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Short Communication

General intelligence, disease heritability, and health: A preliminary test ☆

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ABSTRACT

Cognitive epidemiology shows that more intelligent individuals stay healthier and live longer, but it is not known why. The system integrity theory predicts that more intelligent individuals are more protected from diseases that are more heritable, while the evolutionary novelty theory predicts that they are more protected from diseases that are less heritable. The paper proposes a new method of testing the competing hypotheses. An analysis of two large-scale population data sets from Sweden (n = 1 million for individual data and n = 9.6 million for heritability data) shows that intelligence is more important for health when the cancer heritability is low, supporting the evolutionary novelty theory. While the present results are merely suggestive, not conclusive, the proposed method can be extended to include other diseases and causes of death.

1. Introduction

Studies in the emerging field of cognitive epidemiology (Deary, 2010) demonstrate the strong effect of general intelligence on health and longevity: more intelligent children grow up to stay healthier and live longer than less intelligent children (Batty, Deary, & Gottfredson, 2007; Deary, Whiteman, Starr, Whalley, & Fox, 2004; Kanazawa, 2006, 2008, 2013). While there is by now little doubt that general intelligence exerts an influence on health and longevity, it is not clear *why* (Deary, 2008; Gottfredson & Deary, 2004).

There are currently two possible explanations for the effect of general intelligence on health and longevity. The *system integrity theory* (Arden, Gottfredson, & Miller, 2009; Arden, Gottfredson, Miller, & Pierce, 2009; Deary, 2012; Whalley & Deary, 2001) suggests that general intelligence, among others, is an indicator of underlying genetic and developmental health. Genetically and developmentally healthier individuals with greater body system integrity simultaneously have higher general intelligence, stay healthier, and live longer. A recent study showing that shorter men live longer (He et al., 2014), however, may contradict the system integrity theory.

In contrast, the *evolutionary novelty theory* (or the Savanna–IQ Interaction Hypothesis; Kanazawa, 2006, 2010, 2013) posits that, because general intelligence likely evolved to solve evolutionarily novel adaptive problems (Kanazawa, 2004), more intelligent individuals are better able to recognize and deal appropriately with evolutionarily novel entities and situations. Most health risks and hazards in the contemporary societies are evolutionarily novel; far more people die of heart disease, diabetes, and car accidents than falling off of a cliff, being mauled by wild animals, or in interpersonal fights. So more intelligent individuals should be better able to recognize, deal appropriately with and avoid such health risks and hazards, and, as a result, stay healthier and live longer. For example, prospectively longitudinal data from Sweden, New Zealand, and the United Kingdom show that more intelligent children are significantly less likely to gain weight and become obese as adults (Kanazawa, in press). As a result, the average intelligence of the population, not income inequality, strongly determines the average health of the population both across nations (Kanazawa, 2006) and across states in the US (Kanazawa, 2008).

Because the system integrity theory emphasizes the role of genes, and the evolutionary novelty theory emphasizes the role of behavior and choice, the two theories make contrasting predictions with regard to the effect of general intelligence on the individual's susceptibility to different diseases that are more or less heritable. The system integrity theory would predict that more intelligent individuals are better protected from diseases that are more heritable (more strongly determined by genes) than from diseases that are less heritable. In contrast, the evolutionary novelty theory would make the opposite prediction that more

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intelligent individuals are better protected from diseases that are less heritable (less strongly determined by genes, and, correspondingly, more strongly determined by individual choice and behavior) than from diseases that are more heritable.

Further, across various diseases, the system integrity theory would predict a *negative association* between their heritability and the correlation across individuals between general intelligence and the likelihood of contracting the disease (more intelligent individuals are more likely to contract less heritable diseases than more heritable diseases). The negative effect of intelligence on disease contraction should be stronger for more heritable diseases, for which genes play greater roles, than for less heritable diseases, for which genes play lesser roles.

In sharp contrast, the evolutionary novelty theory would predict a *positive association* between the disease's heritability and the correlation across individuals between general intelligence and the likelihood of contracting the disease (more intelligent individuals are more likely to contract more heritable diseases than less heritable diseases). The negative effect of intelligence on disease contraction should be stronger for less heritable diseases, for which individual choice and behavior make greater difference, than for more heritable diseases, for which individual choice and behavior make less difference.

This paper proposes a new method of testing the contrasting predictions from system integrity and evolutionary novelty theories on the effect of general intelligence on health, and provide a preliminary test with regard to different cancers with varied heritabilities. The analyses will employ individual data (to estimate the effect of general intelligence on cancer susceptibility) and epidemiological data (to estimate the heritability of cancers) both from Sweden.

2. Methods

2.1. Individual data

Batty et al. (2007) use Swedish population data to estimate the effect of general intelligence in early adulthood, measured at the time of universal male conscription at Age 18, and later cancer risk and mortality, assessed from cancer register or mortality records over the next 20 years on average. The men's intelligence measured at conscription and cancer history in medical records can be linked via Swedish personal identity number. Their sample contains 959,540 Swedish men born between 1952 and 1976.

2.1.1. Measures of general intelligence

General intelligence of all Swedish men is measured at 18 at conscription (until universal male conscription ended in 2006). General intelligence is measured with four IQ tests (logic, verbal, spatial, and technical). Batty et al. (2007) compute a measure of general intelligence (or "global IQ") by adding the four scores. Both the general intelligence score and four IQ test scores are standardized into a score between one and nine. Scores on four IQ tests are highly correlated with each other (mean $r = .56$) and the measure of general intelligence is very highly correlated with all of the component IQ scores (mean $r = .80$).

2.1.2. Measures of cancer susceptibility

Batty et al. (2007) use the cancer register and mortality records to ascertain whether the respondents have been diagnosed with or died from any of the 20 different cancers. In total, 10,273 respondents have been diagnosed or died from cancer. The 20 cancers recorded (with the number diagnosed with it in parentheses) are: buccal cavity and pharynx (287); esophagus (38); stomach (139); colorectal (703); larynx (32); lung (200); prostate (84); skin (2079); bone (394); hematopoietic (1557); liver (70); pancreatic (90); testicular (2040); other genital (131); kidney (160); bladder (270); eye (45); brain (1173); thyroid (533); other/unspecified (478).

2.1.3. Computation of correlations

Batty et al. (2007) use the Cox proportional hazard model to estimate the hazard ratio for each cancer associated with one standard deviation (15 IQ points) increase in intelligence, net of age. Hazard ratios less than 1.0 suggest more intelligent individuals are less susceptible to the cancer, whereas hazard ratios greater than 1.0 suggest that they are more susceptible to it. Batty et al. (2007) also estimate the hazard ratios net of age and parental social class, net of age and education, and net of age, parental social class, education, BMI, height, testing center, and birth year. However, all of the substantive conclusions remain virtually identical regardless of which hazard ratio is used, so only the results with the hazard ratios net of age will be presented below.

2.2. Epidemiological (heritability) data

Czene, Lichtenstein, and Hemminki (2002) use a sample of 9.6 million individuals in the Swedish Family-Cancer Database to compute heritabilities and shared environmental effects for different cancers, by comparing the incidence of specific cancers in parent-child, sibling-, and spouse-pairs. They compute heritabilities of 18 different cancers (stomach, colon, rectal, lung, breast, cervical invasive, cervical *in situ*, testicular, kidney, urinary bladder, melanoma, nervous system, nervous system age >15, thyroid, endocrine gland, non-Hodgkin's lymphoma, leukemia, leukemia age >15).

Batty et al.'s 2007 individual data and Czene et al.'s (2002) heritability data therefore have 10 cancers in common (hematopoietic/leukemia, skin/melanoma, testicular, colon, stomach, lung, thyroid, rectal, kidney, and bladder). The analysis below will be limited to these 10 cancers and compute the association between the hazard ratios (as a measure of correlation between intelligence and cancer risk) and heritabilities.

3. Results

Table 1 presents the heritabilities and the hazard ratios of the 10 cancers that the two data sets have in common, and Fig. 1 presents the scatter plot. As Fig. 1 makes clear, the association between the heritabilities and the hazard ratios is strongly positive ($r = .437$, $n = 10$, $p = .206$), even though the bivariate correlation does not reach statistical significance due to a very small sample size. However, if the single outlier in Fig. 1 (thyroid) is excluded, then the bivariate correlation among the nine remaining cancers becomes very strong and statistically significantly positive ($r = .780$, $n = 9$, $p = .013$) despite an even smaller sample size. It is important to note that, while the data presented in Table 1 and Fig. 1 have a small number of cases ($n = 10$), they are nonetheless based on nearly 11 million Swedish individuals, and thus the estimates of both the correlations and heritabilities should be reasonably accurate.

4. Discussion

The positive association between the heritability and the hazard ratio among the 10 different cancers supports the evolutionary novelty theory in cognitive epidemiology. It shows that the less heritable the cancer (where genes are less important in carcinogenesis), the larger the negative association between general intelligence and the likelihood of contracting the cancer, where more intelligent individuals are less likely to contract the cancer,

Table 1
Heritabilities and hazard ratios for 10 cancers.

Cancer type	Heritability	Hazard ratio
Leukemia	.09	1.02
Melanoma	.21	1.18
Testicular cancer	.25	1.05
Colon cancer	.13	.97
Stomach cancer	.01	.82
Lung cancer	.08	1.01
Thyroid cancer	.53	1.00
Rectal cancer	.12	.97
Kidney cancer	.08	.83
Bladder cancer	.07	.90

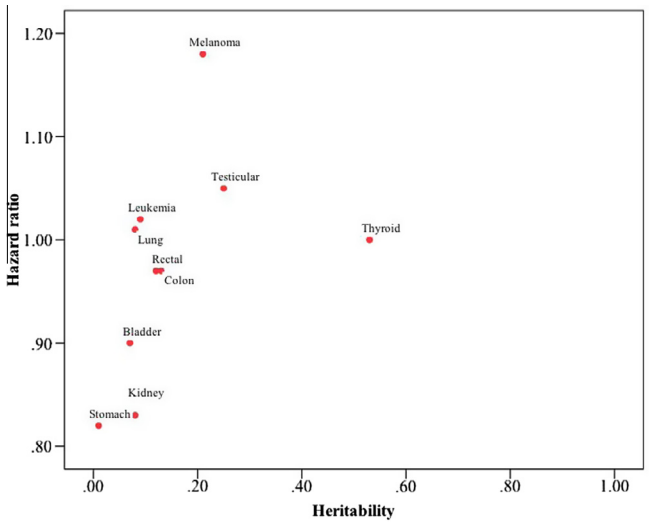

Fig. 1. Association between heritability of cancer and hazard ratio as estimate for the effect of intelligence on cancer.

presumably because of the choices such individuals make in their lives. For example, stomach cancer simultaneously has the lowest heritability (.01) and the lowest hazard ratio (.82), signifying the greater advantage associated with higher intelligence in avoiding the cancer. More intelligent individuals may be better able to avoid foods that are high in sodium known to increase the risk of stomach cancer and preferentially consume fresh fruits and vegetables known to decrease the risk.

The empirical results presented above are consistent with the prediction of the evolutionary novelty theory, which posits that more intelligent individuals stay healthier and live longer because they are better able to recognize, deal appropriately with or altogether avoid evolutionarily novel health risks and hazards. The system integrity theory would predict the opposite, a negative association between heritability and correlation, where more intelligent individuals have comparative advantage in avoiding more heritable cancers.

There are several limitations in this preliminary test of the system integrity and evolutionary novelty theories. First, while the heritability data include both men and women in Sweden, the individual data (derived from universal male conscription) include only men. The analysis has therefore had to exclude cancers that are specific to women, such as breast and cervical cancers. Future studies should estimate the effect of intelligence on cancer susceptibility among women, and explore its association with the heritabilities of cancers.

Second, the data in the current study allow the examination of the association between the heritability and the correlation for only 10 cancers. Future studies will need to expand the number of diseases, both other cancers and other diseases and causes of death, for which the estimates of the heritability and correlation are available. It is particularly important to extend the current methods to other illnesses, because the association between intelligence and cancer mortality may be ambiguous (Batty et al., 2009).

For example, Type I diabetes is known to be much more heritable than Type II diabetes (Hyttinen, Kaprio, Kinnunen, Koskenvuo, & Tuomilehto, 2003; Poulsen, Kyvik, Vaag, & Beck-Nielsen, 1999). The system integrity theory would therefore predict that the negative association between general intelligence and the likelihood of being diabetic is significantly higher for Type I diabetes than for Type II diabetes, such that the protective effect of general intelligence is stronger for Type I diabetes than for Type II diabetes. The evolutionary novelty theory would predict the opposite; the protective effect of general intelligence is stronger for Type II diabetes than for Type I diabetes. The method proposed here and employed in the current study can be extended to this and many other tests of the alternative explanations for the effect of general intelligence on health and longevity. At any rate, for all the limitations of the current study, the empirical results presented above should be interpreted as a merely preliminary and suggestive, not conclusive, test of the competing theories.

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