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Why night owls are more intelligent

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ABSTRACT

The origin of values and preferences is an unresolved theoretical problem in social and behavioral sciences. The Savanna–IQ Interaction Hypothesis suggests that more intelligent individuals are more likely to acquire and espouse evolutionarily novel values and preferences than less intelligent individuals, but general intelligence has no effect on the acquisition and espousal of evolutionarily familiar values and preferences. Individuals can often choose their values and preferences even in the face of genetic predisposition. One example of such choice within genetic constraint is circadian rhythms. Survey of ethnographies of traditional societies suggests that nocturnal activities were probably rare in the ancestral environment, so the Hypothesis would predict that more intelligent individuals are more likely to be nocturnal than less intelligent individuals. The analysis of the National Longitudinal Study of Adolescent Health (Add Health) confirms the prediction.

1. Introduction

Where do individual values and preferences come from? Why do people like or want what they do? The origin of individual values and preferences is one of the remaining theoretical puzzles in social and behavioral sciences (Kanazawa, 2001).

Recent theoretical developments in evolutionary psychology may suggest one possible explanation. On the one hand, evolutionary psychology (Crawford, 1993; Symons, 1990; Tooby & Cosmides, 1990) posits that the human brain, just like any other organ of any other species, is designed for and adapted to the conditions of the ancestral environment (roughly the African savanna during the Pleistocene Epoch), not necessarily to the current environment. It may therefore have difficulty comprehending and dealing with entities and situations that did not exist in the ancestral environment (Kanazawa, 2002, 2004a). On the other hand, an evolutionary psychological theory of the evolution of general intelligence proposes that general intelligence may have evolved as a domain-specific adaptation to solve evolutionarily novel problems, for which there are no predesigned psychological adaptations (Kanazawa, 2004b, 2008).

The synthesis of these two theories, *the Savanna–IQ Interaction Hypothesis* (Kanazawa, 2010), implies that the human brain's difficulty with evolutionarily novel stimuli may interact with general intelligence, such that more intelligent individuals have less difficulty with such stimuli than less intelligent individuals. In contrast, general intelligence may not affect individuals' ability to comprehend and deal with evolutionarily familiar entities and situations. The Hypothesis, applied to values and preferences, may suggest that *more intelligent individuals are more likely to acquire and espouse evolutionarily novel values than less intelligent individuals, whereas general intelligence does not affect the acquisition and espousal of evolutionarily familiar values.* In this paper, we test this prediction with respect to one value domain (circadian rhythms), which is under some genetic influence. We show that, consistent with the Hypothesis, more intelligent individuals are more likely to be nocturnal than less intelligent individuals.

2. Choice within genetic predisposition

Choice is not incompatible with or antithetical to genetic influence. As long as $h^2 < 1.0$, genes merely set a broad reaction range, and individuals can still exercise some choice within broad genetic constraints. For example, political scientists have discovered that two genes are responsible for predisposing individuals to be more or less likely to vote in elections (Fowler & Dawes, 2008). However, individuals can still choose to turn out to vote or not for any election, and there are environmental (nongenetic) factors that can predict their voting (Kanazawa, 1998, 2000).

Similarly, genetic influences and constraints do not preclude individual acquisition and espousal of values and preferences.

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Individuals can still choose certain values and preferences even in the face of genetic predisposition. For example, both political ideology (Alford, Funk, & Hibbing, 2005) and religiosity (Bouchard, McGue, Lykken, & Tellegen, 1999; Koenig, McGue, Krueger, & Bouchard, 2005) have now been shown to have genetic bases; some individuals are genetically predisposed to be liberal or conservative, or more or less religious. Yet more intelligent children are more likely to grow up to be liberal and less likely to grow up to be religious (Kanazawa, 2010). In this paper, we focus on one example of such choice within genetic constraints: whether one is a morning person or a night person (circadian typology).

3. Circadian typology (morningness–eveningness)

Virtually all species in nature, from single-cell organisms to mammals, including humans, exhibit a daily cycle of activity called the circadian rhythm. "This timekeeping system, or biological "clock," allows the organism to anticipate and prepare for the changes in the physical environment that are associated with day and night, thereby ensuring that the organism will "do the right thing" at the right time of the day" (Vitaterna, Takahashi, & Turek, 2001, p. 85). The circadian rhythm in mammals is regulated by two clusters of nerve cells called the suprachiasmatic nuclei (SCN) in the anterior hypothalamus (Klein, Moore, & Reppert, 1991). Geneticists have by now identified a set of genes that regulate the SCN and thus the circadian rhythm among mammals (King & Takahashi, 2000). A behavior genetic study of South Korean twins ($n = 977$ pairs) shows that heritability in morningness–eveningness is .45 and nonshared environment accounts for 55% of the variance, while shared environment does not appear to explain any of the variance in it (Hur, 2007).

"For most animals, the timing of sleep and wakefulness under natural conditions is in synchrony with the circadian control of the sleep cycle and all other circadian-controlled rhythms. *Humans, however, have the unique ability to cognitively override their internal biological clock and its rhythmic outputs*" (Vitaterna et al., 2001, p. 90; emphasis added). While there are some individual differences in the circadian rhythm, where some individuals are more nocturnal than others, humans are basically a diurnal (as opposed to nocturnal) species. Humans rely very heavily on vision for navigation but, unlike genuinely nocturnal species, cannot see in the dark or under little lighting, and our ancestors did not have artificial lighting during the night until the domestication of fire. Any human in the ancestral environment up and about during the night would have been at risk of predation by nocturnal predators. It is therefore safe to assume that our ancestors rose at around dawn and went to sleep at around dusk, to take full advantage of the natural light provided by the sun, and the "night life" (sustained and organized activities at night after dusk) is probably evolutionarily novel.

In order to ascertain the extent to which our ancestors might have engaged in nocturnal activities, we have consulted ethnographic records of traditional societies throughout the world. In the 10-volume compendium *The Encyclopedia of World Cultures* (Levinson, 1991–1995), which extensively describes *all* human cultures known to anthropology, there is no mention of nocturnal activities in any of the traditional cultures. There are no entries in the index for "nocturnal," "night," "evening," "dark(ness)," and "all-night." The few references to the "moon" are all religious, as in "moon deity," "Mother Moon (deity)," and "moon worship." The only exception is the "night courting," which is a socially approved custom of premarital sex observed among the Danes and the Finns, which are entirely western cultures far outside of the ancestral environment.

In addition, we have consulted the following extensive (monograph-length) ethnographies of traditional societies around the world: *Yanomamö* (Chagnon, 1992); *From Mukogodo to Maasai: Ethnicity and Cultural Change in Kenya* (Cronk, 2004); *Ache Life History: The Ecology and Demography of a Foraging People* (Hill & Hurtado, 1996); *The !Kung San: Men, Women, and Work in a Foraging Society* (Lee, 1979); and *Sacha Runa: Ethnicity and Adaptation of Ecuadorian Jungle Quichua* (Whitten, 1976). Many of these ethnographies contain a section where the authors describe what usually happens and what people routinely do in a typical day in the tribal society under study.

These detailed ethnographic records make it clear that the day for people in these traditional societies begins shortly before sun rise, and ends shortly after sun set. "Daily activities begin early in a Yanomamö village" (Chagnon, 1992, p. 129). "The day begins about 6 a.m., when the sun is about to rise" (Cronk, 2004, p. 88). The only routine activities conducted after dark are people conversing and visiting with each other as they drift off to sleep. "Despite the inevitable last-minute visiting, things are usually quiet in the village by the time it is dark" (Chagnon, 1992, p. 132). "Most evenings are spent quietly chatting with family members indoors. If the moon is full then it is possible to see almost as well as during the day, and people take advantage of the light by staying up late and socializing a great deal" (Cronk, 2004, p. 93). "After cooking and consuming food, evening is often the time of singing and joking. Eventually band members drift off to sleep, with one or two nuclear families around each fire" (Hill & Hurtado, 1996, p. 65). The only nocturnal activities, other than chatting, visiting, and making speeches, that we can find in all of these ethnographies is when Mukogodo men go searching for missing animals in the dark, *if* one happens to be missing (Cronk, 2004, p. 92).

Ethnographic evidence of traditional societies therefore suggests that our ancestors probably had a largely diurnal lifestyle, and sustained and routine nocturnal activities may be evolutionarily novel. The Savanna–IQ Interaction Hypothesis would therefore predict that more intelligent individuals are more likely to be nocturnal, getting up later in the morning and going to bed later in the evening, than less intelligent individuals. To our knowledge, there is only one study which examines the association between intelligence and circadian rhythm. Roberts and Kyllonen (1999) find that, in a small sample of United States Air Force recruits ($n = 420$), evening types are significantly more intelligent than morning types. We seek to replicate their findings in a large, nationally representative sample of Americans.

4. Empirical analysis

4.1. Method

4.1.1. Data: National Longitudinal Study of Adolescent Health (Add Health)

A sample of 80 high schools and 52 middle schools from the US was selected with unequal probability of selection. Incorporating systematic sampling methods and implicit stratification into the Add Health study design ensures this sample is representative of US schools with respect to region of country, school size, school type, and ethnicity. A sample of 20,745 adolescents were personally interviewed in their homes in 1994–1995 (Wave I), and again in 1996 (Wave II; $n = 14{,}738$). In 2001–2002, 15,197 of the original Wave I respondents, now age 18–28, were interviewed in their homes. Our sample consists of Wave III respondents.

4.1.2. Dependent variable: nocturnality

Add Health asks its respondents about their sleeping habits with four different questions in Wave III. "On days when you go to work, school, or similar activities, what time do you usually wake up?" "What time do you usually go to sleep the night (or day) before?" "On days you don't have to get up at a certain time, what time do you usually get up?" "On those days, what time do you usually go to sleep the night or day before?" We call the first type of days "weekdays" and the latter type of days "weekend."

For each question, the respondent indicates the time by first marking the hour (from 1:00 to 12:00), then the minute (from 00 to 59), and finally indicating whether the hour is AM or PM. The distributions of indicated bedtimes show that a large number of respondents ($n = 3{,}073$, 20.2% for weeknights, and $n = 2{,}971$, 19.5% for weekends) claim to go to bed at 12:00PM (noon) and 12:30PM (half an hour after noon), when very few people claim to go to bed during the 11:00 h or the 13:00 h. We assume this is a result of the confusion of 12:00AM (midnight) and 12:00PM (noon). We have therefore changed all 12:00 h bedtime to 00:00 h bedtime. The reassignment of these cases does not affect our substantive conclusion at all; in fact, the predicted effect of intelligence on nocturnality is slightly *stronger* if we delete all of these cases rather than reassign them.

4.1.3. Independent variable: childhood IQ

Add Health measures respondents' intelligence with the Peabody Picture Vocabulary Test (PPVT). The raw scores (0–87) are age-standardized and converted to the IQ metric, with a mean of 100 and a standard deviation of 15. The PPVT is a valid measure of verbal intelligence, not general intelligence. However, verbal intelligence is known to be highly correlated with (and thus heavily loads on) general intelligence. Miner's (1957) extensive review of 36 studies shows that the median correlation between vocabulary and general intelligence is .83. Wolfle (1980) reports that the correlation between a full-scale IQ test (Army General Classification Test) and the General Social Surveys synonyms measure is .71. As a result, the GSS synonyms measure has been used widely by intelligence researchers to assess trends in general intelligence (Huang & Hauser, 1998). In order to establish the direction of causality more clearly, we will use the measure of intelligence taken in Wave I (in 1994–1995 when the respondents were in junior high and high school) to predict their adult nocturnality in Wave III (in 2001–2002 when the respondents were in their early adulthood).

Control variables. We control for the following variables: age (even though there is very little variance in it given that these are cohort data); sex (0 if female, 1 if male); race (with three dummies for Asian, black, and Native American, with white as the reference category); marital status (1 if currently married); parental status (1 if parent); education (years of formal schooling); earnings (in dollars); and religion (with four dummies for Catholic, Protestant, Jewish, and other, with none as the reference category).

Further, because previous studies show that students are more likely to be nocturnal than comparable individuals in full-time employment (Mecacci & Zani, 1983), we control for whether or not the respondent is a student (1 if currently in school). In addition, because demands of work can affect one's sleeping patterns, we control for how many hours the respondent typically works in a week.

5. Results

Fig. 1 presents bivariate associations between childhood IQ and chronobiology. We divide the Add Health sample into five "cognitive classes" (Herrnstein & Murray, 1994) by childhood IQ: "Very dull" (IQ < 75); "Dull" (75 < IQ < 90); "Normal" (90 < IQ < 110); "Bright" (110 < IQ < 125); and "Very bright" (IQ > 125). Fig. 1, Panel (a), shows that there is a monotonic association between cognitive class and the time Add Health respondents go to bed on weeknights. "Very dull" individuals ($n = 584$) on average go to bed at 23:41; "dull" individuals ($n = 2{,}967$) go to bed at 00:03; "normal" individuals ($n = 6{,}820$) go to bed at 00:10; "bright" individuals ($n = 3{,}483$) go to bed at 00:21; and "very bright" individuals ($n = 468$) go to bed at 00:29. The absolute differences in minutes are small, but all the differences between two adjacent categories are statistically significant, except for "bright" and "very bright."

Fig. 1, Panel (b), similarly shows that, while individuals of all cognitive classes go to bed roughly one hour later on weekends than they do on weeknights, there is still a monotonic association between cognitive class and the time Add Health respondents go to bed on weekends. "Very dull" individuals ($n = 585$) on average go to bed at 00:35; "dull" individuals ($n = 2{,}985$) go to bed at 01:03; "normal" individuals ($n = 6{,}854$) go to bed at 01:13; "bright" individuals ($n = 3{,}488$) go to bed at 01:25; and "very bright" individuals ($n = 465$) go to bed at 01:44. All the differences between two adjacent categories are statistically significant.

Fig. 1, Panel (c), shows that there is a monotonic association between cognitive class and what time Add Health respondents wake up on weekday morning. "Very dull" individuals ($n = 583$) on average wake up at 07:20; "dull" individuals ($n = 2{,}965$) wake up at 07:25; "normal" individuals ($n = 6{,}814$) wake up at 07:32; "bright" individuals ($n = 3{,}480$) wake up at 07:40; and "very bright" individuals ($n = 468$) wake up at 07:52. All the differences between two adjacent categories are statistically significant, except for "very dull" and "dull."

Finally, Fig. 1, Panel (d), shows that, while individuals of all cognitive classes wake up roughly three hours later on weekends than they do on weekdays, there is still a monotonic association between cognitive class and what time Add Health respondents wake up on weekend morning. "Very dull" individuals ($n = 586$) on average wake up at 10:09; both "dull" individuals ($n = 2{,}986$) and "normal" individuals ($n = 6{,}850$) wake up at 10:14; "bright" individuals ($n = 3{,}488$) wake up at 10:23; and "very bright" individuals ($n = 466$) wake up at 11:07. Only the differences between "normal" and "bright" and between "bright" and "very bright" are statistically significant.

Table 1 presents the results of OLS regression analyses of Add Health respondents' circadian rhythms. (The dependent variable here is converted from the normal base-60 sexagesimal time to the base-10 decimal time.) The first column shows that, net of age, sex, race, marital status, parental status, education, earnings, religion, student status and number of hours worked, childhood IQ significantly delays the time that Add Health respondents usually go to bed on weeknight. Older respondents (even in this limited age range) go to bed earlier than younger respondents, and men go to bed later than women. Consistent with expectations, married individuals and parents go to bed earlier. Christians (Catholics and Protestants) go to bed earlier, and, consistent with a previous finding (Mecacci & Zani, 1983), current students go to bed later than nonstudents. As expected, individuals who work more hours go to bed earlier.

Table 1, second column, shows that, net of the same control variables, childhood IQ significantly delays the time that Add Health respondents usually go to bed on weekends. Most of the other variables in the equation have the same effect on weekend bedtime as they do on weeknight bedtime, with the exception that blacks go to bed significantly later than whites on weekends but not on weeknights. Marital and parental statuses have much greater negative effect on weekend bedtime than weeknight bedtime.

Table 1, third column, shows that, net of the same control variables, childhood IQ significantly delays the time that Add Health respondents usually wake up on weekdays. Most of the other variables in the equation have the same effect on what time they wake

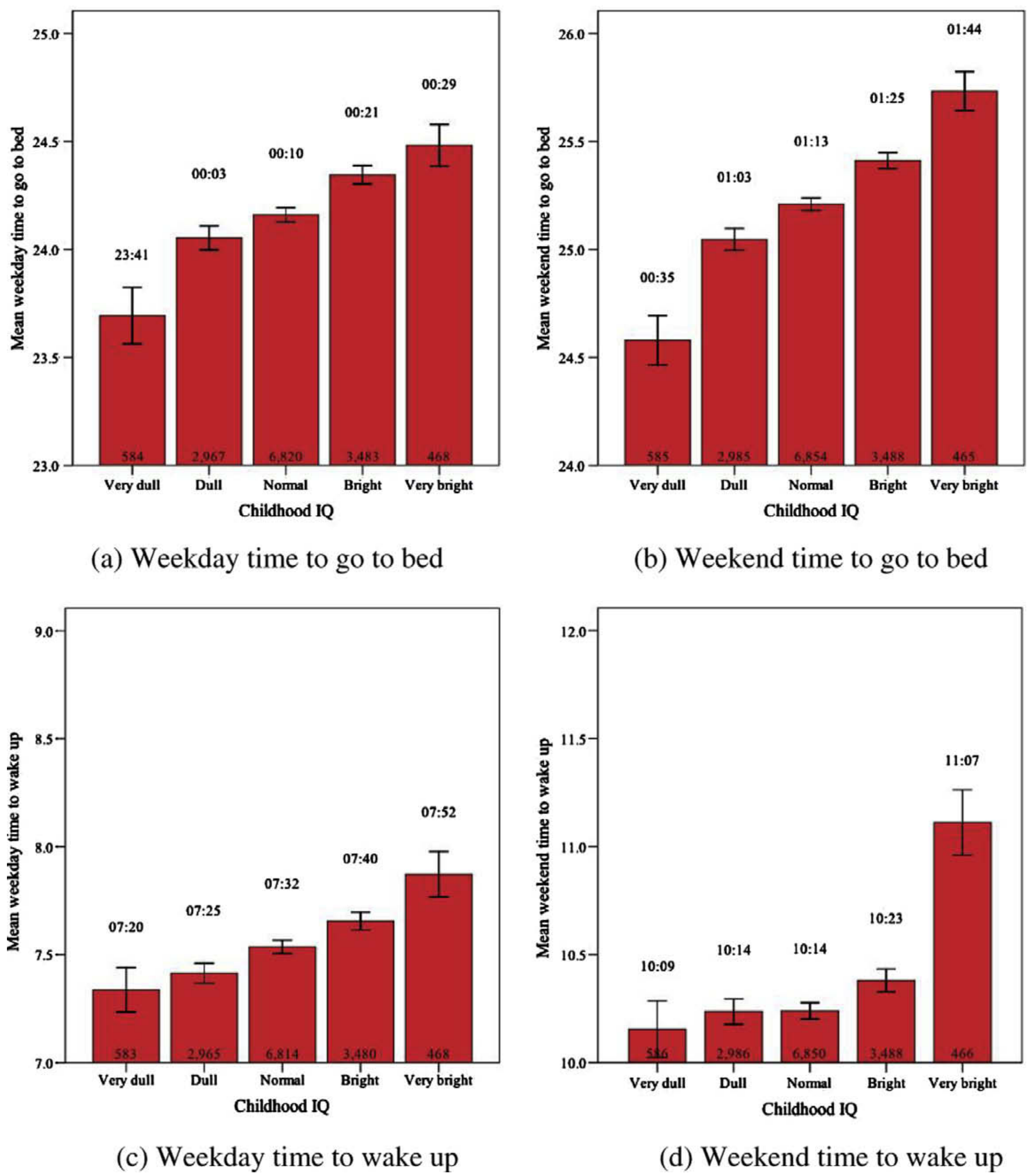

Fig. 1. Bivariate association between childhood IQ and chronobiology. Note: Error bars represent the standard error for the mean.

up on weekdays as they do on what time they go to bed on weeknights, with the exception that more educated people wake up earlier on weekdays. While individuals who work longer hours go to bed earlier and wake up earlier on weekdays, students go to bed *later* and wake up *earlier*. Table 1, fourth column, shows that, while the effect of childhood IQ on what time Add Health respondents wake up on weekend is once again positive, its effect does not reach statistical significance ($p > .18$). Most of the other variables have the same effects as before.

An anonymous reviewer suggests that the Savanna–IQ Interaction Hypothesis may also imply that more intelligent individuals have a greater variance in their chronobiology than less intelligent individuals. It does not appear to be the case, however, with the Add Health data. The test of homogeneity of variances shows that variances are heterogeneous by childhood cognitive class in weekday time to go to bed (Levene statistic = 14.590, df = 4, 14317, $p < .001$), weekend time to go to bed (Levene = 15.295, df = 4, 14372, $p < .001$), and weekday time to wake up (Levene = 3.182, df = 4, 14305, $p < .05$), but not in weekend time to wake up (Levene = 2.084, df = 4, 14371, $p > .05$). However, for weekday and weekend time to go to bed, variance *decreases* with childhood intelligence; for weekday time to wake up, it has an inverted U-shaped distribution, with the greatest variance among the "normal" childhood IQ category.

Taken together, results presented in Table 1 largely support our hypothesis that more intelligent individuals are more likely to be night owls. The effect of childhood IQ on three out of four measures of nocturnality is significantly positive, even net of a large number of demographic and biological variables expected to affect circadian rhythms. However, we should point out that, while the effects of childhood IQ are highly statistically significant due to the large sample size, both the effect size (measured by the standardized regression coefficient) and the proportion of explained variance (R^2) are very small.

Table 1
The effect of childhood IQ on adult circadian typology (measured in hours) Add Health.

	Time to go to bed		Time to wake up	
	Weeknight	Weekend	Weekday	Weekend
Childhood IQ	.0080****	.0088****	.0078****	.0029
	(.0019)	(.0017)	(.0019)	(.0022)
	.0435	*.0529*	*.0443*	*.0134*
Age	−.0430*	−.0957****	−.0893****	−.2200****
	(.0169)	(.0149)	(.0162)	(.0195)
	−.0282	*−.0698*	*−.0611*	*−.1219*
Sex	.3832****	.6119****	.2113****	.5407****
(0 = female, 1 = male)	(.0528)	(.0463)	(.0506)	(.0607)
	.0721	*.1280*	*.0415*	*.0859*
Race				
Asian	.0313	.0479	.0731	−.0465
	(.0596)	(.0524)	(.0571)	(.0686)
	.0060	*.0103*	*.0147*	*−.0076*
Black	.0740	.0980*	−.0352	.1578*
	(.0566)	(.0496)	(.0542)	(.0650)
	.0153	*.0226*	*−.0076*	*.0276*
Native American	−.0592	.0006	.0298	−.0559
	(.0717)	(.0629)	(.0688)	(.0825)
	−.0100	*.0001*	*.0053*	*−.0080*
Marital status (1 if currently married)	−.4591****	−.7419****	−.3207****	−.6765****
	(.0739)	(.0648)	(.0709)	(.0849)
	−.0648	*−.1166*	*−.0473*	−.0808
Parental status (1 if parent)	−.2040**	−.5027****	−.3155****	−1.0129****
	(.0734)	(.0644)	(.0704)	(.0843)
	−.0297	*−.0814*	*−.0479*	*−.1245*
Education	−.0214	−.0312*	−.0384*	−.0596**
	(.0158)	(.0138)	(.0151)	(.0181)
	−.0157	*−.0255*	*−.0294*	*−.0369*
Earnings	.0000****	−.0000	−.0000	−.0000****
	(.0000)	(.0000)	(.0000)	(.0000)
	.0487	*−.0042*	*−.0194*	*−.0387*
Religion				
Catholic	−.2128**	−.0476	−.3124****	−.3124***
	(.0771)	(.0677)	(.0739)	(.0887)
	−.0351	*−.0087*	*−.0538*	*−.0435*
Protestant	−.3106***	−.4255****	−.3220***	−.5402****
	(.0894)	(.0784)	(.0857)	(.1027)
	−.0409	*−.0623*	*−.0442*	*−.0601*
Jewish	.4470	.1745	.2551	.3269
	(.3005)	(.2640)	(.2880)	(.3458)
	.0145	*.0063*	*.0086*	*.0089*
Other	.0162	−.2142***	−.1187	−.4109****
	(.0715)	(.0627)	(.0685)	(.0822)
	.0030	*−.0438*	*−.0227*	*−.0637*
Currently in school (1 if currently in school)	.1576*	.0716	−.2339****	.0906
	(.0613)	(.0538)	(.0588)	(.0705)
	.0288	*.0146*	*−.0446*	*.0140*
Hours worked	−.0051***	−.0016	−.0081****	-.0067****
	(.0015)	(.0013)	(.0014)	(.0017)
	−.0365	*−.0130*	*−.0604*	*−.0409*
Constant	6.5631	8.9344	5.7495	12.1950
	(.4011)	(.3520)	(.3846)	(.4611)
R^2	.0254	.0699	.0258	.0796
Number of cases	10,715	10,733	10,707	10,731

Note: Main entries are unstandardized regression coefficients. (Entries in parentheses are standard errors.). Entries in italics are standardized regression coefficients.
* $p < .05$.
** $p < .01$.
*** $p < .001$.
**** $p < .0001$ (two-tailed).

6. Conclusion

The Savanna–IQ Interaction Hypothesis suggests that more intelligent individuals may be more likely to acquire and espouse evolutionarily novel values and preferences than less intelligent individuals, while general intelligence may have no effect on the acquisition and espousal of evolutionarily familiar values and preferences. An earlier study (Kanazawa, 2010) has shown that more intelligent individuals are more likely to be liberal and atheist, and more intelligent men (but not women) are more likely to value sexual exclusivity, than their less intelligent counterparts. In this paper, we have extended the Hypothesis to circadian rhythms.

While studies show that there is some genetic component to individuals' circadian rhythms (Hur, 2007), heritability of these phenotypes is far from 1.0 and thus there is room for individual choices and decisions. Survey of ethnographies of traditional societies shows that routine nocturnal activities were probably rare in the ancestral environment and are thus evolutionarily novel. The Savanna–IQ Interaction Hypothesis therefore predicts that more intelligent individuals are more likely to be nocturnal than less intelligent individuals.

Our analysis of Add Health data supports the prediction derived from the Hypothesis. Net of age, sex, race, marital status, parental status, education, earnings, religion, whether one is currently a student and the number of hours worked per week, childhood IQ significantly increases nocturnal behavior in early adulthood. More intelligent children are more likely to grow up to be nocturnal adults who go to bed late and wake up late on both weekdays and weekends.

Our results in this paper, along with other empirical support for the Savanna–IQ Interaction Hypothesis, suggests the importance of general intelligence in the acquisition and espousal of preferences and values. Future studies of value acquisition should consider general intelligence as an important factor. One major weakness of the present analysis is that we do not have a direct measure of general intelligence, only verbal intelligence. While verbal intelligence is highly correlated with general intelligence, a future test of the Hypothesis can benefit from a direct measure of general intelligence. Future studies of the effect of general intelligence on circadian rhythms can also benefit from more direct behavioral measures of morningness–eveningness instead of verbal responses to survey questions. More empirical work is clearly necessary, both to test the Hypothesis rigorously and to investigate the origin of individual values.

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