nature human behaviour

LETTERS

https://doi.org/10.1038/s41562-017-0277-0

Happiness, income satiation and turning points around the world

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Income is known to be associated with happiness[1], but debates persist about the exact nature of this relationship[2,3]. Does happiness rise indefinitely with income, or is there a point at which higher incomes no longer lead to greater well-being? We examine this question using data from the Gallup World Poll, a representative sample of over 1.7 million individuals worldwide. Controlling for demographic factors, we use spline regression models to statistically identify points of 'income satiation'. Globally, we find that satiation occurs at $95,000 for life evaluation and $60,000 to $75,000 for emotional well-being. However, there is substantial variation across world regions, with satiation occurring later in wealthier regions. We also find that in certain parts of the world, incomes beyond satiation are associated with lower life evaluations. These findings on income and happiness have practical and theoretical significance at the individual, institutional and national levels. They point to a degree of happiness adaptation[4,5] and that money influences happiness through the fulfilment of both needs and increasing material desires[6].

The relationship between money and happiness has been contemplated—and contested—for hundreds of years. Large-scale reviews have consistently shown that income is positively associated with subjective well-being (SWB)[1,7–9], but one issue in need of clarity is whether there is an eventual ceiling to these positive effects. In other words, is there a level of income at which satiation occurs, when increases in income no longer produce meaningful benefits to happiness? Or, does happiness continue to rise indefinitely with income gains?

Many studies have examined the association between income and one or more of the three components of SWB (that is, life evaluation, positive affect and negative affect[10]). These studies have observed that the strength of the association diminishes with higher income. However, despite its importance, only a few studies have examined explicitly whether this diminishing eventually reaches full satiation, and those that do exist have noteworthy limitations. The most prominent study to date looked at satiation for all three SWB outcomes and found that life evaluation did not satiate, whereas affective well-being satiated at $75,000[2]. However, the study sample was limited to the United States and only used a categorical measure of income rather than a continuous one. Determining satiation from categorical data is possible but will not yield precise estimates of its true location. (Technically, the $75,000 estimate could have been anywhere between $60,000 and $120,000.) Two other studies found no evidence for satiation when using a continuous income variable and data from many different countries[3,11]. However, only one SWB outcome (life evaluation) was analysed, and only a minority of the countries tracked the association beyond $64,000 (due to the authors excluding the upper 90% of income distributions, possibly due to sparse data). Importantly, all of these studies appeared to use raw household income. The problem is that this does not account for household size and therefore assumes that $75,000 for a lone individual operates the same as $75,000 for a family of four. This would have the effect of inflating satiation estimates.

Although previous research has shed important light on income satiation, there is a need for a more thorough investigation that includes all three SWB outcomes and a sufficient range of continuous income data. Satiation is also not likely to be invariant across different cultures, time frames and life circumstances[12]. Thus, apart from the need to have a broader dataset, another pivotal question in need of exploration is: How might various factors like world region, gender and education influence satiation effects?

We addressed this diverse set of questions using data from the Gallup World Poll, which contains observations collected from over 1.7 million people from 164 countries and approximates a worldwide-representative sample of adults aged 15 and older. We found that satiation is a worldwide phenomenon but varies considerably based on SWB type, world region and education. These results carry important implications for stakeholders at multiple levels. Individuals often feel strong pressures to achieve high incomes[13], and establishing points of satiation might advise their chosen aspirations and values. For organizations, an understanding of satiation effects might inform employee pay structures[14], and for governments, it can help motivate policies directed towards wealth redistribution[15]. Establishing satiation points also enriches our theoretical understanding of the relationship between income and happiness, which is often contested as either providing the fulfilment of needs (the human needs model[9], where income leads to SWB) or desires (the relative standards model[6], where income does not lead to SWB or even leads to decrements in SWB). The presence of satiation would point to different income ranges in which these theoretical accounts function.

In our analyses, the income variable was yearly household equivalized income—a measure that can be interpreted as US dollars and controls for the number of individuals within a household (see Supplementary Table 1 for descriptive statistics and Supplementary Methods for more details on this income variable). We fit spline regression models[16] to the data and then located the point at which the slope of log income reached zero when regressed on SWB after controlling for relevant factors. We then conducted confirmatory hypothesis tests using Bayes factors[17] to compare the SWB level at satiation against the SWB of all higher incomes. The Bayes factor is the Bayesian alternative to the *P* value, and it allowed us to quantify support for the null hypothesis of no income difference (as opposed to the *P* value, which can only fail to reject the null). The Bayes factor can be interpreted as how many times more likely a particular hypothesis is compared with its alternative[17,18]. For all Bayes factors

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reported here, values greater than 3 indicate support for the null (no difference), whereas values less than 1/3 indicate support for the alternative (a difference).

In the aggregated global data, we found that the satiation point for life evaluation occurred at approximately $95,000 (see Table 1 for all satiation estimates), at roughly 7.58 on the 11-point scale (Fig. 1a). For positive emotions, satiation occurred at a lower level of income ($60,000), as did negative emotions ($75,000). For all three measures of SWB, there were no appreciable increases in SWB after these incomes. In fact, for life evaluation, we found that after satiation had been reached, further increases in income were associated with slight decrements to SWB. We refer to these as 'turning points' (see Supplementary Table 2 for all test statistics).

While identifying income satiation on the global scale is important, these effects may be heavily qualified by region. Using the same methodology, we located satiation within world regions as classified by the Gallup World Poll and Central Intelligence Agency World Factbook[19] on factors such as location, history, economic development, language root and religion. Our data allowed us to explore satiation points with respect to nine regions: Western Europe/Scandinavia, Eastern Europe/the Balkans, Australia/New Zealand, Southeast Asia, East Asia, Latin America/the Caribbean, Northern America, the Middle East/North Africa and Sub-Saharan Africa. We found substantial variability in satiation across the three types of well-being (Fig. 1a). For life evaluation, the highest satiation points seemed to form two general clusters. The first was made up of regions with high satiation points. These included the Western nations as well as two other regions: Western Europe/Scandinavia ($100,000), Northern America ($105,000), Australia/New Zealand ($125,000), East Asia ($110,000) and the Middle East/North Africa ($115,000). The second cluster had significantly lower satiation points: Eastern Europe/the Balkans ($45,000), Southeast Asia ($70,000), Latin America/the Caribbean ($35,000) and Sub-Saharan Africa ($40,000). The overall mean satiation point for life evaluation was $85,000 (range: $40,000–$125,000). Consistent with past research indicating that income matters more for well-being in wealthier nations[20], this pattern of results suggested that satiation level was related to the overall wealth of the region. Indeed, the correlation between the median income of regions and their satiation point was positive and strong ($r = 0.73$, 95% confidence interval = 0.12–0.94, $P = 0.03$).

Table 1 | Satiation points across region, gender and education

Region	LE satiation	PA satiation	NA satiation
Global	$95,000	$60,000	$75,000
Western Europe/Scandinavia	$100,000	$50,000	$50,000
Eastern Europe/the Balkans	$45,000	$35,000	$35,000
Australia/New Zealand	$125,000	$50,000	$50,000
Southeast Asia	$70,000	N/A	N/A
East Asia	$110,000	$60,000	$50,000
Latin America/the Caribbean	$35,000	$30,000	$30,000
Northern America	$105,000	$65,000	$95,000
Middle East/North Africa	$115,000	$110,000	$125,000
Sub-Saharan Africa	$40,000	$35,000	$50,000
Women	$100,000	$55,000	$60,000
Men	$90,000	$65,000	$60,000
Low education	$70,000	$50,000	$35,000
Moderate education	$85,000	$60,000	$65,000
High education	$115,000	$80,000	$70,000

N/A indicates occasions where no positive relationship was found between log income and SWB. LE, life evaluation; PA, positive affect; NA, negative affect.

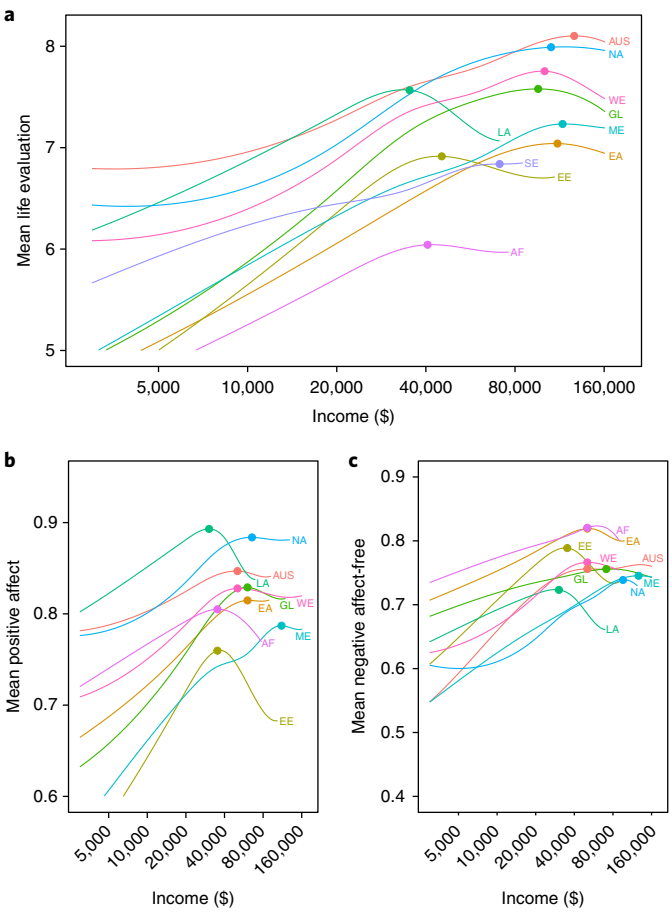

Fig. 1 | Plots of model predictions for life evaluation and affective well-being by income (log scale) in world regions. a, Mean life evaluation. **b**, Mean positive affect. **c**, Mean negative affect-free. Dots indicate where satiation occurred. Some over-fitting is evident in certain regions at incomes after satiation due to increasingly scarce observations. Model predictions were therefore truncated before over-fitting became too severe. AF, Sub-Saharan Africa; AUS, Australia/New Zealand; EA, East Asia; EE, Eastern Europe/the Balkans; GL, global; LA, Latin America/the Caribbean; ME, Middle East/North Africa; NA, Northern America; SE, Southeast Asia; WE, Western Europe/Scandinavia.

In addition to cognitive life evaluations, we conducted similar analyses of satiation with affective measures of SWB (Fig. 1b,c). Just like the aggregated global findings, affective well-being tended to satiate earlier than life evaluation for positive (mean: $55,000, range: $30,000–$110,000) and negative affect (mean: $60,000, range: $30,000–$125,000). Equally profound to the cultural variation in satiation was the variability in turning-point effects. For life evaluation, we found turning-point effects in five regions: Western Europe/Scandinavia, Eastern Europe/the Balkans, East Asia, Latin America/the Caribbean and Northern America. In contrast, we did not find any turning points for affective well-being.

Aside from world region, we examined the effect of gender on satiation. We hypothesized that satiation might occur later for men than women due to the fact that the income–happiness link is empirically stronger in men[21] and because of the strong emphasis on achievement and social status within conventional masculine gender norms[22,23]. However, we found no evidence for this, as women satiated at $100,000 and men at $90,000 for life evaluation, $55,000 and $65,000 for positive affect, and $60,000 and $60,000 for

negative affect (Fig. 2). Both men and women exhibited turning-point effects only for life evaluation as well.

We then examined whether satiation was reached earlier or later depending on one's education level, our prediction being that greater education would result in later satiation due to increased income aspirations[24]. We tested three education groups within the Gallup World Poll: low (0–8 years), moderate (9–15 years) and high (16+ years). We found that satiation varied based on the education level of the individual. For life evaluation, the satiation point rose across each education level: $70,000 for low education, $85,000 for moderate education and $115,000 for high education (Fig. 2a). These differences are probably a function of income aspirations[24] or social comparisons with different groups[25,26]. This pattern was replicated for emotional well-being: positive emotions, $50,000 (low); $60,000 (moderate); and $80,000 (high) and negative emotions, $35,000 (low); $65,000 (moderate); and $70,000 (high) (Fig. 2b,c). Life evaluation but not affective well-being again showed turning points for these groups.

Before discussing the implications of these findings, it is important to understand their place within the context of the study limitations. First, although the size of our sample was ideal for a large-scale examination, we nonetheless found that data for the highest incomes grew increasingly sparse. Although included within the aggregated global analyses, two world regions (Central Asia and South Asia) were not analysed individually for this reason (there were only 15 and 20 data points above $100,000, respectively). Moreover, in Western Europe/Scandinavia, there were just 1,311 cases above $200,000. Sub-Saharan Africa was the poorest region in our sample, where there were only 99 observations above $100,000. These limitations prohibited us from drawing inferences about the form of the association between SWB and income at its highest ranges. We therefore had to test for turning points using mean comparisons that pooled all incomes after satiation instead of relying on predictions from regression models.

Another limitation in our sample was possible non-random unit and item non-response, such that higher incomes were less likely to be reported, and thus the higher ranges of the income distribution were likely to be represented less faithfully. High-income observations could also be expected to contain more measurement error stemming from factors such as social desirability (for example, exaggerations in income) and the greater difficulty in determining one's true income as it grows in complexity (stock options and so on). To guard against these possibilities, we compared several Gallup national income distributions with income distributions reported by three official government statistics bureaus (the United States, Australia and Hong Kong). Comparing these distributions showed a large degree of overlap, and there was little evidence of systematic biases that would impugn the results. These analyses are provided in the Supplementary Methods.

There was also a concern of missing values. Our data from the Gallup World Poll contained 884,229 incomes that were reported exactly by respondents. There were 211,641 additional incomes derived from an income range that respondents had selected. Gallup also provided another 180,842 imputed income values, and we imputed the remaining missing values using a regression strategy based on demographics in a way similar to previous satiation studies[2]. To make sure that our results were robust to these different data sources, we conducted four sets of analyses, the results from which are shown in Supplementary Table 4. Most of the results were replicated to a $5,000–$10,000 increment. However, there were several cases, especially with regard to our own regression imputations, for which differences were significant. The results reported here contain all sources of data from Gallup and exclude those that we ourselves imputed. Further details on these imputation procedures can be found in the Supplementary Methods.

Finally, although the sampling design of the Gallup World Poll is designed to be representative, this ideal cannot be perfectly obtained in research practice. Although response rates for face-to-face interviews covered over three-quarters of all sampling occasions and were acceptable (~70%), telephone response rates were poor (~15%). In certain countries, safety or travel concerns prohibited certain within-country areas from being sampled (largely in Sub-Saharan Africa and the Middle East/North Africa). These exclusions can be found at http://www.gallup.com/file/services/177797/World_Poll_Dataset_Details_122316.pdf.

The current study examined the issue of income satiation; that is, whether there is a level of income after which more money no longer brings more happiness. This topic has implications for individuals, organizations and governments, as well as informing our understanding of the overall association between income and happiness. We found that satiation is a ubiquitous phenomenon for all three measures of well-being.

In reviewing our own results, one of the first things we were surprised by was the satiation points themselves. We had expected satiation to exist but to be significantly higher, especially in the cases of positive and negative affect, which sometimes dipped to around $40,000 in certain regions. Why was satiation lower than we expected? There are several possible answers. First, it is crucial to recognize that it was necessary to control for the number of individuals within households. Our income metric was therefore

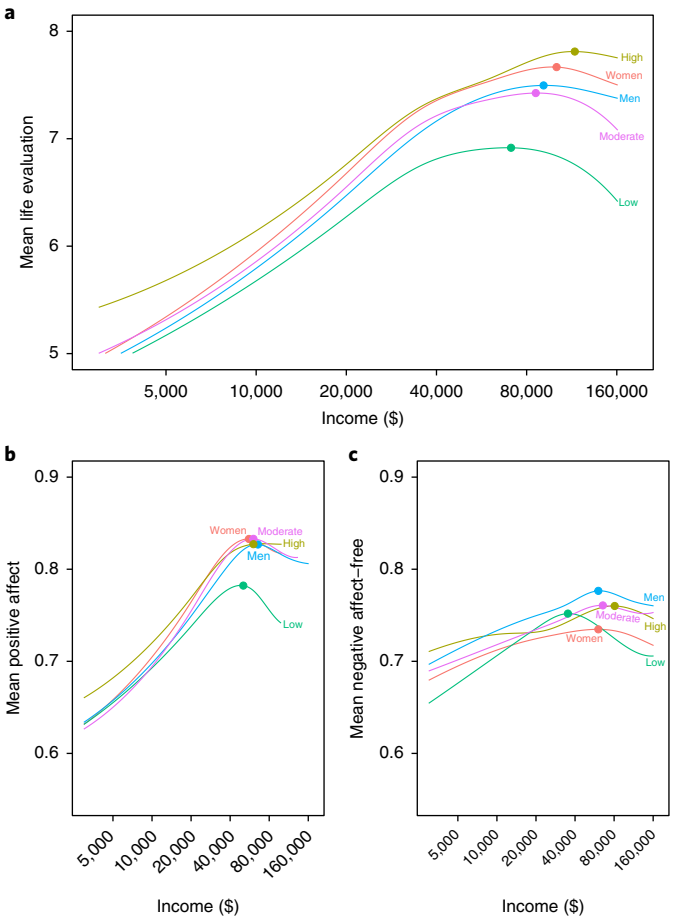

Fig. 2 | Plots of model predictions for life evaluation and affective well-being by income (log scale) in gender and educational groups. **a**, Mean life evaluation. **b**, Mean positive affect. **c**, Mean negative affect-free. Dots indicate where satiation occurred. High, high education (16+ years); Moderate, moderate education (9–15 years); Low, low education (0–8 years).

equivalized household income rather than raw household income. Thus, the estimates here pertain to single-person households only. To obtain estimates for households with more people, one can simply multiply the satiation estimate by the square root of the household size. For instance, a household with four members would have a satiation point two times higher than the estimates reported here.

Second, one should note that our estimates are aggregated over all locations within countries. Even within individual countries, there can be substantial differences in the cost of living across areas (for example, urban versus rural), and exact satiation figures would thus vary depending the specific location in which one is residing. Finally, it is important to remember that income satiation relates to differences between sub-populations and not changes within individuals. If an individual earning an income at satiation received a doubling of their salary, satiation does not mean that they would not feel higher SWB. Rather, satiation means that, at baseline, groups at the higher income are no happier than groups at the lower initial income. Thus, the fact that satiation estimates were lower may speak to the reality of the 'hedonic treadmill'—the well-studied phenomenon that happiness levels tend to return to a relatively constant baseline amidst various life events and circumstances[5].

How do our findings relate to previous studies on satiation? The most prominent satiation study to date[2] estimated satiation for affective well-being in the United States at $75,000 but did not find it for life evaluation. (Other studies have yielded similar results for life evaluation[3,11].) Our findings in the Northern America sample comprising Canada and the United States are slightly lower than their results for affective measures ($65,000 for positive affect and $95,000 for negative affect) and can be explained by our use of equivalized household income. We also found a clear satiation effect at $105,000 for life evaluation. This difference can again be explained by our use of equivalized income and other differences in data and method. The previous study used an income variable that was categorical and found that the highest income category (>$120,000) was still significantly higher in life evaluation than the second-highest group ($90,000–$120,000), implying the absence of satiation. However, we do not know how incomes were distributed within groups. If most of the observations in the second-highest category were near $90,000 (which is plausible), this could lower its mean SWB level to produce a significant difference with the highest income category. Thus, our finding of satiation at $105,000 is fully compatible with their results. With regard to the other studies that found no evidence for satiation in life evaluation[3,11], their different conclusions can be explained by sparse high-income data within countries, whereas pooling countries into world regions helped to alleviate the issue here.

Theoretically, the presence of satiation on all three components of SWB points to the role of both needs- and desire-based accounts of the relationship between income and SWB. From a needs-based perspective, income serves to bring about a fulfilment of basic physical needs that is necessary for high SWB. However, satiation also points to a level of income at which these needs are largely met and transitions towards more desire-based accounts where income comparisons and relative income play a more significant role.

The finding that the wealth of regions correlates very strongly with their satiation point is also theoretically credible. A number of studies have shown that social comparison effects (that is, relative income[25,27]) are equally as strong as the effects of absolute income[26,28]. Higher incomes within regions extend the satiation point because the standards of social comparison are higher. However, it may also be the case that income simply offers greater opportunities for happiness in wealthier regions. In other words, at very high levels, income may still be able to yield greater standards of living, which may not be the case in poorer regions. There was some evidence of this in our data, as the wealthier regions seemed to have higher levels of happiness when satiation was finally reached. Along these lines, research has shown that national income contributes to SWB above and beyond individual-level income[20].

Examining satiation differences between regions also raises a critical question: Is income satiation desirable? And is it better for it to occur earlier or later? The answer is complicated by the fact that observed differences can reflect different underlying mechanisms. If group A satiates at $90,000 and group B satiates at $130,000, this could be seen as a boon for group A because less income is required to maximize SWB. Alternatively, it could be viewed as advantageous for group B because monetary increases still provide an opportunity to attain higher levels of SWB. The desirability of a difference in satiation points thus depends on the SWB level when satiation occurs, with the group with the higher SWB level securing the benefit. Our own data show that life evaluation in Latin America/the Caribbean satiated at one of the lowest points in our sample ($35,000, at a life evaluation score of 7.57). Both Southeast Asia ($70,000) and East Asia ($110,000) satiated at higher incomes but lower levels of evaluation (6.84 and 7.04, respectively). In contrast, Northern America ($105,000) and Western Europe/Scandinavia ($100,000) satiated at much higher incomes, but also with significantly higher levels of evaluation (7.98 and 7.75, respectively).

Another important phenomenon within our data was the presence of turning points at which income levels after satiation saw consistent decrements in happiness. It has been speculated for some time that very high incomes may lead to reductions in SWB[9] and a recent study conducted at the country level found a slight but significant decline in life evaluation in the richest countries[29].

The present study provides preliminary evidence in support of this effect at the individual level. This was limited to only one SWB outcome—life evaluation—and only five of the nine world regions under study: Western Europe/Scandinavia, Eastern Europe/the Balkans, East Asia, Latin America/the Caribbean and Northern America. Why are turning-point effects limited to these specific circumstances? To answer this question, it is important to note that our study provides preliminary, rather than conclusive, evidence on this issue. As stated earlier, there were limitations to our high-income data (greater susceptibility to measurement error and fewer observations) and these might influence tests for turning points. There is therefore reason to believe that turning-point effects may be more prevalent than we found here. Indeed, the trends in both Figs. 1 and 2 suggest that turning-point effects may be present in additional subgroups. Further research with an emphasis on high-income data is needed to understand the prevalence of these effects and why they are present in certain conditions versus others.

Theoretically, it is presumably not the higher incomes themselves that drive reductions in SWB, but the costs associated with them. High incomes are usually accompanied by high demands (time, workload, responsibility and so on) that might also limit opportunities for positive experiences (for example, leisure activities[30]). Additional factors may play a role as well, such as an increase in materialistic values, additional material aspirations that may go unfulfilled, increased social comparisons[31,32] or other life changes in reaction to greater income (for example, more children or living in more expensive neighbourhoods[9]). Importantly, the ill effects of the highest incomes may not just be present when one's maximum income is finally reached, but could also occur in the process of its attainment.

Methods

Sample. Data came from 164 countries in the Gallup World Poll. These countries are listed in Supplementary Table 3. The sample consisted of 1,709,734 observations collected during the years 2005–2016. The mean age of the sample was 40.87 (s.d. = 17.40) and 47% of the sample was male. Across the 12 years of data collection, each independent sampling occasion yielded roughly 1,000 respondents although, in some large countries, sample sizes of 2,000 or more were collected. The years of the sampling occasions and their sample sizes are also reported in Supplementary Table 3. The sampling frame included the entire

civilian, non-institutionalized population of 15 years of age or older. Sampling included the entire country and was nationally representative with the exception of areas where the safety of interviewing staff was threatened, scarcely populated islands in some countries and areas that interviewers could reach only by foot, animal or small boat. Primarily, face-to-face interviews were conducted and lasted one hour. In other countries, telephone surveys were used in countries where telephone coverage represented at least 80% of the population. The local field staff participated in in-depth training before conducting interviews. During the survey process, staff were instructed to follow and not deviate from the interview script. More sampling information is provided in the Supplementary Methods.

Measures. *Income.* Monthly household income was reported in local currency. This was converted into a measure of yearly income in international dollars using the World Bank's private purchasing power parity ratios (see http://data.worldbank.org/indicator/PA.NUS.PPP). These ratios represent the number of units of local currency that are equal to the buying power of one US dollar in the United States (the reference country). Thus, the international dollars figures reported here are interpretable simply as US dollars. However, raw household income would lead to spurious results given differing numbers of people within households (less than 10% of households in our sample had just one adult). We therefore converted our metric to equivalized household income—a measure that controls for the number and composition of individuals within the household. We used the square root equivalency scale, which has been used in the most recent publications by the Organisation for Economic Co-operation and Development[33,34]. All analyses were done using the natural logarithm of income, which is standard practice because the relationship between SWB and income is known to be log-linear[2]. We then reconverted back to dollar units when examining satiation points, rounding to the nearest $5,000 increment for simplicity. More information regarding our income measure can be found in the Supplementary Methods.

World regions. Countries in the Gallup World Poll are classified into world regions that share common features in terms of history, economic development, language root, religion and so forth. Our data allowed us to explore satiation points related to nine of these regions: Western Europe/Scandinavia, Eastern Europe/the Balkans, Australia and New Zealand, Southeast Asia (for example, Thailand and Indonesia), East Asia (for example, China, Japan and South Korea), Latin America/the Caribbean, Northern America (United States and Canada), the Middle East/North Africa and Sub-Saharan Africa. The remaining two regions had sparse data at higher income levels that did not allow for stable within-region estimates of satiation (that is, South Asia and Central Asia). However, these regions were included in the aggregated global analyses.

Education. Many countries have unique education classifications, which requires standardization. To make education levels comparable, every response was standardized by being placed into one of three exhaustive and mutually exclusive categories: elementary education or less (up to 8 years of basic education), secondary and some tertiary education (9–15 years of education) or four years of education beyond high school and/or received a four-year college degree (16+ years of education). We refer to these three categories as 'low', 'moderate' and 'high' education, respectively.

Life evaluation. Life evaluation was measured using Cantril's Self-Anchoring Striving Scale[35]. This measure instructs participants to imagine a ladder with steps labelled 0–10, where 0 represents the 'worst possible life' and 10 is the 'best possible life'. Participants indicate at which step of the latter they personally stand at the present time. The scale has shown test–re-test reliabilities of $r = 0.70$ over a two-year period[36,37] and has been cited as perhaps the best tool for measuring life evaluation[2,38].

Affective well-being. Affective well-being was measured with a variety of dichotomous indicators asking subjects whether they had experienced an emotional state for much of the day yesterday. For positive affect, the emotional states were happiness, enjoyment and smiling/laughter, which, aggregated together, had a reliability of $\alpha = 0.72$. For negative affect, the emotional states were stress, worry and sadness, with a reliability of $\alpha = 0.65$.

Analysis. Satiation is evidenced if the relationship between log income and SWB converges to zero at some income level. The association we were trying to model was thus complex, as we expected an initial linear trend that potentially (but not necessarily) flattened out or even became negative due to turning-point effects. Conventional polynomial regression (for example, a quadratic model) is notoriously inflexible when modelling these complex forms[39], and we opted instead for regression splines. Regression splines are a type of regression model that fits different functions to different sections of the data and allows for changes in the form of the association. These different sections are divided by breakpoints known as knots. For instance, a linear regression spline with one knot would fit a model with two slopes: one before the knot and one after the knot. There are several methodological choices that go into constructing a regression spline. First, the analyst must choose the order of the polynomial functions that are fit to the different portions of the data (for example, linear, quadratic or cubic). Although simplest, linear splines result in very jagged and abrupt shifts in the fitted model, which does not usually represent the true underlying relationship. Quadratic splines also result in non-smooth models, whereas cubic splines, which we chose here, result in smooth models and are thus considered the standard choice for spline order[16]. A second choice in regression splines is the number and location of the knots. Between three and five knots is sufficient to model most data, and these can be placed at equal intervals along the range of the predictor[16,40]. However, we wanted to guard against underfitting, and the size of our dataset allowed us to use more knots when needed. Our final models contained four to six knots depending on the complexity of the function. The Supplementary Methods contain a discussion and example of our model fitting and selection process.

In all models, we controlled for age, gender, marital status, country and survey year. Cases were weighted to account for over-sampling in certain nations. After fitting these models, we located satiation by determining where the slope converged to zero. We then conducted formal hypothesis tests to show that the SWB level at satiation was no different than the SWB level with regard to all higher incomes. We tested this using the Bayes factor[41,42], which offered many advantages for our study; for example, the ability to provide evidence for the null hypothesis of no difference and the avoidance of type I error rate inflation. The Bayes factor is easily interpretable as how many times more likely a particular hypothesis is compared with its alternative[17,18]. We used the Jeffreys–Zellner–Soiw prior[43] and the default scale on effect size of 0.707. Although we side with arguments cautioning the use of discrete cut-offs, rules of thumb for the Bayes factor are as follows: values 1–3 constitute slight evidence, 3–10 constitute moderate evidence, 10–30 constitute strong evidence and 30–100 constitute very strong evidence[17]. To apply these grades of evidence against the null, one simply takes the reciprocal of these values (that is, 1–0.33 is slight, 0.33–0.10 is moderate, 0.10–0.03 is strong and 0.03–0.001 is very strong). In most comparisons, the SWB at satiation was no different when compared with higher incomes (Bayes factor > 3). In others, the SWB level at satiation was greater due to turning-point effects (Bayes factor < 1/3). In no case was the SWB at satiation significantly lower than after satiation (that is, satiation was always reached). Bayes factors were also supplemented by one-sample *t*-tests that report two-tailed *P* values, as shown in Supplementary Table 2.

Ethical considerations. This study complies with all relevant ethical regulations. Data were collected by Gallup and no institutional review board was needed for approval.

Code availability. All analyses were conducted in R, and the code is available from the corresponding author.

Data availability. The data that support the findings of this study are available from Gallup, but restrictions apply to their availability. The data were used under license for the current study, and are not publicly available. The data are, however, available from the authors upon reasonable request and with permission from Gallup.

Received: 19 January 2017; Accepted: 4 December 2017;
Published online: 8 January 2018

References

1. Howell, R. T. & Howell, C. J. The relation of economic status to subjective well-being in developing countries: a meta-analysis. *Psychol. Bull.* **134**, 536–560 (2008).
2. Kahneman, D. & Deaton, A. High income improves evaluation of life but not emotional well-being. *Proc. Natl Acad. Sci. USA* **107**, 16489–16493 (2010).
3. Sacks, D. W., Stevenson, B. & Wolfers, J. The new stylized facts about income and subjective well-being. *Emotion* **12**, 1181–1187 (2012).
4. Diener, E., Lucas, R. E. & Scollon, C. N. Beyond the hedonic treadmill: revising the adaptation theory of well-being. *Am. Psychol.* **61**, 305–314 (2006).
5. Brickman, P. & Campbell, D. T. in *Adaptation Level Theory: A Symposium* (ed. Appley, M. H.) 287–302 (Academic Press, New York, NY, 1971).
6. Diener, E., Ng, W., Harter, J. & Arora, R. Wealth and happiness across the world: material prosperity predicts life evaluation, whereas psychosocial prosperity predicts positive feeling. *J. Pers. Soc. Psychol.* **99**, 52–61 (2010).
7. Howell, R. T., Kern, M. L. & Lyubomirsky, S. Health benefits: meta-analytically determining the impact of well-being on objective health outcomes. *Health Psychol. Rev.* **1**, 83–136 (2007).
8. Lucas, R. E. & Schimmack, U. Income and well-being: how big is the gap between the rich and the poor? *J. Res. Pers.* **43**, 75–78 (2009).
9. Diener, E. & Biswas-Diener, R. Will money increase subjective well-being? *Soc. Indic. Res.* **57**, 119–169 (2002).
10. Lucas, R. E., Diener, E. E. & Suh, E. Discriminant validity of well-being measures. *J. Pers. Soc. Psychol.* **71**, 616–628 (1996).

11. Stevenson, B. & Wolfers, J. *Subjective Well-being and Income: Is There Any Evidence of Satiation?* (IZA Institute of Labor Economics, 2013); https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2265690
12. Gelman, A. The connection between varying treatment effects and the crisis of unreplicable research: a Bayesian perspective. *J. Manag.* **41**, 632–643 (2015).
13. Kahneman, D., Krueger, A. B., Schkade, D., Schwarz, N. & Stone, A. A. Would you be happier if you were richer? A focusing illusion. *Science* **312**, 1908–1910 (2006).
14. Clark, A. E. Are wages habit-forming? Evidence from micro data. *J. Econ. Behav. Organ.* **39**, 179–200 (1999).
15. Deaton, A. Policy implications of the gradient of health and wealth. *Health Aff.* **21**, 13–30 (2002).
16. Harrell, F. E. *Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression, and Survival Analysis* (Springer, New York, NY, 2015).
17. Wagenmakers, E.-J. A practical solution to the pervasive problems of *P* values. *Psychon. Bull. Rev.* **14**, 779–804 (2007).
18. Schönbrodt, F. D., Wagenmakers, E., Zehetleitner, M. & Perugini, M. Sequential hypothesis testing with Bayes factors: efficiently testing mean differences. *Psychol. Methods* **22**, 322–339 (2017).
19. *The World Factbook* (Central Intelligence Agency, 2009).
20. Tay, L., Morrison, M. & Diener, E. Living among the affluent: boon or bane? *Psychol. Sci.* **25**, 1235–1241 (2014).
21. Adelmann, P. K. Occupational complexity, control, and personal income: their relation to psychological well-being in men and women. *J. Appl. Psychol.* **72**, 529–537 (1987).
22. Levant, R. & Richmond, K. A review of research on masculinity ideologies using the male role norms inventory. *J. Mens. Stud.* **15**, 130–146 (2007).
23. Mahalik, R. et al. Development of the conformity to masculine norms inventory. *Psychol. Men Masculin.* **4**, 3–25 2003).
24. Stutzer, A. The role of income aspirations in individual happiness. *J. Econ. Behav. Organ.* **54**, 89–109 (2004).
25. Clark, A. E. & Oswald, A. J. Satisfaction and comparison income. *J. Public Econ.* **61**, 359–381 (1996).
26. Clark, A. E. & Senik, C. Who compares to whom? The anatomy of income comparisons in Europe. *Econ. J.* **120**, 573–594 (2010).
27. Diener, E. & Oisho, S. in *Culture and Subjective Well-being* (eds Diener, E. & Suh, E. M.) 185–218 (MIT Press, Cambridge, MA, 2000).
28. Layard, R., Mayraz, G. & Nickell, S. *International Differences in Well-Being* Ch. 6 (Oxford Univ. Press, New York, NY, 2010).
29. Proto, E. & Rustichini, A. A reassessment of the relationship between GDP and life satisfaction. *PLoS ONE* **8**, e79358 (2013).
30. Kuykendall, L., Tay, L. & Ng, V. Leisure engagement and subjective well-being: a meta-analysis. *Psychol. Bull.* **141**, 364–403 (2015).
31. Cheung, F. & Lucas, R. E. Income inequality is associated with stronger social comparison effects: the effect of relative income on life satisfaction. *J. Pers. Soc. Psychol.* **110**, 332–341 (2016).
32. Ferrer-i-Carbonell, A. Income and well-being: an empirical analysis of the comparison income effect. *J. Public Econ.* **89**, 997–1019 (2005).
33. *Divided We Stand – Why Inequality Keeps Rising* (Organisation for Economic Co-operation and Development, 2011).
34. *Growing Unequal? Income Distribution and Poverty in OECD Countries* (Organisation for Economic Co-operation and Development, 2008)
35. Cantril, H. *The Pattern of Human Concerns* (Rutgers Univ. Press, New Brunswick, 1965).
36. Levin, K. A. & Currie, C. Reliability and validity of an adapted version of the Cantril ladder for use with adolescent samples. *Soc. Indic. Res.* **119**, 1047–1063 (2014).
37. Palmore, E. & Kivett, V. Changes in life satisfaction: a longitudinal study of persons aged 40–70. *J. Gerontol.* **32**, 311–316 (1977).
38. Beckie, T. M. & Hayduk, L. A. Using perceived health to test the construct-related validity of global quality of life. *Soc. Indic. Res.* **65**, 279–298 (2004).
39. Lind, J. T. & Mehlum, H. With or without U? The appropriate test for a U-shaped relationship. *Oxf. Bull. Econ. Stat.* **72**, 109–118 (2010).
40. Korn, E. L. & Graubard, B. I. in *Analysis of Health Surveys* 345–346 (John Wiley & Sons, Hoboken, NJ, 1999).
41. Kass, R. E. & Raftery, A. E. Bayes factors. *J. Am. Stat. Assoc.* **90**, 773–795 (1995).
42. Jeffreys, H. *Theory of Probability* (Oxford Univ. Press, Oxford, 1961).
43. Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D. & Iverson, G. Bayesian *t* tests for accepting and rejecting the null hypothesis. *Psychon. Bull. Rev.* **16**, 225–237 (2009).

Acknowledgements

This research was not supported by any funding.

Author contributions

A.T.J. analysed the data and wrote the paper. Project planning, data access and critical feedback were provided by E.D., L.T. and S.O.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information is available for this paper at https://doi.org/10.1038/s41562-017-0277-0.

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