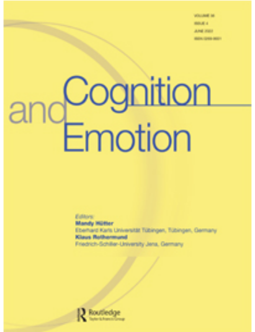

Routledge
Taylor & Francis Group

Cognition and Emotion

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/pcem20

Sunshine on my shoulders makes me happy. . . especially if I'm less intelligent: how sunlight and intelligence affect happiness in modern society

Satoshi Kanazawa, Norman P. Li & Jose C. Yong

To cite this article: Satoshi Kanazawa, Norman P. Li & Jose C. Yong (2022) Sunshine on my shoulders makes me happy. . . especially if I'm less intelligent: how sunlight and intelligence affect happiness in modern society, Cognition and Emotion, 36:4, 722-730, DOI: 10.1080/02699931.2022.2029358

To link to this article: https://doi.org/10.1080/02699931.2022.2029358

COGNITION AND EMOTION
2022, VOL. 36, NO. 4, 722–730
https://doi.org/10.1080/02699931.2022.2029358

BRIEF ARTICLE

Sunshine on my shoulders makes me happy. . . especially if I'm less intelligent: how sunlight and intelligence affect happiness in modern society

Satoshi Kanazawa[a], Norman P. Li[b] and Jose C. Yong[c]

[a]Department of Management, London School of Economics and Political Science, London, UK; [b]School of Social Sciences, Singapore Management University, Singapore; [c]Department of Psychology, Northumbria University, Newcastle upon Tyne, UK

ABSTRACT

The savanna theory of happiness proposes that, due to evolutionary constraints on the human brain, situations and circumstances that would have increased our ancestors' happiness may still increase our happiness today, and those that would have decreased their happiness then may still decrease ours today. It further proposes that, because general intelligence evolved to solve evolutionarily novel problems, this tendency may be stronger among less intelligent individuals. Because humans are a diurnal species that cannot see in the dark, darkness always represented danger to our ancestors and may still decrease our happiness today. Consistent with this prediction, the analysis of the National Longitudinal Study of Adolescent to Adult Health (Add Health) data shows that exposure to sunlight was associated with happiness but the association was significantly weaker among more intelligent individuals.

ARTICLE HISTORY
Received 10 May 2021
Revised 28 December 2021
Accepted 10 January 2022

Keyword
Seasonal affective disorder (SAD); subjective well-being; life satisfaction

Happiness researchers have conducted a large number of studies that identified many empirical correlates of happiness such as *who* is happier than *whom* under *what* circumstances. Yet there is an acute dearth of general theories in positive psychology that can explain *why* some people are happier than others. Kanazawa and Li (2018) have recently proposed the *savanna theory of happiness* as one such general theory. It draws on insights from evolutionary psychology to explain subjective well-being in terms of the evolutionary constraints on the human brain and the power of general intelligence partially to overcome such constraints. Happiness is a higher-order (secondary) adaptation that increases the likelihood that individuals execute primary adaptations to maximise their evolutionary fitness (Diener et al., 2015; Kanazawa, 2015).

For nearly a century, scientists have speculated that exposure to sunlight might increase happiness (Levine, 1929). Recent empirical studies indeed show that exposure to sunlight has a positive effect on happiness and life satisfaction. Kämpfer and Mutz (2013) analyze three large-scale German surveys and discover that respondents interviewed on exceptionally sunny days report higher life satisfaction than those interviewed on days with more ordinary weather. They summarise their finding succinctly: "The supposed sunshine effect on people's life satisfaction does indeed exist" (p. 590). In fact, the effect of sunshine on happiness is so taken for granted that Guven (2012) uses regional sunshine as an instrument for personal happiness to predict consumption and savings behaviour. Exposure to sunlight increases Vitamin D and serotonin, both of which increase happiness (Anglin et al., 2013; Lambert et al., 2002). Yet,

CONTACT Satoshi Kanazawa S.Kanazawa@lse.ac.uk Department of Management, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK

Supplemental data for this article can be accessed https://doi.org/10.1080/02699931.2022.2029358

there is also counterevidence that exposure to sunshine has little to no impact on happiness (Buscha, 2016). More importantly, there has not been a systematic theoretical explanation for *why* exposure to sunlight might increase happiness. In this paper, we first extend the savanna theory of happiness and explain why sunlight might affect happiness and why such an effect might interact with intelligence. We then analyze a large, nationally representative, and prospectively longitudinal data to demonstrate that exposure to sunshine is indeed associated with greater happiness and the association is stronger among less intelligent individuals.

The Savanna Principle

Evolutionary psychologists contend that the human brain is evolutionarily designed for and adapted to the conditions that prevailed during human evolutionary history, not necessarily the present conditions. The human brain is therefore biased to respond to the current environment as if it were the ancestral environment (Kanazawa, 2004b; Li et al., 2018). For example, the *Savanna Principle* (Kanazawa, 2004b) states that "the human brain has difficulty comprehending and dealing with entities and situations that did not exist in the ancestral environment," roughly the African savanna during the Pleistocene Epoch (approximately 2.6M to 12K years ago).

At the same time, what we call general intelligence today originally evolved as a domain-specific psychological mechanism to solve evolutionarily novel adaptive problems that did not routinely present themselves to our ancestors during human evolutionary history (Kanazawa, 2004a). The logical conjunction of these observations suggests that the evolutionary constraints on the human brain may be stronger among less intelligent individuals than among more intelligent individuals. Such evolutionary logic suggests that individuals with lower levels of general intelligence may have correspondingly greater difficulty with evolutionarily novel entities and situations than individuals with higher levels of general intelligence do. At the same time, general intelligence may not make any difference in the human brain's ability to comprehend and deal with evolutionarily familiar entities and situations that existed throughout human evolutionary history (Kanazawa, 2010).

The savanna theory of happiness

The *savanna theory of happiness* applies the insight from evolutionary psychology behind the Savanna Principle to the realm of happiness, and avers that it is not only the current consequences of any situation that influence current levels of happiness but also its ancestral consequences – what the situation *would have meant* for happiness in the ancestral environment. Because the human brain is biased to view the present environment as if it were the ancestral environment and respond to it accordingly (Kanazawa, 2004b; Li et al., 2018), the theory suggests that happiness in modern society may fluctuate at least partly according to the ancestral consequences of the current situation for the individual. The theory further suggests that, because the evolutionary constraints on the human brain are weaker for individuals with higher levels of intelligence, subjective well-being of less intelligent individuals might be influenced by such ancestral consequences of the current situation to a greater extent than that of more intelligent individuals.

Several recent studies have reported empirical support for the theory. Our ancestors throughout human evolutionary history lived in ethnically homogeneous environment, and extended contact with others of different cultures, languages, appearances, and customs almost always signalled danger, because it normally happened under conditions of conquest, imprisonment, slavery, abduction, and capture by hostile neighbouring groups (Chagnon, 1992). Consistent with this reasoning, data show that members of ethnic minorities in the United States are less happy than members of ethnic majorities are, but the effect of ethnic composition on happiness has a negative interaction with intelligence (Kanazawa & Li, 2015). Our ancestors lived in hunter-gatherer bands of roughly 150 related individuals in vast open savannas (Dunbar, 1993). When the group became too large, it split into two groups to maintain a manageable size, as social control became increasingly more difficult in larger groups. As a result, our ancestors experienced very low population density in their lives, and their brain may respond negatively to crowded conditions, as it might have signified impending breakdown of social order based on personal ties. Consistent with this reasoning, population density in the United States has a significantly negative association with happiness – ruralites are significantly happier than urbanites – but the association between population density and happiness has a negative statistical interaction with intelligence (Li & Kanazawa, 2016). Finally, friendships and alliances were crucial for survival for our ancestors, a physically vulnerable species living in harsh environments. Ostracism from their group was tantamount to a death sentence, and, as a result, our ancestors valued friendships and close alliances for protection and survival. Consistent with this reasoning, the frequency of socialisation with friends is significantly positively associated with happiness in a contemporary American sample, but the association has a very strong negative statistical interaction with intelligence (Li & Kanazawa, 2016). In fact, the interaction with intelligence is so strong that, while less intelligent individuals become happier if they spend more time with friends, more intelligent individuals actually become less happy if they do so.

In sum, a growing body of research demonstrates that general intelligence moderates the effect of evolutionarily relevant factors on happiness. In particular, the relationship between evolutionarily desirable outcomes and happiness is less pronounced or even reversed among individuals with higher levels of general intelligence. We consider next how the savanna theory of happiness applies to yet another factor that carries important evolutionary implications – sunlight.

Applying the savanna theory of happiness to sunlight

In the current environment with abundant artificial illumination, some individuals are more nocturnal than others (Kanazawa & Perina, 2009). However, humans are evolutionarily designed to be diurnal, not nocturnal. For navigation, humans depend almost entirely on vision, rather than smell, sound, taste, or touch as with other species, and sunlight and moonlight were the only natural sources of illumination during human evolutionary history until the domestication of fire. As a result, in traditional societies, individuals typically rise right before sunrise and go to sleep right after sunset (Kanazawa & Perina, 2009). They cautiously avoid nocturnal activities because in darkness they may be vulnerable to physical danger presented by nocturnal predators.

Given the significant and imminent danger of darkness throughout human evolutionary history, in contrast to the safety and opportunities afforded by bright sunshine for a diurnal species like humans that relied heavily on vision, prolonged periods of darkness might have made our ancestors nervous, fearful, and therefore unhappy. Indeed, studies show that darkness increases fear among experimental subjects (Schaller et al., 2003). Kanazawa and Li (2018) suggest that this might have been the evolutionary origin of the seasonal affective disorder (SAD). Scientists have known since the 1980s that a lack of daylight leads some individuals to experience chronic depression (Rosenthal et al., 1984). Individuals typically experience SAD during winter with fewer daylight hours, especially in higher latitudes, and, as a result, the most effective treatment of SAD is extended exposure to many hours of artificial light (Winkler et al., 2006). Such treatment simulates daylight, which signified relative safety to our ancestors, compared to the danger inherent in darkness. Light therapy may therefore be a trick to fool our stone-age brains.

Further consistent with the savanna theory of happiness, individuals who suffer from SAD score lower on standardised IQ tests than controls and unaffected relatives (Rajajärvi et al., 2010; Sullivan & Payne, 2007). The authors of both of these studies unquestioningly assume that SAD leads to cognitive impairment. However, the data in both studies are correlational; SAD symptoms and IQ were measured at the same time. Their findings are therefore equally compatible with the interpretation from the savanna theory of happiness that less intelligent individuals are more likely to suffer from SAD than more intelligent individuals are. As a general rule, given its very high heritability, when intelligence is correlated with something else, it is almost always the cause, not the effect (Kanazawa, 2014, 2017, 2019).

Current research

In this study, we test the predictions derived from the savanna theory of happiness with regard to sunlight exposure with correlational survey data. We predict that, because darkness and a lack of sunlight indicates inherent danger and thus induces fear and anxiety, exposure to sunlight increases happiness, and that its effect on happiness is stronger among less intelligent individuals than among more intelligent individuals.

Empirical analysis

Data

National Longitudinal Study of Adolescent to Adult Health (Add Health) is a prospectively longitudinal study of a nationally representative sample of American youths, initially sampled when they were in junior high and high school in 1994–1995 (Wave I, $n = 20{,}745$, mean age = 15.6) and reinterviewed in 1996 (Wave II, $n = 14{,}738$, mean age = 16.2), in 2001–2002 (Wave III, $n = 15{,}197$, mean age = 22.0), and in 2007–2008 (Wave IV, $n = 15{,}701$, mean age = 29.1). See additional details of sampling and study design at http://www.cpc.unc.edu/projects/addhealth/design. Means, standard deviations, and bivariate correlations for all variables used in the empirical analysis are presented in the Appendix table.

Dependent variable: happiness

At Wave IV, interviewers asked the respondents: "How often was each of the following things true during the past seven days: You felt happy," to which they could respond: 0 = "never or rarely," 1 = "sometimes," 2 = "a lot of the time," or 3 = "most of the time or all of the time."[1]

Independent variable: mean annual sunshine hours

Add Health Wave IV contextual data include the mean annual sunshine hours in the respondent's census tract from 1961 to 1990. The information comes from the Climate Atlas of the United States developed by the National Oceanic and Atmospheric Administration's National Climatic Data Centre.

Independent variable: intelligence

Add Health measured respondents' intelligence at Wave III by an abbreviated version of the Peabody Picture Vocabulary Test. Their raw scores were transformed into the standard IQ metric, with a mean of 100 and a standard deviation of 15. The Peabody Picture Vocabulary Test is properly a measure of verbal intelligence. However, verbal intelligence is known to load heavily on general intelligence (Wolfle, 1980).

Control variables: demographic and socioeconomic factors

In our analysis, we controlled for respondents' demographic and socioeconomic characteristics: Age (in years); sex (0 = female, 1 = male); race (with three dummies for black, Asian, and Native American, with white as the reference category); education (in years of formal schooling); earnings (natural log of personal earnings in \$1K); and current marital status (1 = currently married; 0 = otherwise).

Control variables: climate variables

In addition to mean annual sunshine hours, Add Health Wave IV contextual data include six other climate variables: Mean number of hot days with temperature higher than 90°F; mean number of cold days with temperature lower than 32°F; mean maximum daily temperature; mean minimum daily temperature; mean annual precipitation; and mean annual snowfall. All seven climate variables are significantly correlated with each other; locations with more sunshine simultaneously have significantly more hot days, fewer cold days, higher maximum and minimum temperatures, and less precipitation and snow. In order to ascertain that it is the sunshine and not its correlates that affect happiness, we controlled for all six climate variables.

Results

Analytic approach. Because the dependent variable was ordinal, we used ordinal regression to analyze it. We first entered the main predictors (sunshine and intelligence), then its interaction, and finally all the control variables in the regression model.

Table 1, Column (1), shows that, when entered alone and net of each other, both sunshine hours ($b = 1.453^{-4}$, SE = 4.516^{-5}, $p = .001$) and intelligence ($b = .008$, SE = .001, $p < .001$) were independently and significantly positively associated with happiness. More intelligent individuals were happier than less intelligent individuals, and individuals exposed to more sunshine were happier than individuals exposed to less sunshine. Table 1, Column (2), further shows that the interaction between sunshine hours and intelligence was significantly negative ($b = -6.308^{-6}$, SE = 2.565^{-6}, $p = .014$). The positive association between sunshine hours and happiness

Table 1. The associations between sunshine hours, intelligence, and their interaction with happiness.

	(1)	(2)	(3)
Sunshine hours	1.453^{-4}**	.001**	.001*
	(4.516^{-5})	(.000)	(.000)
Intelligence	.008***	.026***	.019*
	(.001)	(.007)	(.008)
Sunshine hours x intelligence		-6.308^{-6}*	-5.399^{-6}*
		(2.565^{-6})	(2.706^{-6})
Demographic controls			
Age			-.049***
			(.010)
Sex			.061
			(.035)
Race			
Black			-.150***
			(.045)
Asian			-.283***
			(.069)
Native American			-.126
			(.076)
Education			.086***
			(.010)
ln(Earnings)			.015**
			(.005)
Currently married			.472***
			(.036)
Climate variables			
Number of hot days			-.003***
			(.001)
Number of cold days			.001
			(.001)
Maximum temperature			.029***
			(.007)
Minimum temperature			-.001
			(.006)
Precipitation			.002
			(.002)
Snow			.002
			(.002)
Threshold			
Y = 0	−2.729 (.181)	-.929	-.039
		(.753)	(.970)
Y = 1	-.033	1.768	2.681
	(.171)	(.750)	(.969)
Y = 2	1.632	3.434	4.396
	(.171)	(.751)	(.969)
−2LogLikelihood	4410.838	4404.868	27275.222
χ^2	69.193***	75.162***	429.989***
Cox & Snell pseudo R^2	.006	.006	.035
Number of cases	12,537	12,537	12,241

Note: Main entries are unstandardised regression coefficients.
(Entries in parentheses are standard errors.)
"Thresholds" are ordinal-regression equivalents of the OLS intercepts.
*$p < .05$, **$p < .01$, ***$p < .001$

was significantly weaker for more intelligent individuals than for less intelligent individuals. Table 1, Column (3), shows that the significantly negative interaction remained unchanged ($b = -5.399^{-6}$, SE = 2.706^{-6}, $p = .046$) when all the demographic and climate controls were included in the multiple ordinal regression equation.

Figure 1 graphically represents the negative interaction between sunshine hours and intelligence on happiness. Among less intelligent individuals (with a mean IQ of 81.40, one standard deviation below the sample mean), sunshine hours had a strong positive association with happiness. Those who were exposed to more sunshine (mean annual sunshine

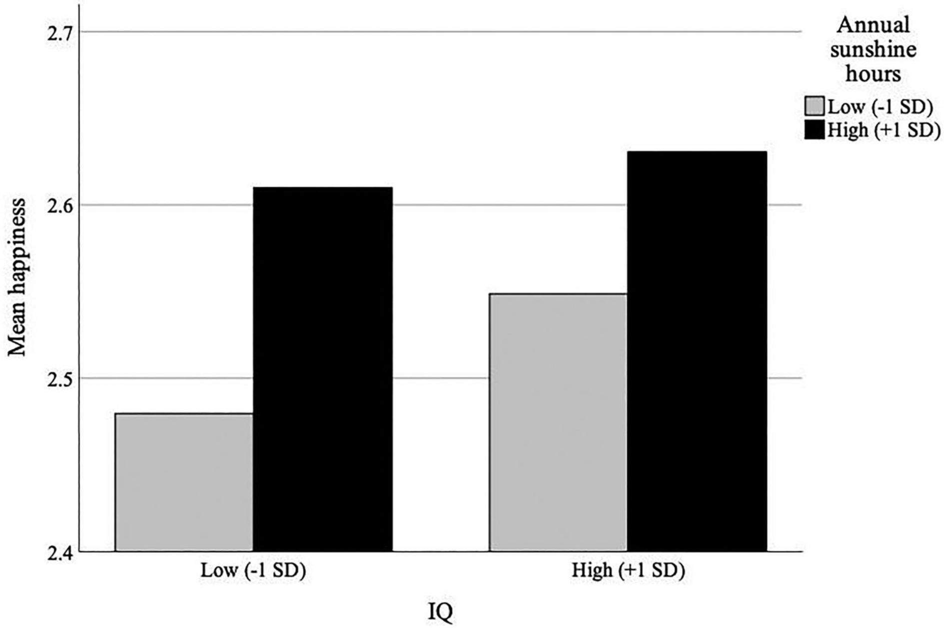

Figure 1. Interaction effect between sunshine hours and intelligence on happiness.

hours of 3122.7, one standard deviation above the sample mean) were much happier than those exposed to less sunshine ($M = 2391.3$, one standard deviation below the sample mean) ($M = 2.48$ vs. 2.61). Among more intelligent individuals (with a mean IQ of 115.57, one standard deviation above the sample mean), the positive association between sunshine and happiness was much weaker ($M =$ 2.55 vs. 2.63).[2]

Alternative explanations

It is important to emphasise that we simultaneously entered all climate variables available in the Add Health Wave IV data in the regression equation (Table 1, Column (3)). So even though all seven climate variables are significantly correlated with each other, and thus sunnier locations are simultaneously warmer, with more hot days and fewer cold days, and have less rain and snow, it is *not* because of these correlates of sunlight hours that people in sunnier locations are happier. Consistent with the prediction, it is the amount of sunlight itself, net of all measures of temperature and precipitation, that is significantly positively associated with happiness. Our full regression equation rules out any other climate reasons for the greater happiness of individuals in sunnier locales.

Discussion

The savanna theory of happiness avers that it is not only the current consequences of a given situation but also its ancestral consequences that affect our happiness. Circumstances that would have made our ancestors happier in their environment may still make us happy in our environment today, and those that would have made them unhappy then may still make us unhappy now. Darkness (lack of sunlight) always represented imminent danger for our ancestors, a diurnal species who could not see in the dark and did not have artificial means of illumination until the domestication of fire. Prolonged periods of darkness would have made them uneasy, nervous, afraid, and unhappy. The savanna theory of happiness therefore predicts that a lack of sunlight would make us unhappy today, even with our abundant use of artificial illumination. Consistent with the prediction, the analysis of the Add Health data shows that sunlight exposure was significantly associated with happiness. Individuals who lived in locations with more hours of sunshine were happier than those who lived in locations with fewer hours of sunshine. Further, the association between sunlight and happiness was significantly weaker among more intelligent individuals. In addition, the mediation analysis (presented in the online supplementary materials) showed that the effect of sunlight hours on happiness was entirely mediated by optimism. Even net of baseline optimism in adolescence, the amount of exposure to sunshine in adulthood appeared to increase current optimism, which in turn increased current happiness. Among other things, our results provide one evolutionary mechanism behind seasonal affective disorder and explain why less intelligent individuals might be more likely to suffer from it.

The association between annual sunshine hours and happiness in the Add Health data was small ($r = .023$). However, Abelson (1985) and Funder and Ozer (2019) convincingly demonstrate that even correlations as small as $r = .05$ will have a large *consequential cumulative* effect after 550 repeated interactions. Given that exposure to sunshine (or lack thereof) happens every day, it is reasonable to conclude that even a correlation as small as .023 (roughly half of .05) will have a large and consequential cumulative effect after three years (1,100 days). The magnitude of association between sunshine hours and happiness was comparable to those between happiness and other predictors used in previous tests of the savanna theory of happiness: ethnic composition (Kanazawa & Li, 2015): $r = .072 - .077$; population density (Li & Kanazawa, 2016): $r = -.044 - -.061$; friendship (Li & Kanazawa, 2016): partial r (net of current marital status) = .035. At the same time, it is worth noting that the effect, while small in magnitude, was nevertheless in the theoretically predicted direction and exhibited the theoretically predicted significant interaction with intelligence.

Limitations

There are some limitations that require caution in the interpretation of our results. First, our data are correlational, not experimental. However, our main independent variable (annual sunshine hours) was measured independently and separately from publicly available climate data, not from the respondents in the survey. And the independent variable was measured decades before the dependent variable. Further, prior experimental studies that directly manipulated exposure to bright light and established its effect on subjective well-being (Winkler et al., 2006) lend support to the causal interpretation of our results.

Second, although sunshine hours were associated with happiness in our analysis, we cannot be certain that respondents in sunnier locations did in fact spend more time experiencing the sunlight. They could be spending all their daylight hours indoors, for example. However, there are several reasons that allay concerns in this regard. First, we have no reason to expect individuals to keep themselves indoors in locations with more versus less sunshine. In a large, nationally representative sample like Add Health, the proportions of respondents who are introverted, who are less physically active, who have indoor occupations, or who otherwise like to stay indoors should be randomly distributed with respect to sunshine hours. If anything, we would expect people to spend more time outdoors in sunnier locations, thus the climatological measure of sunshine hours might be a *conservative* estimate of how much Americans in various locations are directly exposed to sunshine. Second, most buildings have windows, so even if people in sunnier locations, more than people in less sunny locations, were to hole themselves up inside all year around, they can still view the sunshine through windows. Research indicates that viewing online pictures of sunshine in advertisement (El Hazzouri et al., 2020) and pictures of nature (van der Wal et al., 2013), all on computer screens, can influence mood, attitudes, and behaviours. Viewing through windows should be at least as impactful as viewing on computer screens.

Third, while we hypothesise that fear and anxiety caused by darkness might be a mediator of the effect of sunshine on happiness, we were unable to test the mediation because Add Health does not have any measure of fear or anxiety. Finally, the crucial interaction effect between sunshine hours and intelligence predicted by the savanna theory of happiness was only just statistically significant ($p = .046$) when all the control variables were simultaneously entered into the equation. It therefore requires caution in interpreting the supportive results for the theory, and the finding needs to be replicated and further confirmed with additional experiments and studies.

Conclusion

The current study adds to a growing number of studies that confirm implications of the savanna theory of happiness in various contexts and highlight the potential importance of ancestral consequences of a given circumstance for current happiness in modern society (Kanazawa & Li, 2015, 2018; Li & Kanazawa, 2016). Factors as varied as being in an ethnic majority, low population density, socialising with friends, and exposure to sunshine have all been shown to be associated with happiness, and their associations with happiness have all been shown to interact with intelligence, as predicted by the savanna theory of happiness.

The fact that more intelligent individuals get comparatively less happiness benefit from sunshine might be related, either as a cause or an effect, to their tendency to be more nocturnal; more intelligent individuals spend significantly more time in darkness than less intelligent individuals do (Kanazawa & Perina, 2009). However, there is no evidence that individuals necessarily seek to engage in behaviour that makes them happy. For example, even though more intelligent individuals are comparatively more likely (relative to less intelligent individuals) to be happy in urban areas, they are more likely to live in rural areas (Li & Kanazawa, 2016). More theoretical and empirical work is clearly necessary to disentangle the relationship between sunlight exposure, nocturnal preference, intelligence, and happiness.

Notes

1. Add Health Wave IV measures the frequency of nine other positive and negative emotional states in the last seven days on the same scale: "You were bothered by things that usually don't bother you," "You could not shake off the blues, even with help from your family and your friends," "You felt you were just as good as other people," "You had trouble keeping your mind on what you were doing," "You felt depressed," "You felt that you were too tired to do things," "You enjoyed life," "You felt sad," "You felt that people disliked you." The measure of happiness was significantly and very strongly correlated with all nine measures of positive and negative emotions in the expected directions (bothered: $r = -.317$; blues: $r = -.430$; self-respect: $r = .441$; distracted: $r = -.277$; depressed: $r = -.495$; tired: $r = -.232$, enjoyed life: $r = .743$; sad: $r = -.477$; disliked: $r = -.244$). It therefore appears to be a valid measure of positive, eudemonic state. Previous studies show that single-item measures of happiness are extremely valid and correlate highly with multi-item batteries such as the Oxford Happiness Inventory and the Satisfaction with Life Scale (Abdel-Khalek, 2006; Cheung & Lucas, 2014).
2. In generalised linear models (like ordinal regression that we employed here), the independent variables have proportional effects on the dependent variable in its natural unit and constant effects *on the logit* (natural log of odds of a respondent being in one category of the dependent variable versus another). As a result, simple slope analysis, of the kind typically conducted for OLS regression, cannot be performed on raw dependent variable and must instead be performed on the logit. Because the logit has no intuitive or readily interpretable meaning, we have chosen not to perform a simple slope analysis.

Data availability statement

Certified researchers may obtain replication data and materials from the Carolina Population Centre by contacting addheath_-contracts@unc.edu and signing a limited, one-year, no-fee contract for replication purposes only.

Disclosure statement

The authors declare absolutely no conflict of interest, real or perceived.

Funding

The authors received no funding associated with the work featured in this article.

References

Abdel-Khalek, A. M. (2006). Measuring happiness with a single-item scale. *Social Behavior and Personality: An International Journal*, *34*(2), 139–150. https://doi.org/10.2224/sbp.2006.34.2.139

Abelson, R. P. (1985). A variance explanation paradox: When a little is a lot. *Psychological Bulletin*, *97*(1), 129–133. https://doi.org/10.1037/0033-2909.97.1.129

Anglin, R. E. S., Samaan, Z., Walter, S. D., & McDonald, S. D. (2013). Vitamin d deficiency and depression in adults: Systematic review and meta-analysis. *British Journal of Psychiatry*, *202*(2), 100–107. https://doi.org/10.1192/bjp.bp.111.106666

Buscha, F. (2016). Does daily sunshine make you happy? Subjective measures of well-being and the weather. *The Manchester School*, *84*(5), 642–663. https://doi.org/10.1111/manc.12126

Chagnon, N. (1992). *Yanomamö, 4th ed*. Harcourt Brace Jovanovich.

Cheung, F., & Lucas, R. E. (2014). Assessing the validity of single-item life satisfaction measures: Results from three large samples. *Quality of Life Research*, *23*(10), 2809–2818. https://doi.org/10.1007/s11136-014-0726-4

Diener, E., Kanazawa, S., Suh, E. M., & Oishi, S. (2015). Why people are in a generally good mood. *Personality and Social Psychology Review*, *19*(3), 235–256. https://doi.org/10.1177/1088868314544467

Dunbar, R. I. M. (1993). Coevolution of neocortical size, group size and language in humans. *Behavioral and Brain Sciences*, *16*(4), 681–694. https://doi.org/10.1017/S0140525X00032325

El Hazzouri, M., Main, K. J., & Shabgard, D. (2020). Reminders of the sun affect men's preferences for luxury products. *Journal of Business Research*, *120*, 551–560. https://doi.org/10.1016/j.jbusres.2019.04.049

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, *2*(2), 156–168. https://doi.org/10.1177/2515245919847202

Guven, C. (2012). Reversing the question: Does happiness affect consumption and savings behavior? *Journal of Economic Psychology*, *33*(4), 701–717. https://doi.org/10.1016/j.joep.2012.01.002

Kanazawa, S. (2004a). General intelligence as a domain-specific adaptation. *Psychological Review*, *111*(2), 512–523. https://doi.org/10.1037/0033-295X.111.2.512

Kanazawa, S. (2004b). The Savanna Principle. *Managerial and Decision Economics*, *25*(1), 41–54. https://doi.org/10.1002/mde.1130

Kanazawa, S. (2010). Evolutionary psychology and intelligence research. *American Psychologist*, *65*(4), 279–289. https://doi.org/10.1037/a0019378

Kanazawa, S. (2014). Intelligence and obesity. *Current Opinion in Endocrinology, Diabetes & Obesity*, *21*(5), 339–344. https://doi.org/10.1097/MED.0000000000000091

Kanazawa, S. (2015). Where do gods come from? *Psychology of Religion and Spirituality*, *7*(4), 306–313. https://doi.org/10.1037/rel0000033

Kanazawa, S. (2017). Higher intelligence and later maternal age: Which way does the causal direction go? *Journal of the American Geriatrics Society*, *65*(8), 1884–1885. https://doi.org/10.1111/jgs.14924

Kanazawa, S. (2019). Cognitive function and crossword puzzles: Which way does the causal direction go? *International Journal of Geriatric Psychiatry*, *34*(11), 1734–1735. https://doi.org/10.1002/gps.5181

Kanazawa, S., & Li, N. P. (2015). Happiness in modern society: Why intelligence and ethnic composition matter. *Journal of Research in Personality*, *59*, 111–120. https://doi.org/10.1016/j.jrp.2015.06.004

Kanazawa, S., & Li, N. P. (2018). The savanna theory of happiness. In R. L. Hopcroft (Ed.), *The Oxford handbook of evolution, biology, and society* (pp. 171–194). Oxford University Press.

Kanazawa, S., & Perina, K. (2009). Why night owls are more intelligent. *Personality and Individual Differences*, *47*(7), 685–690. https://doi.org/10.1016/j.paid.2009.05.021

Kämpfer, S., & Mutz, M. (2013). On the sunny side of life: Sunshine effects on life satisfaction. *Social Indicators Research*, *110*(2), 579–595. https://doi.org/10.1007/s11205-011-9945-z

Lambert, G. W., Reid, C., Kaye, D. M., Jennings, G. L., & Esler, M. D. (2002). Effect of sunlight and season on serotonin turnover in the brain. *The Lancet*, *360*(9348), 1840–1842. https://doi.org/10.1016/S0140-6736(02)11737-5

Levine, V. E. (1929). Sunlight and its many values. *Scientific Monthly*, *29*, 551–557.

Li, N. P., & Kanazawa, S. (2016). Country roads, take me home … to my friends: How intelligence, population density, and friendship affect modern happiness. *British Journal of Psychology*, *107*(4), 675–697. https://doi.org/10.1111/bjop.12181

Li, N. P., van Vugt, M., & Colarelli, S. M. (2018). The evolutionary mismatch hypothesis: Implications for psychological science. *Current Directions in Psychological Science*, *27*(1), 38–44. https://doi.org/10.1177/0963721417731378

Rajajärvi, E., Antila, M., Kieseppä, T., Lönnqvist, J., Tuulio-Henriksson, A., & Partonen, T. (2010). The effect of seasons and seasonal variation on neuropsychological test performance in patients with bipolar I disorder and their first-degree relatives. *Journal of Affective Disorders*, *127*(1-3), 58–65. https://doi.org/10.1016/j.jad.2010.04.021

Rosenthal, N. E., Sack, D. A., Gillin, J. C., Lewy, A. J., Goodwin, F. K., Davenport, Y., Mueller, P. S., Newsome, D. A., & Wehr, T. A. (1984). Seasonal affective disorder. *Archives of General Psychiatry*, *41*(1), 72–80. https://doi.org/10.1001/archpsyc.1984.01790120076010

Schaller, M., Park, J. H., & Mueller, A. (2003). Fear of the dark: Interactive effects of beliefs about danger and ambient darkness on ethnic stereotypes. *Personality and Social Psychology Bulletin*, *29*(5), 637–649. https://doi.org/10.1177/0146167203029005008

Sullivan, B., & Payne, T. W. (2007). Affective disorders and cognitive failures: A comparison of seasonal and nonseasonal depression. *American Journal of Psychiatry*, *164*(11), 1663–1667. https://doi.org/10.1176/appi.ajp.2007.06111792

van der Wal, A., Schade, H. M., Krabbendam, L., & van Vugt, M. (2013). Do natural landscapes reduce future discounting in humans? *Proceedings of the Royal Society, Series B*, *280*, 20132295. https://doi.org/10.1098/rspb.2013.2295

Winkler, D., Pjrek, E., Iwaki, R., & Kasper, S. (2006). Treatment of seasonal affective disorder. *Expert Review of Neurotherapeutics*, *6*(7), 1039–1048. https://doi.org/10.1586/14737175.6.7.1039

Wolfle, L. M. (1980). The enduring effects of education on verbal skills. *Sociology of Education*, *53*(2), 104–114. https://doi.org/10.2307/2112492