of the K factor

A national *K* factor was computed from six life history indicators (for sources, see web references):

(i) *Teenage childbearing* is the proportion of children born to mothers aged 19 and below. Data are from the *Demographic Yearbook of the United Nations* (2008). Missing data points were extrapolated from World Bank data.
(ii) *Contraceptive prevalence* among married couples is averaged from several sources including the *United Nations' Human Development Report* (2004) and the UN statistics division.
(iii) *Sexually transmitted diseases (STDs)*, from the World Health Report of the WHO (2004 edition), include syphilis, gonorrhea and chlamydia. HIV/AIDS is not included because of its recent African origin, which affects its present geographical distribution.
(iv) *Homicide rate* (last available date) is from the UN office of drugs and crime.
(v) *Crime* is a measure of crime victimization derived from the Gallup World Poll. It is the unrotated first principal component of the proportion reporting theft during the last year, proportion reporting assault/mugging, and proportion feeling unsafe on the streets at night.
(vi) *Savings rate* is gross domestic savings, 1975–2005 average, from the World Bank.

These variables were selected to capture the elements of early reproduction (teenage pregnancy), promiscuity (STDs), crime (homicide rates, crime victimization), and future orientation (contraception, savings).

2.2. Development indicators

Intelligence is averaged from two variables: (1) national IQs reported in Lynn and Vanhanen (2006), with amendments and extensions reported in Lynn (2010). Minor corrections were used for Morocco (Sellami, Infanzón, Lanzón, Díaz, & Lynn, 2010) and Saudi Arabia (Batterjee, 2011) based on more recent results; (2) results of international scholastic assessments in mathematics, science and/or reading as described in Meisenberg and Lynn (2011), with additional data points obtained from the International Mathematics Olympiads (Rindermann, 2011).

IQ and school achievement were averaged with weighting for data quality as described in Meisenberg and Lynn (2011). IQ is available for 137 countries and school achievement for 148. IQ correlates with school achievement at $r = .875$ for the 108 countries having both measures. For countries having only school assessment scores or only IQ, the available measure was used.

lgGDP is log-transformed per capita GDP adjusted for purchasing power from the Penn World Tables 3.6 (Heston, Summers, & Aten, 2011), average 1985–2005.

Education measures length of schooling for adults 25+ years old, based on the Barro–Lee data set for 143 countries. Missing data points were extrapolated from World Bank and United Nations sources.

2.3. Evolutionary measures

(i) Skin reflectance (skin color), as reported in Jablonski and Chaplin (2000). High values indicate light skin. This is an approximate measure of the proportion of the population's ancestors living in non-tropical regions with low sunlight levels.

(ii) Evolutionary novelty, measured as distance from sub-Saharan Africa (defined here as Africa south of 20th degree northern latitude), under the assumption that early humans spread along the coasts of the Indian Ocean before entering North-East Asia and that Europe was settled from southeast. Evolutionary novelty is hypothesized to favor the evolution of higher intelligence, based on the hypothesis that intelligence is an adaptation to conditions that were different from the environment of evolutionary adaptedness (Kanazawa, 2008).

(iii) Time since the origin of agriculture, as reported by Puttermann and Trainor (2006). Agriculture in seasonal climates is hypothesized to select for foresight and long-term planning.

(iv) Average winter temperature (January temperature in the northern hemisphere), obtained from weatherbase. Cold winters have been postulated as an environmental challenge that selected for higher intelligence and cultural complexity (Lynn, 1987).

(v) Historical importance of pastoralism in the country, estimated as the percentage of the population depending on this mode of subsistence. Pastoralism may have imposed different selective pressures from settled agriculture.

(vi) Cranial capacity obtained from Beals, Smith, and Dodd (1984). Cranial capacity correlates highly with brain size, which in turn correlates at approximately $r = .40$ with psychometric intelligence (Rushton & Ankney, 2009).

Six racial groups were defined for the purpose of this study: European, Middle Eastern (West Asia, North Africa, Indian subcontinent), East Asian, Southeast Asian (including Pacific Islanders), and Native American.

3. Results

3.1. Properties of K

A national *K* factor was extracted as the unrotated first factor of a maximum-likelihood factor analysis of the six indicators described under Section 2. The correlations of this national *K* factor with its indicators as well as with intelligence (*g*) and log-transformed GDP are shown in Table 1. Most striking is the high correlation of .877 between *K* and *g*. This is about as high as the correlation between school achievement and IQ, the two variables from which *g* was averaged. The close relationship between *K* and *g* is also shown when the correlations of the six *K* indicators with *K* are correlated with their correlations with *g* ($r = .831$, $N = 6$, $p = .041$). At the level of world regions *g* and national *K* vary in parallel. Average values for *K* range from 69.3 in sub-Saharan Africa to 101.5 in East Asia, and *g* varies from 70.7 in Africa to 103.0 in East Asia.

3.2. Evolutionary indicators

Rushton attributed country-level differences in *g* and *K* to genetics and race. Therefore we should first verify whether national intelligence and our national *K* factor do indeed vary systematically with the racial composition of the population. Regression models were constructed in which either *g* or *K* was predicted only by the composition of racial groups residing in the country, with "European" as the omitted control. Regressions were done separately for Old World and New World countries because the racial origins of New World populations can only be estimated. Also, because in the New World countries multiple racial groups coexist or are hybridized, and country-level environmental influences are expected to be important determinants of both *g* and *K*, we expect smaller race differences in the New World than the Old World.

Table 2 shows the results, with values for *g* and *K* scaled to 100 for "European." In the New World, the numerically small racial groups other than European, Native American and African were lumped with the Europeans. The adjusted R^2 values show that as expected, racial composition of the population is a less potent predictor of both outcomes in the New World. In the Old World, however, 80% of the variance in *K* and 85% of the variance in *g* is explained by racial denomination. The results suggest that populations with high proportions of Native Americans score slightly lower on *K* than populations with equally high proportions of Africans, although this ranking is reversed for *g*. Otherwise, *g* and *K* generally vary in parallel.

If population-level variations in *g* and *K* are based on genetics, they were most likely selected by conditions to which human ancestors were exposed during the last 50,000 years, which is the approximate time scale for modern human racial evolution (Goebel, 2007); and if they are non-genetic responses to contemporary life conditions, they should be related most closely to indicators of contemporary environmental quality, rather than to past conditions. Table 3 shows correlations of *g* and *K* with plausible evolutionary factors that might have selected for or against these traits in the past. Log-transformed per-capita GDP and length of schooling are included as measures of contemporary environment. We observe again that the correlates of *K* and *g* are similar. The environmental indicators (lgGDP and education) correlate somewhat more with *K* than with *g*, while the opposite is seen with most of the evolutionary indicators, except for time since agriculture and pastoralism.

This analysis is refined in the regression models of Table 4. Model 1 shows that *g* is predicted by skin reflectance, lgGDP, cranial capacity, evolutionary novelty, and absence of pastoralism. Owing to relatively high collinearity with variance inflation factors (VIFs) up to 8.8, Model 1 was refined by eliminating non-predictors, producing Model 2, in which the highest VIF is 3.4. The same strategy was followed for the prediction of *K* in Models 3–6.

When *g* is excluded from the model, lgGDP is the most important predictor of *K* followed by skin color, education, and early introduction of agriculture. These models validate Table 3, indicating that evolutionary history is more important for *g*, and contemporary environment is relatively more important for *K*. When *g* is included as a predictor, it becomes a major predictor of *K*, together with lgGDP and skin reflectance (Models 5 and 6).

Attempts to model national *K* as a latent variable when *g* and lgGDP are included were unsuccessful. The correlations of the latter two variables with latent *K* approached unity, and multiple effects of *g* and lgGDP on the *K* indicators were required for acceptable model fit. However, using *K* as a measured variable produced meaningful relations with hypothesized predictors.

In path models predicting *g* without *K*, the important predictors were skin color ($\beta = .464$), lgGDP ($\beta = .243$), cranial capacity ($\beta = .233$), evolutionary novelty ($\beta = .178$), and pastoralism

Table 1
Correlations of *K* with *g*, log-transformed GDP, and the *K* indicators: teenage childbearing (Teenpreg), log of sexually transmitted diseases (lgSTDs), contraceptive prevalence, log-transformed homicide rate, crime victimization, and national savings rate. $N = 97$ countries. Correlations higher than .200 are significant at $p < .05$.

	K	*g*	lgGDP	Teenpreg	STDs	Contrac.	lgHomic.	Crime
g	.877	1						
lgGDP	.819	.756	1					
Teenpreg	−.865	−.689	−.665	1				
lgSTDs	−.866	−.877	−.795	.607	1			
Contraception	.690	.734	.649	−.434	−.774	1		
lgHomicide	−.808	−.638	−.564	.669	.551	−.336	1	
Crime	−.713	−.507	−.463	.575	.454	−.299	.692	1
Savings	.422	.338	.602	−.398	.304	.192	−.295	−.235

Table 2
Relative scores on *g* and *K* for racial groups worldwide, with European scaled to 100. The country-level regressions used racial denomination as the predictor of the outcome measures.

	K predicted			*g* predicted		
	All countries	Old world	New world	All countries	Old world	New world
European	100.0	100.0	100.0	100.0	100.0	100.0
Middle Eastern	89.4	88.9	–	86.5	86.2	–
African	74.2	72.2	95.4	73.6	73.7	71.0
East Asian	104.7	104.2	–	106.4	106.3	–
Southeast Asian	86.3	85.9	–	90.2	90.0	–
Native American	70.7	–	87.8	77.0	–	75.8
N (countries)	161	128	33	167	136	31
Adj. R^2	.731	.800	.092	.821	.850	.585

Table 3
Correlations of *K* and *g* with environmental and evolutionary determinants. Cranium = cranial capacity, Novelty = evolutionary novelty (distance from Africa), Temperature = winter temperature, Agriculture = time since introduction of agriculture, and Pastoralism = importance of pastoralism in prehistoric and early historic times. $N = 143$ countries. For correlations higher than .165, $p < .05$.

	K	*g*	Educ.	lgGDP	Skin	Cranium	Novelty	Temp.	Agric.
g	.867	1							
Education	.758	.750	1						
lgGDP	.803	.732	.762	1					
Skin color	.821	.859	.701	.685	1				
Cranium	.721	.773	.584	.556	.732	1			
Novelty	.273	.433	.337	.319	.485	.461	1		
Temperature	−.705	−.746	−.666	−.484	−.785	−.785	−.215	1	
Agriculture	.567	.512	.308	.399	.645	.411	.181	−.419	1
Pastoralism	.051	−.132	−.177	.035	−.079	.063	−.214	.004	.170

($\beta = -.118$) ($p < .001$, $N = 123$ countries). Cranial capacity was predicted by winter temperature ($\beta = -.667$), evolutionary novelty ($\beta = .356$), lgGDP ($\beta = .135$), and pastoralism ($\beta = .116$). When *K* was predicted with the same variables, significant ($p < .05$) effects were observed for lgGDP ($\beta = .441$), skin color ($\beta = .339$), evolutionary novelty ($\beta = .129$) and time since agriculture ($\beta = .098$).

Figure 1 shows a path model including both *g* and *K*. It shows three major effects on *K*: *g*, lgGDP, and skin reflectance (lighter skin → higher *K*). Thus at least one of the evolutionary indicators apparently directly affects *K* independently of *g* and lgGDP.

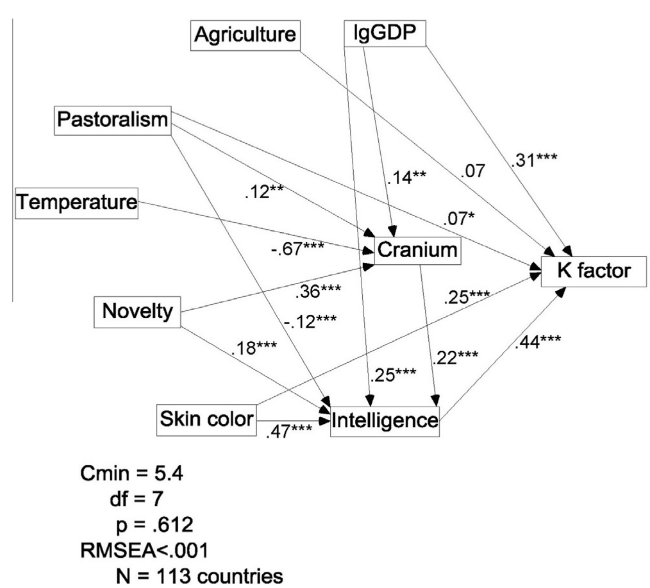

Fig. 1. Path model predicting *g* (intelligence) and *K* with indicators of evolutionary history and current prosperity. Cranium = cranial capacity.

4. Discussion

Rushton (1985, 2000, 2004) argued that *g* is related to a "slow" (high-*K*) life history, and was differentially selected along with other *K*-related traits in different climatic and ecologic zones. Rushton proposed a close relationship between these two constructs at the species level in animals, and at both the racial group and individual differences level in humans.

Evidence indicates an association between *g* and *K* at the racial group differences level (Rushton, 2000), and at the cross-species level when proxies for intelligence such as encephalization quotient are employed (Rushton, 2004). It also needs to be noted that our national *K* factor is not the first attempt at creating a cross-national measure of differential-*K*. Templer (2008) found that measures of

Table 4
Prediction of *g* and *K* with development and evolutionary indicators.

	g predicted		*K* predicted			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Nat. Intell					.301**	.315***
lgGDP	.203**	.209***	.332***	.346***	.259***	.281***
Education	.106	.071	.190**	.173**	.108	.080
Skin color	.301**	.430***	.311**	.293***	.276**	.236**
Cranium	.160*	.210***	.100	.103*	.109	.082
Novelty	.250***	.160***	.096	.093	.007	
Temperature	−.054		.015		.066	
Agriculture	.040		.110*	.119**	.083	.090*
Pastoralism	−.095**	−.103**	.031	.071*	.067	
N (countries)	121	124	124	124	113	114
Adj. R^2	.879	.867	.886	.887	.908	.909

* $p < .05$.
** $p < .01$.
*** $p < .001$.

infant mortality, GDP, skin color, longevity, fertility and HIV/AIDS prevalence all share a common source of variance stemming from what he termed a *K* superfactor. Templer also included a measure of national IQ amongst his *K* superfactor components, and subsequent work expanded it to include homicide rates (Rushton & Templer, 2009; Templer & Rushton, 2011). We excluded GDP, infant mortality, birth rate and fertility from our definition of *K* because these "development indicators" are known to correlate highly with IQ at the country level (Lynn & Vanhanen, 2006).

However, meta-analysis does not support an association between *g* and *K* at the individual differences level (Woodley, 2011a). What then could account for this "Rushton paradox"?

One possibility is that at the individual differences level, *g* genes assort independently with *K* genes, and became correlated at the inter-population level because selective pressures favoring higher *g* also favored higher *K*. A second possibility is clinal variation. As Sub-Saharan Africans exhibit low *g* relative to other populations, any trait that systematically differs between Africans and non-Africans would therefore become incidentally correlated with *g* at the population level. A third possibility is that because both *K* and *g* are, in part, dependent upon environmental conditions, poor environments favoring fast life history might also inhibit *g* (Figueredo, 2009). A fourth possibility is that at the level of international comparisons, IQ tests lose their *g*-loadings, such that national differences become accentuated by the Flynn effect. This suggests that effort allocation into the development of specific abilities rather than differences in levels of *g* may partially account for the association between national intelligence measures and national *K* (Woodley, 2011b, 2012).

The first question addressed in this research is whether a *K* factor exists. The evidence indicates that something resembling this factor can be isolated from theoretically meaningful measures, and that it exhibits a very high correlation with national intelligence, however it is recognized that the construct in question needs fuller validation. In the path model of Fig. 1 this is revealed by a strong direct path between *g* and *K* ($\beta = .44$). The path from lgGDP seems to be a little stronger to *K* (.31) than to *g* (.25), suggesting a slightly stronger developmental input into *K*. Skin reflectance also appears to associate more strongly with *g* than with *K* (.47 vs. .25). A history of pastoralism seems to have had opposing effects on *K* and *g*, with the former association being positive (.07) and the latter negative (−.12). It is not clear however whether postoralism failed to select for higher intelligence in the past, or whether it is better considered a recent cultural or environmental influence. There are also variables which uniquely associate with each construct, evidencing their distinctness. *g* receives a significant path from cranial capacity (.22), which is in turn influenced by temperature (−.67). Contra Rushton (2010), neither of these variables appear to influence *K*. Similarly, evolutionary novelty is associated with *g* both directly and through cranial capacity, independently of *K*.

The results show that *K* can be operationalized at the country level with variables that conform to current understanding of this construct. However, the relationship between country-level *g* and country-level *K*, and especially between country-level *K* and individual-level *K*, require further investigation. Evolutionary conditions appear to be plausible contributors to the current worldwide distributions of both traits.

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