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Temperature and evolutionary novelty as forces behind the evolution of general intelligence ☆

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Abstract

How did human intelligence evolve to be so high? Lynn [Lynn, R. (1991). The evolution of race differences in intelligence. Mankind Quarterly, 32, 99–173] and Rushton [Rushton, J.P. (1995). Race, evolution, and behavior: A life history perspective. New Brunswick: Transaction] suggest that the main forces behind the evolution of human intelligence were the cold climate and harsh winters, which selected out individuals of lower intelligence. In contrast, Kanazawa [Kanazawa, S. (2004). General intelligence as a domain-specific adaptation. Psychological Review, 111, 512–523] contends that it is the evolutionary novelty of the environment which increased general intelligence. Multiple regression analyses support both theories. Annual mean temperature and evolutionary novelty (measured by latitude, longitude, and distance from the ancestral environment) simultaneously have independent effects on average intelligence of populations. Temperature and evolutionary novelty together explain half to two-thirds of variance in national IQ.

Keywords: Evolutionary psychology; Population differences in general intelligence; *IQ and the Wealth of Nations*; *IQ and Global Inequality*

1. Introduction

How did human intelligence evolve? Why did humans attain such high levels of general intelligence?

Two leading intelligence researchers (Lynn, 1991; Rushton, 1995) both point to the importance of climate and temperature in the evolution of general intelligence. Life in temperate and cold climate in Asia and Europe is harder to survive than that in tropical and subtropical climate in Africa, where humans lived most of their evolutionary history. Food is scarcer, and shelter and clothing more difficult to construct properly, in colder than in warmer climate. Cognitive demands placed by the need to survive harsh winters in cold climate select for higher intelligence, and thus general intelligence is expected to evolve and become higher in colder climates. In this view, the colder the climate, the higher general intelligence evolves.

Kanazawa (2004) offers a slightly different explanation for the evolution of general intelligence. He argues that what we now call general intelligence originally evolved as a domain-specific adaptation to solve evolutionarily novel problems. Since, by definition, there were very few evolutionarily novel problems for our ancestors to solve during most of human evolutionary history, general intelligence was never that important in the ancestral environment. It has become universally important now in the modern world because our environment, and the problems it presents us, are almost entirely

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evolutionarily novel. In this view, the more evolutionarily novel the environment, the higher general intelligence evolves. Cold climate is part of evolutionary novelty, so Kanazawa's (2004) *evolutionary novelty theory* in a sense subsumes Lynn's (1991) and Rushton's (1995) *temperature theory*, but there are other aspects of evolutionary novelty besides cold temperature, such as new species of fauna and flora, geography, topography, and altitude.

Given that cold temperature emphasized in Lynn and Rushton's theory is part of evolutionary novelty underscored in Kanazawa's theory, it would be difficult to adjudicate between them. Templer and Arikawa's (2006) recent study provides empirical support for Lynn and Rushton's view. Their analysis shows that, across 129 nations, winter temperature is negatively correlated with average intelligence ($r=-.76$, $p<.01$, with winter high temperature, and $r=-.66$, $p<.01$, with winter low temperature). The negative correlations hold for both within ($r=-.32$, $p<.05$, with winter high temperature, and $r=-.37$, $p<.05$, with winter low temperature) and outside ($r=-.56$, $p<.01$, with winter high temperature, and $r=-.47$, $p<.01$, with winter low temperature) sub-Saharan Africa. However, Templer and Arikawa do not include measures of evolutionary novelty in their analysis.

In this paper I empirically test Lynn (1991) and Rushton's (1995) temperature theory and Kanazawa's (2004) evolutionary novelty theory of the evolution of general intelligence in a cross-sectional analysis similar to Templer and Arikawa's (2006) study. If Lynn and Rushton's theory is correct, then geographical distribution of general intelligence will be negatively correlated with the annual mean temperature. If Kanazawa's theory is correct, then it will be correlated with the degree of evolutionary novelty.

I measure evolutionary novelty of an environment by its latitude, longitude, and distance from three arbitrarily chosen locations for the ancestral environment (the intersection of the prime meridian and the equator, South Africa, and Ethiopia). Given that mean temperature is negatively correlated with latitude but positively correlated with longitude, Lynn and Rushton's theory would predict opposite effects of latitude and longitude on the evolution of general intelligence. In contrast, Kanazawa's theory would predict that both latitude and longitude (as well as distance) have positive effects.

2. Data

2.1. Dependent variable

I use data on national IQ (the mean IQ of a national population) from Lynn and Vanhanen (2006), which is an updated and expanded edition of Lynn and Vanhanen (2002). Lynn and Vanhanen (2006) compile a comprehensive list of national IQs of 192 nations in the world (all the nations with a population of at least 40,000), either by calculating the mean scores from primary data or carefully estimating them from available sources.

In the 2006 edition, Lynn and Vanhanen increase the number of nations with measured (as opposed to estimated) national IQ from 81 to 113, and the total number of nations in their data from 185 to 192. They also address the criticisms leveled against their national IQ data presented in their 2002 book. First, they demonstrate the validity of the national IQ estimation procedure (as do Kanazawa, 2006; Templer and Arikawa, 2006), by showing that the correlation between the estimated national IQs of 26 nations in the 2002 book and their subsequently measured national IQ in the 2006 book is .9230 (Lynn & Vanhanen, 2006, pp. 53–55).[1]

Second, Lynn and Vanhanen establish the reliability of the construct of national IQ by showing that the correlation between two extreme scores (the highest and the lowest) across 71 nations for which two or more IQ scores are available is .92. The correlation between the second highest and the second lowest scores across 15 nations for which five or more scores are available is .95 (Lynn & Vanhanen, 2006, pp. 61–62).

Third, they underscore the validity of the construct of national IQ by showing that the correlation between national IQ and national scores on tests of mathematics and science range from .79 to .89 ($ps<.01$). Correction for measurement errors, by assuming the reliability of .95 for national IQ and of .83 for test scores produces a corrected correlation of 1.0 between national IQ and educational achievement (Lynn & Vanhanen, 2006, pp. 62–66).

2.2. Independent variable: temperature

I use data on annual mean temperature from Lynn and Vanhanen (2006, pp.327–333, Appendix 3). Unlike Templer and Arikawa's (2006) measures for seasonal highs and lows, Lynn and Vanhanen's is an annual (January–December) mean temperature (in degrees Celsius) over the entire 20th century (1901–2000).

[1] Lynn and Vanhanen (2006, p. 55) report a correlation of −.913 across 25 nations. However, their Table 4.2. (p. 54) inadvertently omits Cameroon. If one includes Cameroon in the calculation, the correlation increases slightly to −.923.

Table 1
Correlation matrix ($n=192$)

(a) Baseline (evolutionary environment = 0E 0N)

	Mean temperature	Latitude	Longitude	Distance
National IQ	−.6311****	.6765****	.2277****	.4538****
Mean temperature		−.8842****	.1981**	−.0369
Latitude			−.2613***	.0095
Longitude				.9520****

(b) Evolutionary environment = South Africa (30S 30E)

	Mean temperature	Alternative latitude	Alternative longitude	Distance
National IQ	−.6311****	.5531****	.1461*	.5368****
Mean temperature		−.6737****	.2683***	−.1908**
Alternative latitude			−.3249****	.2621***
Alternative longitude				.7936****

(c) Evolutionary environment = Ethiopia (10N 40E)

	Mean temperature	Alternative latitude	Alternative longitude	Distance
National IQ	−.6311****	.6134****	.1102	.2210**
Mean temperature		−.8340****	.2537***	.1065
Alternative latitude			−.2054**	−.0232
Alternative longitude				.9780****

Note: *$p<.05$, **$p<.01$, ***$p<.001$, ****$p<.0001$.

2.3. Independent variable: evolutionary novelty

The evolutionary novelty of an environment is the extent to which it differs from the evolutionary environment in sub-Saharan Africa. It includes all features of the environment and is therefore difficult to operationalize and measure precisely. I use three comprehensive (and necessarily approximate) indicators of evolutionary novelty: latitude, longitude, and distance from the evolutionary environment. While these are far from perfect measures of evolutionary novelty, they capture important aspects of it. For example, fauna

Table 2
The effects of temperature, latitude, longitude, and distance on nation IQ — baseline (evolutionary environment = 0E 0N)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean temperature (degrees Celsius)	−.9036****	−.2161	−.1228	−.1329			−1.0077****	−.8808****
	(.0806)	(.1635)	(.1355)	(.1307)			(.0730)	(.0672)
	−.6311	*−.1509*	*−.0858*	*−.0928*			*−.7038*	*−.6152*
Latitude (degrees)		.3811****	.5006****	.4142****	.5543****	.4717****		
		(.0801)	(.0674)	(.0640)	(.0320)	(.0299)		
		.5430	*.7133*	*.5902*	*.7899*	*.6722*		
Longitude (degrees)			.1131****		.1139****		.0963****	
			(.0120)		(.0120)		(.0133)	
			.4311		*.4342*		*.3671*	
Distance (1000 km)				1.1965****		1.2036****		1.1597****
				(.1147)		(.1145)		(.1263)
				.4448		*.4474*		*.4311*
Constant	101.3612	78.8066	67.8061	67.5794	64.0908	63.5680	98.0174	92.3787
	(1.6658)	(4.9976)	(4.2926)	(4.1304)	(1.2732)	(1.2275)	(1.5509)	(1.6990)
R^2	.3982	.4626	.6348	.6596	.6332	.6578	.5277	.5838
Number of cases	192	192	192	192	192	192	192	192

Note: Main entries are unstandardized regression coefficients.
(Numbers in parentheses are standard errors.)
Numbers in italics are standardized regression coefficients (betas).
*$p<.05$, **$p<.01$, ***$p<.001$, ****$p<.0001$.

and flora must physically travel from one location to another in order to migrate to a new environment (just as our ancestors did). Thus the farther away two locations are, the less likely it is that the fauna and flora of the two locations share many species in common.

2.3.1. Latitude

Because the evolutionary environment in sub-Saharan Africa is close to the equator (0 latitude), latitude (distance from the equator) serves as a rough indicator of evolutionary novelty. The higher the latitude in either direction, and thus the farther away from the equator, the more evolutionarily novel the environment in some way. It is important to note, however, that, as the analysis below shows, latitude is strongly negatively correlated with temperature, so it is at least a partial indicator of it. I use data on latitude from Lynn and Vanhanen (2006), who measure the distance from the equator to the rough geographical center of the country in degrees (no minutes or seconds). Since what matters for evolutionary novelty is the distance, not the direction, I make no distinction between north and south latitudes.

2.4. Longitude

By the same token, given that the prime meridian (0 longitude) runs very near the evolutionary environment of sub-Saharan Africa, I use longitude as another measure of evolutionary novelty. The higher the longitude in either direction, and thus the farther way from the prime meridian, the more evolutionarily novel the environment in some way. One advantage of using longitude, as well as latitude, as a measure of evolutionary novelty is that, unlike latitude, longitude is not strongly correlated with temperature; in fact, longitude is *positively* correlated with annual mean temperature (r=.1981), while latitude is *negatively* correlated with it (r=−.8842) (see Table 1 below). It therefore allows me more precisely to adjudicate between the two theories under consideration here. I use data on longitude from the World Factbook (Central Intelligence Agency, 2006). Since what matters for evolutionary novelty is the distance, not the direction, I make no distinction between east and west longitudes.

2.5. Distance

Using the Pythagoras' Theorem, I calculate the distance, "as the crow flies," between the evolutionary environment (the intersection of the equator and the prime meridian) and each country, with the formula

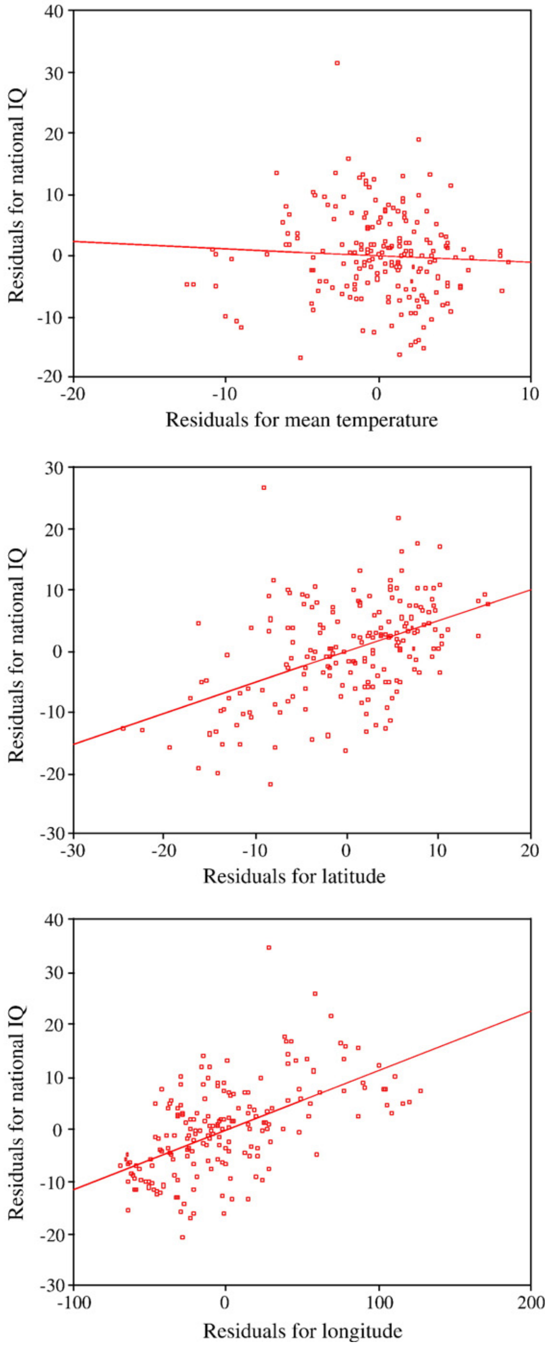

Fig. 1. Partial relationships between national IQ and mean temperature (top panel), latitude (middle panel), and longitude (bottom panel) from Model (3), Table 2 baseline model (evolutionary environment = 0E 0N).

distance $= \sqrt{(\text{Latitude}*111)^2+(\text{Longitude}*111)^2}$, 111 km being both the distance of one degree latitude, and one degree longitude at the equator (0N) (http://jan.ucc.nau.edu/~cvm/latlongdist.html).

Table 3
The effects of temperature, alternative latitude, alternative longitude, and distance on nation IQ — evolutionary environment = South Africa (30E 30S)

	(1)	(2)	(3)	(4)
Mean temperature (degrees Celsius)	−.9036****	−.6777****	−.7285****	−.6198*****
	(.0806)	(.1066)	(.0934)	(.0961)
	−.6311	*−.4733*	*−.5088*	*−.4328*
Alternative latitude (degrees from 30S)		.1183**	.1706****	.0029
		(.0376)	(.0336)	(.0584)
		.2342	*.3377*	*.0058*
Alternative longitude (degrees from 30E)			.1005****	−.0659
			(.0131)	(.0497)
			.3923	*−.2571*
Distance (1,000 km)				2.2667***
				(.6549)
				.6568
Constant	101.3612	91.3322	84.6083	80.5564
	(1.6658)	(3.5793)	(3.2492)	(3.3684)
R^2	.3982	.4282	.5652	.5913
Number of cases	192	192	192	192

Note: Main entries are unstandardized regression coefficients.
(Numbers in parentheses are standard errors.)
Numbers in italics are standardized regression coefficients (betas).
$^*p<.05$, $^{**}p<.01$, $^{***}p<.001$, $^{****}p<.0001$.

2.6. Alternative locations for the "evolutionary environment"

The use of latitude, longitude, and distance as calculated by the above formula all implicitly assumes that the site of the evolutionary environment is at or near the coordinate (0N 0E), where the equator and the prime meridian intersect. This is unfortunate because the coordinate (0N 0E) happens to be in the middle of the Atlantic Ocean off the coast of Nigeria. So this is one place where we know no humans have ever lived or evolved. I use the latitude, longitude and the coordinate (0N 0E) as a reference point purely for mathematical convenience.

While it is universally agreed that ancestral humans evolved in sub-Saharan Africa (Oppenheimer, 2003), we do not know where exactly it was in sub-Saharan Africa. Further, it is not likely to be any one location. In order to make sure that my substantive conclusions below are not dependent on the arbitrary choice of the coordinate (0N 0E) as the location of the ancestral environment, I repeat my analyses with two other equally arbitrary locations.

First, I choose the coordinate (30S 30E), because this is as far within sub-Saharan Africa from the original coordinate of (0N 0E) as one can go. The coordinate (30S 30E) is in the southeast corner of South Africa. Second, I choose the coordinate (10N 40E), because it is as far from (0N 0E) in another direction as (30S 30E). The coordinate (10N 40E) is in the middle of Ethiopia. The three chosen locations for the ancestral environment happen to be near the vertices (tips) of an inverted triangle that forms sub-Saharan Africa, so these are the three most extreme locations within sub-Saharan Africa. If my substantive conclusions hold for all three locations for the ancestral environment, I can be reasonably certain that they hold for any other point in sub-Saharan Africa.

I calculate alternative latitude and longitude for both (30E 30S) and (10N 40E), and compute the distance accordingly. For example, from (30S 30E), the coordinate (35N 65E) for Afghanistan becomes (65N 35E); from (10N 40E), it becomes (25N 25E). The formulae for calculating the distance are $\sqrt{(\text{Alternative latitude*111})^2+(\text{Alternative longitude*96})^2}$ for (30S 30N), and $\sqrt{(\text{Alternative latitude*111})^2+(\text{Alternative longitude*110})^2}$ for (10N 40E). (The distance of one degree of longitude is 96 km at 30S and 110 km at 10N. (http://jan.ucc.nau.edu/~cvm/latlongdist.html)).

3. Results[2]

3.1. Baseline models

Table 1 (a) presents the correlation matrix among the dependent variable (national IQ) and the four independent

[2] In all regression analyses below, Singapore is an outlier. None of my substantive conclusions change when I exclude Singapore from the sample, however, except, of course, to increase R^2. There are also some subnational populations, such as Australian Aborigines and Alaskan Eskimos, which have relatively low general intelligence despite low temperature or great distance from the ancestral environment (Lynn, 2006).

variables (annual mean temperature, latitude, longitude, and distance). It shows that, as predicted by Lynn and Rushton's theory, national IQ is significantly negatively correlated with annual mean temperature ($r=-.6311$, $p<.0001$). Further, consistent with Kanazawa's theory, it is also significantly positively correlated with latitude ($r=.6765$, $p<.0001$), longitude ($r=.2277$, $p<.0001$), and distance ($r=.4538$, $p<.0001$).

Among other correlations in Table 1 (a), it is important to note that annual mean temperature is significantly *negatively* correlated with latitude ($r=-.8842$, $p<.0001$), as one would expect, but significantly *positively* correlated with longitude ($r=.1981$, $p<.01$). Thus Lynn and Rushton's temperature theory would predict that latitude and longitude have opposite effects on national IQ, whereas Kanazawa's evolutionary novelty theory would predict that they would have the same effect.

Table 2 presents the results of multiple regression analyses. Column (1) shows that, consistent with Lynn and Rushton's theory, and the bivariate correlation in Table 1 (a), annual mean temperature has a significantly negative effect on national IQ ($b=-.9036$, $p<.0001$, beta$=-.6311$). The unstandardized coefficient of −.9036 means that a decrease of 1 °C in annual mean temperature is associated with an increase in national IQ of .9 point. Annual mean temperature accounts for 40% of variance in national IQ by itself.

Column (2) shows, however, that, once latitude, which is highly correlated with annual mean temperature ($r=-.8842$), is entered into the model, annual mean temperature ceases to have a significant effect on national IQ ($b=-.2161$, *ns*, beta$=-.1509$), while latitude has a significantly positive effect on national IQ ($b=.3811$, $p<.0001$, beta$=.5430$). Despite the high correlation between latitude and annual mean temperature, collinearity is not a problem (VIF$=4.58$ for both annual mean temperature and latitude).

Latitude continues to have a significant effect on national IQ ($b=.5006$, $p<.0001$, beta$=.7133$) when longitude is added to the model. Consistent with Kanazawa's theory, longitude also has a significantly positive effect on national IQ ($b=.1131$, $p<.0001$, beta$=.4311$). Despite the fact that latitude and longitude are negatively correlated ($r=-.2613$, $p<.001$) among the 192 nations in this sample, they both significantly increase national IQ. The farther away a nation is from the coordinate (0N 0E), both latitudinally and longitudinally, the higher the average intelligence of a population. Model (3) accounts for 63% of the variance in national IQ.

Because longitude and distance are very highly correlated ($r=.9520$, $p<.0001$), I cannot enter them

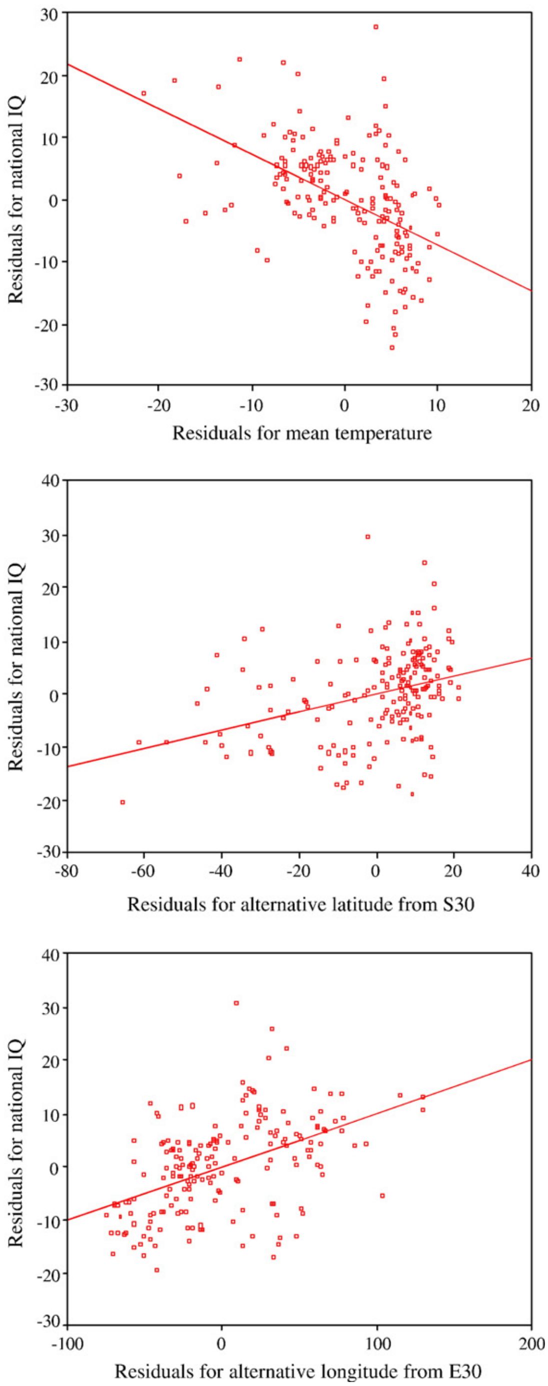

Fig. 2. Partial relationships between national IQ and mean temperature (top panel), alternative latitude from 30S (middle panel), and alternative longitude from 30E (bottom panel) from Model (3), Table 3 evolutionary environment = South Africa (30E 30S).

both simultaneously into a model; if I did, collinearity results (VIF$=49.03$ for longitude, and 45.62 for distance). So Model (4) includes annual mean

Table 4
The effects of temperature, alternative latitude, alternative longitude, and distance on nation IQ — evolutionary environment = Ethiopia (40E 10N)

	(1)	(2)	(3)	(4)
Mean temperature (degrees Celsius)	−.9036****	−.5620***	−.6732****	−.6752****
	(.0806)	(.1434)	(.1354)	(.1359)
	−.6311	*−.3925*	*−.4701*	*−.4716*
Alternative latitude (degrees from 10N)		.2269**	.2222**	.1797*
		(.0794)	(.0741)	(.0748)
		.2861	*.2803*	*.2265*
Alternative longitude (degrees from 40E)			.0737****	
			(.0137)	
			.2870	
Distance (1,000 km)				.7210****
				(.1366)
				.2765
Constant	101.3612	90.2378	88.4553	88.3408
	(1.6658)	(4.2224)	(3.9546)	(3.9672)
R^2	.3982	.4232	.5002	.4976
Number of cases	192	192	192	192

Note: Main entries are unstandardized regression coefficients.
(Numbers in parentheses are standard errors.)
Numbers in italics are standardized regression coefficients (betas).
*$p<.05$, **$p<.01$, ***$p<.001$, ****$p<.0001$.

temperature, latitude, and distance in 1000 km from the coordinate (0N 0E) without longitude. Annual mean temperature has no significant effect ($b=-.1329$, *ns*, beta$=-.0928$), while both latitude ($b=.4142$, $p<.0001$, beta$=.5902$) and distance ($b=1.1965$, $p<.0001$, beta$=.4448$) have significantly positive effects on national IQ. The unstandardized coefficient of 1.1965 for distance means that, controlling for annual mean temperature and latitude, an increase in distance of every 1000 km from the coordinate (0N 0E) increases national IQ by 1.2 points. Model (4) accounts for two-thirds of the variance in national IQ.

A comparison of Models (5) and (3) shows that latitude and longitude alone account for 63% of the variance in national IQ, and annual mean temperature does not add at all to the explained variance. A comparison of Models (6) and (4) shows that latitude and distance alone account for 66% of the variance in national IQ, and annual mean temperature does not add at all to the explained variance. On the other hand, however, Models (7) and (8) show that annual mean temperature has a significant effect on national IQ, either with longitude or distance, *as long as latitude is not included in the model*. So latitude and annual mean temperature appear to be the indicators of each other; however, latitude explains more variance in national IQ than annual mean temperature does.

Fig. 1 presents the scatterplots, depicting partial relationships between national IQ on the one hand, and annual mean temperature (top panel), latitude (middle panel), and longitude (bottom panel) from Model (3) in Table 2. It shows that the partial correlation between annual mean temperature and national IQ is virtually zero (partial $r=-.0858$), whereas both latitude and longitude are strongly and positively correlated with national IQ (partial $r=.7133$ with latitude and .4311 with longitude). It is interesting to note that the intercept for both Models (3) and (4), which represents the predicted national IQ at the coordinate (0N 0E) (when the annual mean temperature is zero) is 68, very close to the average IQ in sub-Saharan Africa of 69, according to Lynn (2006).

3.2. Alternative models: ancestral environment = South Africa

Table 3 presents the results of multiple regression analyses when I choose South Africa (30S 30E) as the arbitrary location for the ancestral environment. Column (1) is reproduced here from Table 2 for the purpose of comparison to other columns in the table. Column (2) shows that, unlike when I choose (0N 0E) as the arbitrary location for the ancestral environment, annual mean temperature has a significantly negative effect even when alternative latitude is controlled ($b=-.6777$, $p<.0001$, beta$=-.4733$). The alternative latitude (degrees from 30S) has a significantly positive effect on national IQ ($b=.1183$, $p<.01$, beta$=.2342$). Column (3) shows that, even with annual mean temperature and alternative latitude controlled, alternative longitude (degrees from 30E) has a significantly positive effect on national IQ (b=.1005, p<.0001, beta=.3923).

Unlike when I choose the coordinate (0N 0E) as the arbitrary location of the ancestral environment, longitude and distance are not too highly correlated when I choose South Africa (30S 30E) as the reference point. Table 1 (b) shows that the correlation between alternative longitude and distance is only .7936. This allows me to enter both alternative longitude and distance into the multiple regression model simultaneously without the problem of collinearity (VIF=17.24 for alternative longitude and 16.48 for distance). Column (4) shows that, when distance is included in the model, alternative latitude and longitude cease to have significant effects on national IQ, but distance does (b=2.2667, p<.001, beta=.6568). The unstandardized coefficient of 2.2667 means that national IQ increases by more than two and a quarter points for every 1000 km from South Africa.[3] While annual mean temperature continues to have a significantly negative effect on national IQ (b=−.6198, p<.0001, beta=−.4328), a comparison of standardized coefficients shows that distance from South Africa has a much larger effect on national IQ than annual mean temperature (−.4328 vs. .6368). Model (4) accounts for nearly 60% of the variance in national IQ.

Fig. 2 depicts partial relationships between national IQ on the one hand, and annual mean temperature (top panel), alternative latitude (middle panel), and alternative longitude (bottom panel) taken from Model (3) in Table 3. The scatterplots show that both temperature and evolutionary novelty (measured by distance from South Africa) have significant and strong partial correlations with national IQ.

3.3. Alternative models: ancestral environment = Ethiopia

Table 4 presents the results of multiple regression analyses when I choose Ethiopia (10N 40E) as the arbitrary location for the ancestral environment. Column (2) shows that, as when I choose South Africa as the arbitrary location for the ancestral environment, when entered simultaneously, both annual mean temperature

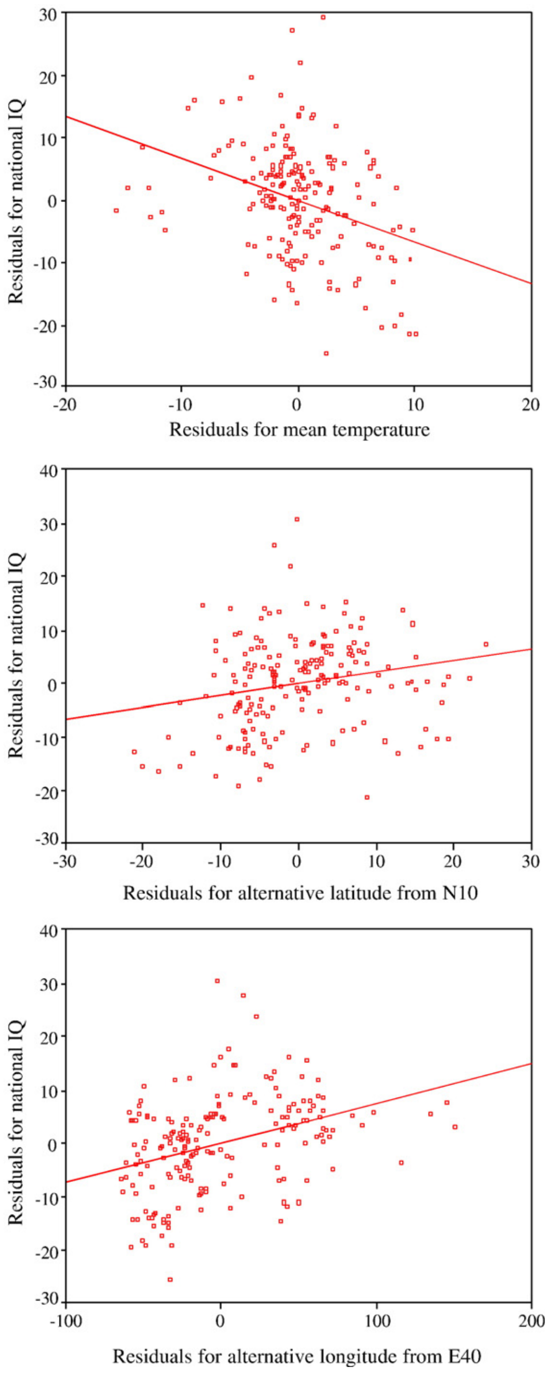

Fig. 3. Partial relationships between national IQ and mean temperature (top panel), alternative latitude from 10N (middle panel), and alternative longitude from 40E (bottom panel) from Model (3), Table 4 evolutionary environment = Ethiopia (10N 40E).

and alternative latitude (degrees from 10N) have significant effects on national IQ: Annual mean temperature significantly decreases national IQ (b=−.5620, p<.001, beta=−.3925) and alternative latitude significantly

[3] Caution is necessary in interpreting the regression coefficient for distance in Model 4, Table 3, when latitude and longitude are included in the model. It is physically impossible to increase the distance while holding both latitude and longitude constant, as the latter two uniquely and mathematically determine the former. This probably explains why neither latitude nor longitude has a significant effect in Model 4, Table 3, when distance is included. I thank one anonymous reviewer for pointing this out to me.

increases it ($b=.2269$, $p<.01$, beta=.2861). Column (3) shows that, when entered simultaneously, annual mean temperature, alternative latitude, and alternative longitude all have significant effects on national IQ. Annual mean temperature decreases it ($b=-.6732$, $p<.0001$, beta=−.4701) and alternative latitude ($b=.2222$, $p<.01$, beta=.2803) and alternative longitude ($b=.0737$, $p<.0001$, beta=.2870) increase it.

When I choose the coordinate (10N 40E) right in the middle of Ethiopia as the arbitrary location for the ancestral environment, alternative longitude and distance are once again very highly correlated ($r=.9780$), and they cannot be entered into the model simultaneously without causing collinearity (VIF=99.79 for alternative longitude and 95.79 for distance). So I enter distance without alternative longitude in Model (4). It shows that, even when annual mean temperature and alternative latitude are controlled, distance from Ethiopia has a significantly positive effect on national IQ ($b=.7210$, $p<.0001$, beta=.2765). Both annual mean temperature ($b=-.6752$, $p<.0001$, beta= −.4716) and alternative latitude ($b=.1797$, $p<.05$, beta=.2265) continue to have significant effects on national IQ. Whether I use alternative longitude (Model (3)) or distance (Model (4)), the multiple regression model accounts for exactly half of the variance in national IQ.

Fig. 3 depicts partial relationships between national IQ on the one hand, and annual mean temperature (top panel), alternative latitude (middle panel), and alternative longitude (bottom panel) taken from Model (3) in Table 4. The scatterplots show that both temperature and evolutionary novelty (measured by distance from Ethiopia) have significant and strong partial correlations with national IQ.

4. Conclusion

My multiple regression analyses strongly support both Lynn and Rushton's temperature theory and Kanazawa's evolutionary novelty theory of the evolution of general intelligence. Except when I choose the intersection of the equator and the prime meridian as the arbitrary location of the ancestral environment, the annual mean temperature of a nation has a consistently negative effect on the nation's average intelligence. Precisely as Lynn (1991) and Rushton (1995) predict, the colder the climate on average, the higher the population's intelligence, even when its location (in terms of longitude and latitude) is controlled.

The analysis also supports Kanazawa's (2004) theory of the evolution of general intelligence as a domain-specific adaptation for evolutionary novelty. Even when annual mean temperature is controlled, the evolutionary novelty of the location, measured by the distance from various locations for the ancestral environment, has a consistently strong positive effect on national IQ. The more evolutionarily novel the environment, that is, the farther away from anywhere in sub-Saharan Africa, the higher the average intelligence of a population. It is important to note that, while latitude and alternative latitudes are predictably negatively correlated with annual mean temperature, longitude and alternative longitude are positively correlated with it, *yet both latitude and longitude have significantly positive effects on national IQ*. It appears that longitude and latitudes are measuring something quite different from temperature. The farther away a nation is from sub-Saharan Africa, both latitudinally and longitudinally, the higher the average intelligence of the nation's population.

The importance of temperature and evolutionary novelty remains regardless of the location I arbitrarily choose as the ancestral environment. I have chosen three extreme locations within sub-Saharan Africa as a possible site of human evolution: the coordinate (0N 0E), which happens to be off the coast of Nigeria in the middle of the Atlantic Ocean; the coordinate (30S 30E), which is on the southeast edge of present-day South Africa; and the coordinate (10N 40E), which is right in the middle of present-day Ethiopia. Regardless of how I measure evolutionary novelty, the substantive conclusions remain the same. The colder the climate, the higher the average intelligence. The more evolutionarily novel the environment, the higher the average intelligence. Temperature and evolutionary novelty together account for between half and two-thirds of the international variance in national IQ.

Of course, the farther away two populations are, the more phylogenetically and genetically distant they are (Oppenheimer, 2003), and this may provide a proximate explanation for the evolution of general intelligence. However, it is not necessary that general intelligence increase with phylogenetic distance. There are many human traits which do not vary as a function of phylogenetic distance, such as vision and hearing. Kanazawa's evolutionary novelty theory may explain why general intelligence is correlated with phylogenetic distance.

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