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County-level IQ and fertility rates: A partial test of *Differential-K* theory

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ABSTRACT

Human intelligence (IQ) correlates with a number of important life outcomes ranging from mortality and morbidity to social rank and status. Noticeably absent from the literature, however, has been a unifying framework from which to examine why IQ should correspond to so many seemingly disparate outcomes. Rushton's *Differential-K* theory represents a theoretical perspective capable of accounting for the role of IQ in understanding human flourishing. We tested predictions suggested by *Differential-K* theory by examining the association between IQ at the aggregate level and two life-history variables: parental investment and fertility rates. Our results provide tentative support for some of the predictions of *Differential-K* theory.

1. Introduction

Perhaps one of the most interesting and important questions that researchers have endeavored to answer has to do with the origins of human intelligence (IQ) (Miller, 2000; Rushton, 2004). Despite being a source of some controversy, cognitive abilities represent a key component of life in the human species influencing multiple domains and cutting across very important outcomes (Herrnstein & Murray, 1994). Importantly, the relevance of IQ for human thriving extends beyond predictions of behavior and social acumen (Beaver & Wright, 2011; Miller, 2000) to include physiological and developmental outcomes as well (Rushton, 2004). IQ levels, for instance, correlate with gestation time during pregnancy (Rushton, 2004), disease rates (Templer & Rushton, 2011) and life expectancy (Lynn & Vanhanen, 2012). Moreover, geographic locales with higher IQ levels report lower rates of medical (as well as social) pathologies (Barnes, Beaver, & Boutwell, 2013; Lynn & Vanhanen, 2006).

Rushton (2004) suggested that IQ is the evolved product of human life history in which ecological pressures selected for slower maturation, fewer offspring, larger brains, and ultimately higher IQs. There has been some effort to test Rushton's (2004) propositions at various levels of analysis, including the national level, (e.g., Lynn & Vanhanen, 2006) state level (e.g., Rushton, 2010), and individual level (e.g., Gladden, Figueredo, & Jacobs, 2009; Sefcek & Figueredo, 2010). At least some evidence exists which appears supportive of Rushton's propositions concerning the role of ecological pressures in explaining the origins of human cognitive abilities (for exceptions, see Gladden et al., 2009; Sefcek & Figueredo, 2010). The current study is intended to push this line of inquiry forward by examining the association between IQ and two important life-history traits—parental investment and fertility rates—at the county level.

Beyond offering a potential explanation of how cognition evolved, however, what should not be overlooked is that Rushton's, (1985a) *Differential-K* theory has clear ramifications for societal issues, more broadly conceived. Consider the fact that epidemiologists, sociologists, criminologists and political scientists have all expended a considerable amount of time attempting to explain the underlying causal structure for a host of macro-level socio-political outcomes. Why, for example, do certain neighborhoods, cities, and counties report higher levels of social disorganization and social pathology than others (Sampson, Raudenbush, & Earls, 1997)? Typically, explanations for these various outcomes hinge on socio-political and cultural factors such as the presence of concentrated disadvantage or a lack of collective efficacy (i.e., feelings of unity and solidarity amongst the populace) (Sampson et al., 1997).

The factors mentioned above are doubtless of great importance. Yet, outside of Rushton (2004) and a handful of other scholars (e.g., Gottfredson, 1997; Herrnstein & Murray, 1994; Lynn & Vanhanen, 2006; Templer, 2008), almost no consideration has been given to the possibility that factors such as IQ might underlie many of the

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important macro-level events that occur within geographic localities. Beaver and Wright (2011), for example, uncovered negative correlations between county-level IQ and county-level crime rates (net of other important control variables). Barnes and colleagues (2013), more recently, reported evidence that average county IQ levels predicted lower levels of concentrated disadvantage but also lower rates of mortality and disease. In the concluding comments of their study, these same scholars suggested that context for their findings could be extracted from *Differential-K* theory. If Rushton's, (1985a) is correct, for example, and IQ correlates with various life-history outcomes (such as fecundity, life span, parenting strategies, disease, longevity, etc.), then it could offer a window from which to further evaluate the *ultimate* reasons why certain geographic areas report more social pathologies than others.[1]

2. Life-history theory and IQ

Rushton's (1985a, 1985b, 2000, 2004) application of a life history framework to human cognition has elicited both attention and criticism from scholars (Wicherts, Borsboom, & Dolan, 2010). Rushton argued that IQ is the product of human life history and exists as one of many traits evolved via natural selection to overcome challenges of growth, survival, and reproduction (Rushton, 2004). From this vantage point, all animal species (humans included) occupy a position along a spectrum ranging from *r* (defined by population growth) to *K* (defined by the carrying capacity of the environment) (Pianka, 1970; Stearns, 1992; Wilson, 1975). Organisms falling more towards *r* would be favored under conditions of population growth while *K*-selected organisms would be favored as populations stabilize. A point worth noting, though, is that *r* and *K* should not be thought of in strict dichotomy but rather as a complete spectrum of life history strategies (Figueredo, Vasquez, Brumbach, & Schneider, 2004).

For humans, life-history theory makes certain predictions about why various phenotypic traits tend to correlate. Research has demonstrated, for example, a moderately consistent correlation among IQ, brain size, longevity, birth weight, and gestation length (to mention a few examples) (Rushton, 2010). These associations become clearer considering the differences between *r*-selected organisms and *K*-selected organisms. Specifically, *r*-selected organisms mature in a relatively rapid fashion, producing more eggs and giving birth to greater numbers of offspring, (e.g., fish) (Rushton, 2000). *K*-selected organisms, on the other hand, mature at a slower rate, grow larger brains that consume increased amounts of energy and, reproductively speaking, invest heavily in fewer offspring (Rushton, 2010).

3. Existing research in humans

As Rushton (2004) notes, shifting ecological factors selected for more complex nervous systems and bigger brains in certain primates and other mammals. For humans, this necessarily meant higher levels of IQ (the correlation between brain size and IQ can range between .20 and .40 depending on measurement technique) (Rushton, 2010). A number of scholars have extended this logic and examined the correlation between IQ and various life-history outcomes at different levels of aggregation. At the state level, for example, IQ correlates negatively with measures of birth rate, positively with life expectancy and negatively with infant mortality (Templer & Rushton, 2011). These findings accord closely with those of Lynn and Vanhanen (2006) who examined IQ at the national level and uncovered a positive correlation with average life expectancy along with a host of other outcomes. More directly, Wicherts et al. (2010) reported a significant negative correlation between national IQ rates and fertility rates.

As illustrated above, a good portion of the extant research in this area has been conducted in the aggregate. Two recent studies, however, have tested life history explanations of IQ at the individual level. Gladden and his colleagues (2009), for instance, examined a sample of 100 undergraduate students who were administered a test of general intelligence (Advanced Progressive Matrices-18) as well as items intended to assess slower life history (LH) strategies (*K* selection) along with a range of other personality and behavioral indicators. Interestingly, the results revealed no association between general intelligence (*g*) and a latent factor of *K*-ness, a result that conflicts with Rushton's life history explanation of human intelligence. If *g* was indeed shaped by the life history of the human species then it should be expected to correlate with an indicator of *K*.

More recently, Sefcek and Figueredo (2010) uncovered a similar pattern of findings also utilizing a sample of university students. In this case, Sefcek and Figueredo (2010) examined competing accounts regarding the evolution of intelligence: *Fitness indicator theory* (Miller, 2000) and Rushton's (1985a, 1985b, 2004) *Differential-K theory*. According to Miller (2000), higher levels of *g* signify the quality of the genes possessed by individuals. As a result, ancestral females preferred males with higher levels of cognitive functioning and thus the evolution of intelligence was driven largely by female choice and sexual selection. With this in mind, Sefcek and Figueredo (2010) examined whether a measure of *g* correlated more strongly with a measure of "*K*" or a measure of "*F*" (i.e., fitness). Importantly, general intelligence failed to correlate with either *K* or *F*.

To date, then, studies at the aggregate level have shown some support for Rushton's propositions. However, emergent research at the individual level has offered less in the way of empirical support for *Differential-K* theory. The current analysis is thus intended to further examine some of the propositions offered by Rushton at the level of the county. Should a similar set of findings emerge herein, they would further support a *Differential-K* explanation of cognitive abilities at the aggregate level. With this in mind, the current study will examine the interrelationships between IQ and two important life history variables: parental investment and fertility rates. All measures were assessed at the county level.

4. Methods

4.1. Data

Data from The National Longitudinal Study of Adolescent Health (Add Health; Harris, 2009) were utilized in order to test aspects of *Differential-K* theory in the current study. The Add Health is a longitudinal study of American adolescents enrolled in middle and high school between the years of 1994–1995 (see Harris (2009) as well as Kelley and Peterson (1997) for more detailed treatments of the sample design and data collection procedures). Currently, four waves of data have been collected: waves 1 (N = 20,745; ages 11–21), 2 (N = 14,738; ages 11–23), 3 (N = 15,197; ages 18–28), and 4 (N = 15,701; ages 24–34). In addition to a host of individual-level items included in the study, data pertaining to the county of residence for each of the participants were also collected. Respondents during the wave 1 surveys resided in over 200 counties drawn from a total of 37 different states. Along with information concerning state and county of residence, numerous items were also drawn from various other data sources (such as the US

[1] At this point, it should be noted that life-history theory would suggest that any correlation which might exist between IQ and various life-history traits should theoretically be spurious, owing to the selection pressures in our ancestral environment that drove the evolution of each trait. Even so, it remains reasonable to suggest that IQ might predict human outcomes in a modern society.

Census and the Centers for Disease Control and Prevention) regarding demographics of the county, health outcomes, and disease prevalence, along with a host of additional information (Billy, Wenzlow, & Grady, 1998).

4.2. Measures

4.2.1. Average county IQ

In order to calculate the average IQ level within counties, the current study followed the lead of prior research (Barnes et al., 2013) and relied on individual-level IQ scores collected during wave 1 of the Add Health. Participants in the Add Health were administered the Peabody Picture Vocabulary Test (PVT) which was developed in order to measure variation in verbal skills and receptive vocabulary (Rowe, Jacobson, & Van den Oord, 1999). For the current analysis, county-level estimates of verbal IQ represent each respondent's score on the PVT that has been aggregated up to the county-level. More specifically, the average PVT score was calculated for respondents residing in the same county. IQ scores were aggregated when a minimum of 10 respondents reported residing in a given county (mean = 100.97, SD = 6.20, min. = 85.80, max. = 116.45).

4.2.2. Parental investment

In order to construct an index of parental investment, three items were included from the 1990 US census, all of which assess family structure and availability of resources (Billy et al., 1998). Specifically, the parental investment measures included the proportion of two parent married families with children <18 years old, the proportion of females married (with spouse present), and finally the proportion of males married (with spouse present). By including these measures, we attempted to approximate previous measures of parental investment (Figueredo et al., 2005) as closely as possible using aggregate information, in this case information concerning counties rather than individuals. We should point out that Figueredo and his colleagues (2005) were assessing emotional closeness of fathers with their offspring. Obviously, our measure cannot assess this particular dimension of parental investment. More broadly, our measure is an attempt to assess the availability of both parents as a resource to the child (which might include both emotional and other forms of investment). All of the individual items reported factor loadings equal to, or exceeding, .80. As a result, we extracted a single factor and included it in the current analysis.

4.2.3. Fertility rates

The contextual data collected during wave 1 of the Add Health included information regarding the fertility rate in the sampled participants. Specifically, a measure of fertility rate was calculated by the Add Health researchers and was intended to reflect the estimated number of children that 1000 women would be projected to have given birth to by the time they had reached adulthood (approximately 40 years old). In this way, the fertility rates reflected the birth rates in the united states for 1990 (for all races in the population) (Billy et al., 1998; see also the contextual data codebook for additional information regarding the fertility rates measure).

4.2.4. Concentrated disadvantage

Census information from 1990, as well as guidance from prior research, was utilized in order to construct a measure of county-level concentrated disadvantage (Sampson et al., 1997). Three items were used to construct the scale and included the unemployment rate, the proportion of households with income less than $15,000, and the proportion of residents receiving public assistance. These three measures were factor analyzed and the results suggested they be combined into a single construct similar to what previous scholars have utilized to operationalize aggregate levels of disadvantage (Sampson et al., 1997). We should note, at this point, that the typical approach utilized for creating this item is to include measures of proportion black residents in a given locale as well as proportion of female-headed households. These two items, however, accord very closely with life history outcomes—especially considering the predictions made by Rushton (2004) regarding racial differences.[2] As a result, we calculated all of our models using the five item measure of concentrated disadvantage and the substantive conclusions remained largely unchanged from what is presented below. Ultimately, we extracted one factor via the use of regression scoring techniques for the three items described above.

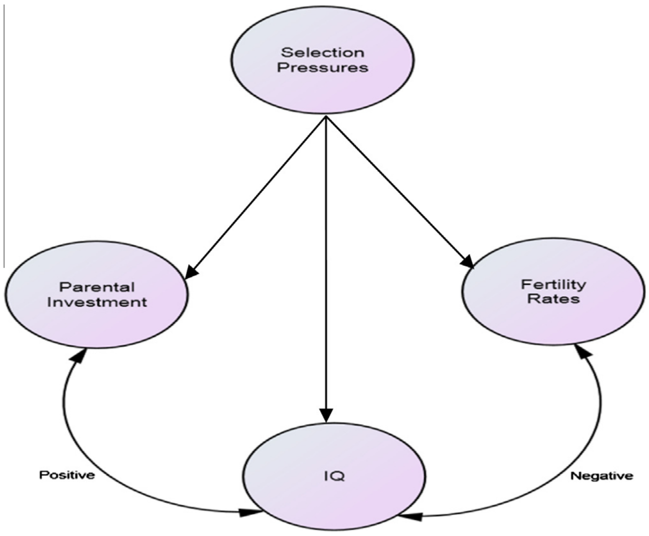

Fig. 1. Theoretical model.

4.2.5. Access to fertility counseling

It may be the case that IQ influences a tendency to seek out fertility treatment, assuming that problems with conception arise. Because access to fertility counseling is an evolutionarily modern resource, this aspect of medical care was not an option for our ancestors. In modern western society, though, access to fertility treatment could influence the covariation between IQ and fertility rates. In order to gauge the availability of fertility counseling services in a given county, the current study included a measure assessing the number of short term hospitals with fertility counseling available per 100,000 residents (Billy et al., 1998).

4.3. Analytical plan

Using Fig. 1 as a theoretical backdrop, the plan of analysis for the current study proceeded in two stages. First, we examined the association between IQ and parental investment using a sequential approach. Specifically, we calculated a set of ordinary least squares (OLS) regression equations in order to examine the relationship between IQ and parental investment, along the way controlling for important covariates that might mediate the association. The second phase of the analysis mirrored the first with the exception being that the outcome variable became county-level fertility rates. In this case, based on Fig. 1 we expected to uncover a negative correlation between IQ and fertility rates at the county level.

It is worth noting that counties, especially in the United States, are subject to considerable population turnover. In other words, human populations in geographic regions similar in size to

[2] The correlation between IQ and proportion black in a county is, for instance, $r = -.41$.

counties have continued to shift over the last several thousand years. As a result, we are not suggesting that counties represent an evolutionary environment in the sense that the populations have been isolated for periods of time sufficient to witness the effects of ecological pressures encompassed by life history theory. In light of this, it might be appropriate to view our study as examining the most conservative unit of analysis. Our findings are presented below.

5. Findings

Table 1 examines the relationship between county-level IQ and parental investment. As can be seen, the bivariate association between IQ and investment is positive and statistically significant. The association remains, although somewhat attenuated, once concentrated disadvantage is entered into the equation. Table 2 examines the relationship between IQ and fertility rates. The results, in each case, revealed that a negative and significant association between county IQ and fertility rates remained regardless of the covariates that were introduced into the model. We should note that we conducted all of our analyses with the inclusion of a regression weight that adjusted the estimates based on the number of cases used to calculate the county IQ variable (i.e., some counties were larger—contributing more participants—and were, therefore, given a larger influence on the resulting regression estimate as compared to smaller counties). Importantly, the results remained substantively unchanged regardless of whether the weights were included our excluded in the analysis.

6. Discussion

Rushton (2004) suggested that IQ correlates with numerous human outcomes—ranging from mortality rates to fertility rates—because of the evolutionary life history of humans. Because the environment of our ancestors favored genes that coded for slower maturation, heavy parental investment, larger brains, and higher cognitive functioning, these traits should, over time, begin to covary. Evidence that this is the case has been detected at the national and state level (Templer & Rushton, 2011). Yet conflicting evidence has emerged in studies examining individuals (Gladden et al., 2009; Sefcek & Figueredo, 2010). Our study extended these findings and examined correlations between IQ and two life-history traits—parental investment and fertility rates—at the county level. Several important findings emerged.

First, at the bivariate level, the correlation between IQ and parental investment, as well as the correlation between IQ and fertility rates, was statistically significant and in the predicted direction. Counties with higher IQs, on average, reported lower overall fertility rates and increased levels of parental investment. Second, the association between IQ and life-history outcomes (i.e., parental investment and fertility rates) remained statistically significant even after controlling for potential mediator variables. What these findings suggest is that IQ and life-history traits may covary, not necessarily because of social factors common to modern western culture, but because the items share an evolutionary origin.

Table 1
The effect of county IQ on county parental investment.

	Model 1		Model 2	
	Beta	t	Beta	t
County level IQ	.42**	4.53	.36**	3.52
Concentrated disadvantage	–		–.16†	–1.62

** $p < .05$.
† $p = .108$.

In the interest of being thorough, we also examined whether additional variables might further mediate the association between IQ and various life history traits. We estimated our equations including a measure of county-level educational attainment, for example (specifically, we included a variable representing the proportion of residents aged 25 years and older without a high school diploma). The association remained between IQ and the life history outcome variables. We should note one exception was when the variable assessing proportion of black residents was included in the analysis (without the regression weights used to adjust for number of respondents residing within individual counties). In this case, the association between IQ and life history outcomes diminished completely. This is not unexpected, though, given the predictions of life-history theory regarding racial differences (and also the strong negative correlation between IQ and racial composition within counties) (Rushton, 2000).

This study was not without limitations and it is important to explore how future studies might improve on our analysis. The parental investment item in particular has the potential to introduce error. Admittedly, the items used to construct the measure—proportion of two parent married families with children <18 years old, proportion of females married (with spouse present), and proportion of males married (with spouse present)—could be improved upon. To the extent that these items tap actual investment on the part of the parents toward the child remains an empirical question. Even so, it is logical that having two parents available for the care of a child is an indicator of more investment on the part of the parents toward the offspring. Ultimately, future research will either support or refute our findings.

The results presented here can be interpreted as offering partial support for a life-history explanation for human intelligence (Rushton, 2004). This, however, does not rule out alternative explanations. Miller (2000) has suggested that IQ evolved via the mechanisms of sexual selection and there is evidence in favor of this line of thinking (e.g., Kanazawa, 2011). Indeed, research at the individual level appears to contradict the suggestion that a life-history explanation can explain the evolution of IQ (Gladden et al., 2009; Sefcek & Figueredo, 2010). While our results do not obfuscate sexual selection explanations, they may provide a more cogent framework for why so many key human traits covary with IQ (Gottfredson, 1997). Even so, we are left to consider why our results diverged from prior research at the individual level.

From our vantage point, there appear to be two reasons why our findings may differ from those at the individual level. First, our measure of county-level IQ was comprised of individual-level scores on the Peabody Picture Vocabulary Test (PVT) which were averaged and aggregated to the county level. While informative, this particular indicator of IQ does not fully encapsulate the latent concept of general intelligence (g), which may have been more fully captured by measures used previously at the individual level (Sefcek & Figueredo, 2010). Certainly, the PVT would be expected to load significantly on the latent construct of g, however, perhaps not as strongly as other indicators of general intelligence. Should it be the case, moreover, that the general intelligence more fully encapsulates, and more readily signals, genetic quality (more so than verbal IQ alone) it would be expected to correlate more strongly with an F factor (Miller, 2000).

Second, and on a related point, Sefcek and Figueredo (2010) mentioned that while general intelligence might not be a life history product—other intelligences might be (e.g., social intelligence). Moreover, they also note that cognitive capacities related to *executive functioning* could represent more direct life history outcomes (Sefcek & Figueredo, 2010). More to the point, Sefcek and Figueredo (2010, p. 61) suggest that "Because a harsh, predictable environment

Table 2
The effect of county IQ on county fertility rates.

	Model 1		Model 2		Model 3		Model 4	
	Beta	*t*	Beta	*t*	Beta	*t*	*Beta*	*t*
County level IQ	−.38**	−3.95	−.32**	−3.11	−.35**	−3.59	−.29**	−2.75
Concentrated disadvantage	–		.13	1.27	–		.14	1.35
Access to fertility counseling	–		–		.17*	1.76	.17*	1.82

* $p < .10$.
** $p < .05$.

would necessitate the ability to delay gratification, plan ahead, and live in large social groups; high-*K* individuals should have the ability to control impulsive behaviors, shift attention in a quick, flexible manner, and integrate, organize, and monitor their performance.'' This makes for interesting and relevant conjecture given the nature of our IQ measure—the PVT—which captures variation in verbal ability. Consider the findings of prior research in this regard. Beaver, DeLisi, Vaughn, Wright, and Boutwell (2008) reported evidence of genetic overlap in language development (most likely capturing some aspect of verbal IQ) and impulse control/self-regulation (an example of executive functioning). As a result, these two traits appear linked even at the level of the genome. If this is indeed the case, and if Sefcek and Figueredo (2010) are correct, it could further explain the divergence in our findings from previous research conducted using alternative IQ measures.

A final possibility that should be contemplated regarding the nature of our findings, and their possible interpretation, is that IQ works in a causal fashion directly predicting the decisions of individuals concerning parental investment. Individual differences in cognitive functioning, for example, might directly impinge on decisions to remain married or in a cohabitating relationship once children enter the equation. While this is highly likely, a purely causal explanation cannot fully explain the relationship between IQ and fertility, which in some respects, are beyond the conscious manipulation of the individual. Ultimately, though, it is entirely plausible that individual differences in the population for measures of intelligence have at least some direct and causal ramifications for short-term social interactions in humans.

Templer (2008) reported evidence that a higher-order latent factor of ''*K*-ness'' accounted for 75% of the variance in national differences for IQ, life expectancy, birth rate, infant mortality, as well as various other life history variables. What this suggests is that these traits cling together because of some underlying, perhaps evolved, tendency for them to do so. The litmus test for this assumption will be a genetically sensitive analysis capable of determining whether similar suites of genes predict variation across IQ and other life history outcomes. Ultimately, evolutionary explanations for human cognition remain controversial and no definitive answer has been reached regarding the evolutionary pressures (sexual or ecological) that drive the development of human intelligence. Even so, science in this area continues to progress toward this goal.

The current effort was intended to represent one modest step forward in the debate between life history theory and sexual selection theory. A parallel goal, moreover, was to offer a framework from which to view macro-level outcomes that extend beyond purely socio-political explanations. While it is certainly the case that cultural, sociological and other environmental processes can impact human affairs; these types of explanations can be complemented by an evolutionary framework capable of unifying extant research. Regardless of the relevance of *Differential-K*, sociological and cultural explanations will always be important to consider. Without some conception of the evolutionary past of our species, however, such explanations will only represent surface theories, lacking any real depth or substance.

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