

## Does intelligence have nonlinear effects on political opinions?

### Abstract

We sought to study intelligence's relationship with political opinions with particular interest in nonlinear associations. We surveyed 1,003 American adults using Prolific, where we measured English vocabulary ability, as well as 26 political opinions. We find that intelligence has detectable linear associations with most political opinions (21 of 26). Using natural splines and the multivariate adaptive regression splines (MARS) algorithm, we find evidence of nonlinear effects on both individual opinions (15 of 26) and a general conservatism score. Specifically, the association between intelligence and conservatism is mainly negative, but becomes positive in the right tail.

### Introduction

There is a long standing interest in intelligence's relationship with political opinions (Carl, 2014, 2015a; Jeding & Burger, 2021; Kirkegaard, 2022; Leeson et al., 2012; Rindermann et al., 2012). In general, it has been found that measures of social conservatism show negative relationships to intelligence, while measures of free market support (economic liberalism) show positive relationships. In terms of party support in many-party systems, generally populist parties attract voters of below average intelligence. Differences between voters in large, centrist parties are usually very close to average intelligence. Most studies were done in the USA, and there is enough data e.g. from the General Social Survey (GSS) or the American National Election Studies (ANES) to study changes in the associations over time. There has been multiple changes over time. Republican voters used to be on average slightly more intelligent, but they have lost this advantage recently with the rise of more populist of the party.

A main limitation of the GSS and ANES based studies is that they employ only a weak measure of intelligence, a 10-item vocabulary test (Wordsum) (Malhotra et al., 2007). This test has quite limited reliability and poor ability to discriminate among subjects who are not of average intelligence. Furthermore, the ceiling is about 120 IQ, so any changes in intelligence's relationship to other variables beyond that point (about 90th centile) are not possible to study using this test. This limits the ability to find nonlinear associations if such exist in the right tail.

In the present study, we sought to re-evaluate the relationship between intelligence and political opinions using a longer test with much better reliability in the tails, including the right tail.

### Data

We used data from 2 surveys. The first (n = 499) was part of a larger study and we reused part of it here. After the analysis of this survey, we realized statistical power was too low for some analyses, so we carried out a replication survey (n = 504). The data were then combined into a single dataset.

#### *The first survey*

We used data from an online survey of 499 American adults. These were recruited to participate in a survey using the Prolific platform (<https://www.prolific.com/>), by way of the "representative sample" method called "United States of America" which gives a

balanced sample for “Sex, Age, Ethnicity (Simplified US Census)”. The resulting sample was approximately representative of adult American citizens aged 19-85 in terms of age, sex, and ethnicity. 52% of the subjects were female. The average age was 46 with a range from 19 to 83 and a standard deviation of 16. Of the subjects, 72% were White, 13% were Black, 4% were East Asian, but only 6% were Hispanic (in any combination). The remaining part was composed of other smaller groups or subjects who chosen multiple ethnic categories (e.g. South Asians were 1%, White Jews were 1%).

We sought to measure a wide variety of political opinions. To this end, we constructed a set of 26 questions all of which were rated by subjects on a 5-point Likert-like scale from “Strongly agree” to “Strongly disagree”.

To measure intelligence, we included a newly developed, public use English vocabulary test. Our survey formed the basis of its standardization sample. The vocabulary test included 232 items in total, some of which were given in a follow-up survey to reduce the survey length. The test was scored using item response theory (IRT) based on the 2-parameter logistic model. This was done using the **mirt** package (Chalmers et al., 2020). The resulting scores were normed to the White subset after age adjustments.<sup>1</sup> Thus, the White subset has an average IQ of 100 with a standard deviation of 15 by construction. To total sample’s IQ was 98.2 (standard deviation 15.6). Although vocabulary and general intelligence are distinct factors, they are very strongly correlated at about .80 (Gignac, 2015). We thus used vocabulary ability as a proxy for general intelligence (g, (A. R. Jensen, 1998)). Reliability of the vocabulary scores was .98 (*empirical\_rxx()* function).

### *The second survey*

The second survey was intended as a replication of the first using only the necessary variables. For this survey, we used the representative method of “Political affiliation” which gives a balanced sample for “Sex, Age, Political Affiliation”. This method was chosen to obtain higher precisions, as online survey data has an overrepresentation of left-wingers.<sup>2</sup> As the original vocabulary test was too long, we used an optimally chosen 50-item abbreviation of this. The scoring norms from the first study were used to score the second survey. The reliability of vocabulary score was .94 in both the replication and the original, Figure S11 shows the functions. Figure S4 shows the distributions of vocabulary IQ. Figure S6 shows the reliability functions. The same 26 political questions were reused. By mistake, a wrong set of ethnicity questions were used in the replication that were not identical to the first set. In practice, this had little effect, however, because most groups were too small to be used for modeling and were combined into an “other” category.

## **Results**

### *Linear effects of intelligence*

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<sup>1</sup> We removed both the effect of age on the central tendency and on the dispersion.

<sup>2</sup> We replicated this finding. The conservatism score for the second sample was 0.35 d lower in conservatism, see Figure S5. However, both samples seemed to be left-leaning, as the conservative tail was longer.

To examine whether intelligence in general had at least a linear effect of political opinions, we fit regression models for each opinion separately. Figure 1 shows the linear, standardized effect of intelligence.

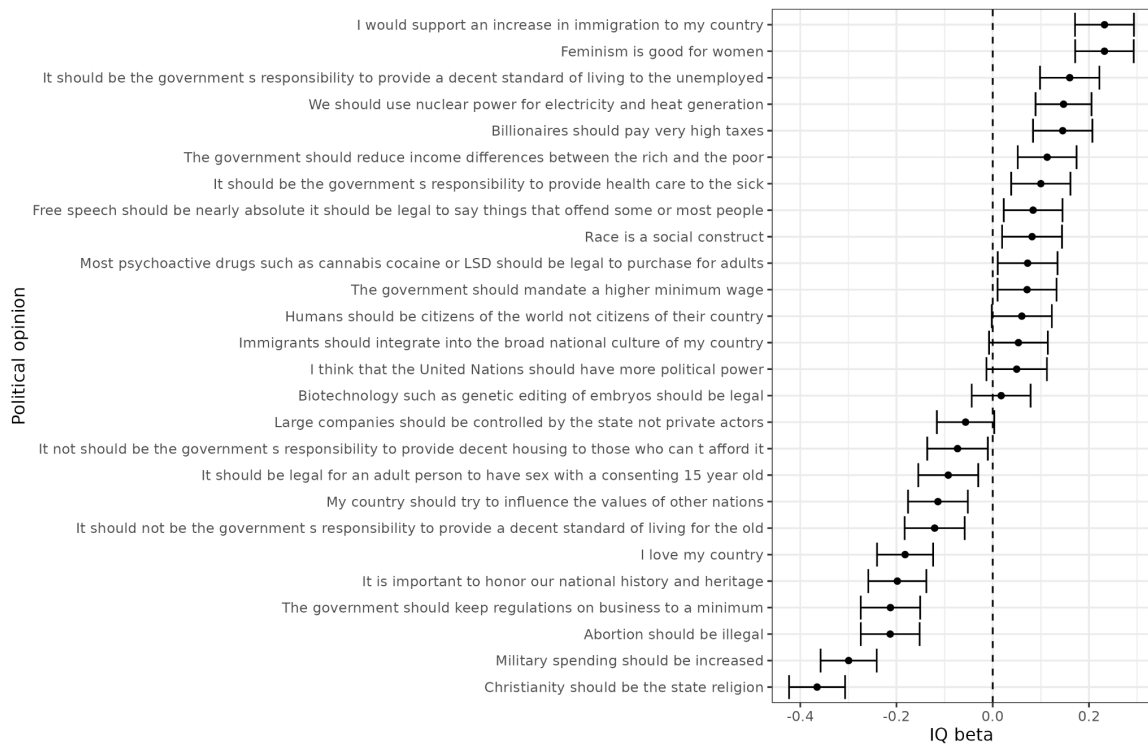


Figure 1. Linear effect of intelligence on political opinions. Results from separate regression models with controls for age, sex, and ethnicities. Error bars show 95% confidence intervals.

Of the 26 opinions, intelligence had a detectable effect ( $p < .05$ ) on 21 (81%) of them net of demographics (age, sex, ethnicity). Using Bonferroni correction for multiple testing, there were 15 models with detectable effects (58%). Some of these effects were considerable, e.g., the negative effect on agreeing that Christianity should be the state religion (beta = -0.37). Table S1 gives the summary statistics for all models.

### *Nonlinear effects of intelligence using natural splines*

In order to detect possible nonlinear effects, we refit the same regression models using natural spline functions with 3, 4, or 5 knots. We used model likelihood ratio comparisons to determine the optimal number of spline knots, and whether splines were necessary in the first place. This was done using the **rms** package using the *rCs()* function (Harrell, 2024). The model comparisons showed that 4 spline knots was the best overall choice for this dataset with 15 of the 26 (58%) models showing evidence ( $p < .05$ ) of nonlinear effects (Figure S1 gives additional information about the pattern.). After Bonferroni correction, 5 models (19%) showed detectable nonlinear effects. The 9 models with the strongest evidence are shown in Figure 2 (maximum  $p$  value = .0031; Figures S7 and S8 show the remaining models). These plots are based on the model predictions holding

covariates constant at their mean or modal values. This was accomplished using the **ggeffects** package by the function *ggpredict()* (Lüdtke, 2018).

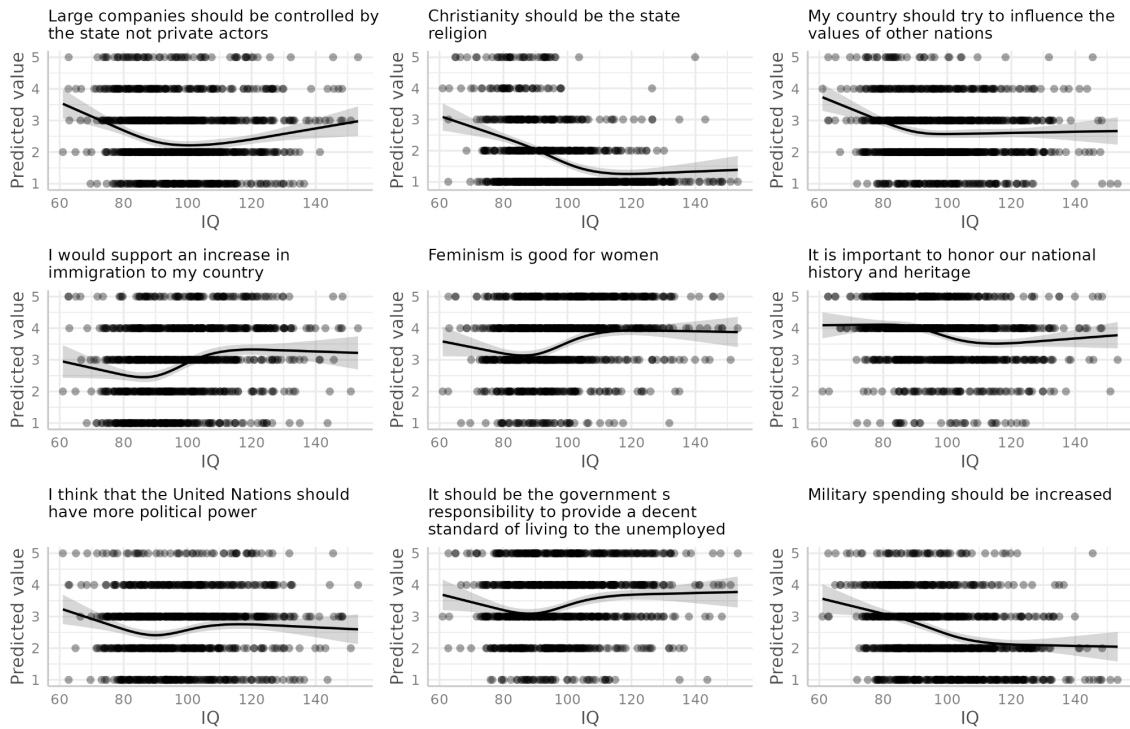


Figure 2. Nonlinear effects of intelligence on specific political opinions. Scatterplots of the 9 models with strongest evidence of nonlinearity. Error bars are 95% confidence intervals. Models include controls for age, sex, and ethnicity.

The shape of intelligence’s association with political opinions varied. Some show a diminishing returns pattern (e.g. Christianity as state religion showed approximately no association after 110 IQ), while others show apparently non-monotonic patterns (e.g. government should control large companies shows a U-shaped pattern).

### *General conservatism*

Next, we analyzed the relationship between intelligence and overall conservatism, scored as the first factor of a factor analysis of the 26 opinions. This analysis was done using the **psych** package (Revelle, 2020). This factor accounted for 27% of the variance. Positive loadings corresponded to more conservative opinions, and negative loadings for left-wing or socialist opinions. Figure 3 shows the factor loadings.

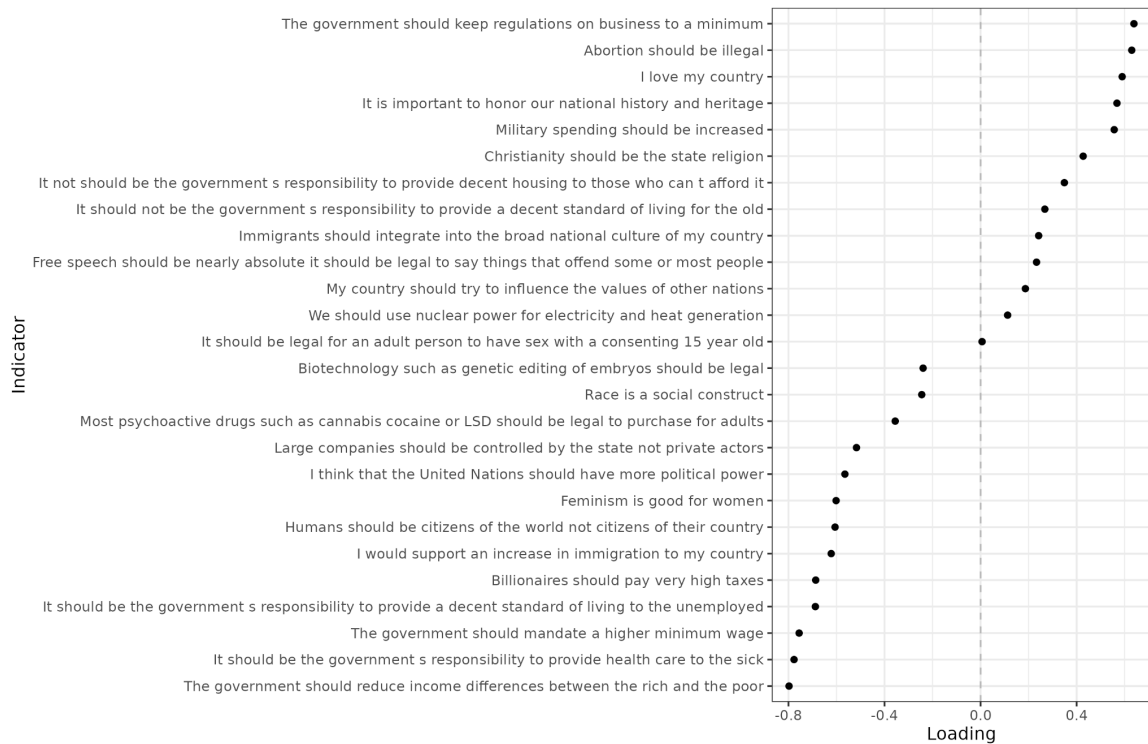


Figure 3. Factor loadings of political opinions.

The pattern of loadings was generally sensible. Opposition to government regulations and legalized abortion had strong positive loadings, as did love for one's country. On the other hand, support for increasing the minimum wage and support for income redistribution policies had strong negative loadings.

In order to examine the effects of intelligence on the conservatism score, we fit the same spline models as used above. Likewise, we carried out model comparisons to determine the best number of splines. This was done by comparing the spline models to the linear model, and with each other. In this case, 5 knots appeared to be optimal based on both approaches (linear vs. 5 knots  $p = .0008$ ; 4 vs. 5 knots  $p = 0.07$ ). Table 1 shows the resulting models.

Predictor	Model	
	Linear	Spline, 5 knots
Intercept	0.14 (0.048, 0.003**)	0.35 (0.234, 0.132)
IQ	-0.22 (0.030, <0.001***)	(nonlinear)
sex = Female	-0.24 (0.060, <0.001***)	-0.24 (0.060, <0.001***)
age	0.22 (0.031, <0.001***)	0.24 (0.031, <0.001***)
asian	-0.19 (0.202, 0.358)	-0.18 (0.201, 0.37)
black	-0.39 (0.103, <0.001***)	-0.37 (0.104, <0.001***)
east_asian	0.17 (0.218, 0.442)	0.18 (0.217, 0.399)
hispanic	0.14 (0.170, 0.412)	0.14 (0.169, 0.419)
white, hispanic	-0.24 (0.216, 0.27)	-0.24 (0.215, 0.27)

white, jewish	0.31 (0.245, 0.204)	0.33 (0.244, 0.171)
Other	-0.04 (0.116, 0.737)	-0.04 (0.115, 0.752)
R2 adj.	0.118	0.13
N	1003	1003

Table 1. Models for predicting conservativeness. Numerical variables were standardized. Spline terms omitted. Values in parentheses are standard errors and p values. \* =  $p < .01$ , \*\* =  $p < .005$ , \*\*\* =  $p < .001$ .

The linear model showed a negative relationship between intelligence and conservatism (beta = -0.22). The other associations were also roughly as expected, with women being less conservative than men (beta = -0.24), older people being more conservative (beta = 0.24), and Blacks being less conservative (beta = -0.37).

Since spline terms are not easily interpretable based on regression coefficients (omitted above), we plotted the model predictors. These are shown in Figure 4 (Figure S2, S3 and S9 show additional scatterplots).

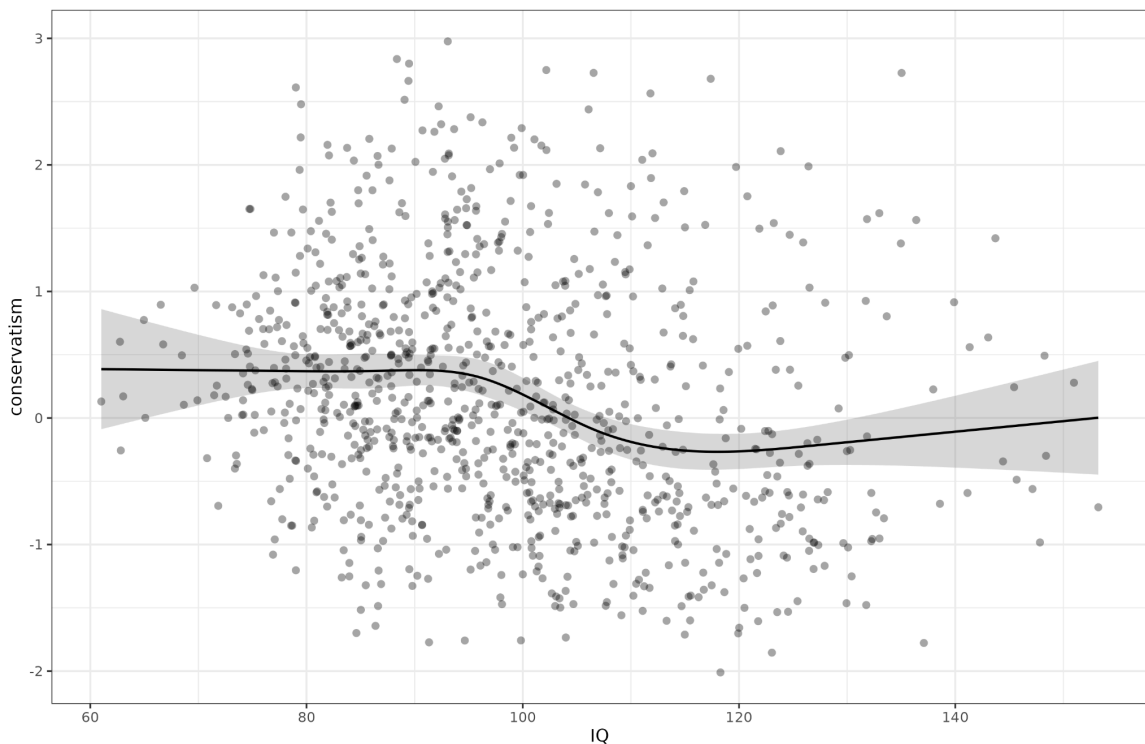


Figure 4. Model predictions for predicting conservatism from intelligence based on an ordinary least squares model with a natural spline for intelligence, holding covariates constant at mean or modal values. Error bar shows 95% confidence interval. The model include controls for age, sex, and ethnicities. Data points are partial residuals.

The relationship appeared to be complex, with no association below 95 IQ, a linear negative relationship between 90 and 115 IQ, and a slight upwards linear trend after 115 IQ.

### *Nonlinear effects of intelligence using multivariate adaptive regression splines (MARS)*

In order to test the robustness of the nonlinear association of intelligence, we applied the multivariate adaptive regression spline (MARS) algorithm to the data. This was done using the **earth** package (Milborrow, 2024). This approach automatically test 100s or 1000s of regression models to search for nonlinear effects of numerical variables and interactions between variables (Friedman & Roosen, 1995). Nonlinear effects of variables are modeled using linear splines. We allowed the algorithm to search for up to 2-way interactions. Figure 5 shows the model predictions.

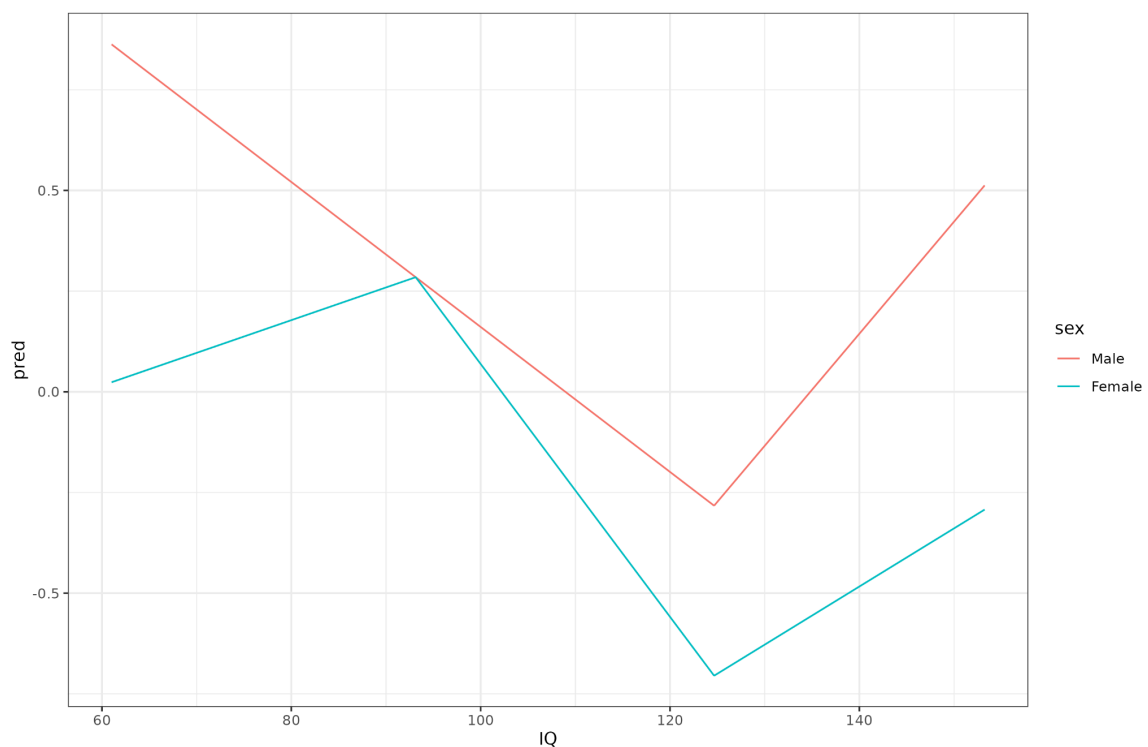


Figure 5. Model predictions for predicting conservatism from intelligence based on the multivariate adaptive regression splines algorithm, holding covariates constant at mean or modal values. Confidence intervals not possible.

The MARS algorithm findings supported the results from the natural spline regression models with breakpoints for the effect of intelligence on conservatism changing at 93 and 125 IQ. MARS additionally identified interactions with IQ and sex, as well as IQ and ethnicity, the former which can be seen in Figure 5 (above).

### *Robustness tests*

To examine the robustness of the results, we also fit MARS in each wave of the sample independently. The results are shown in Figure 6.

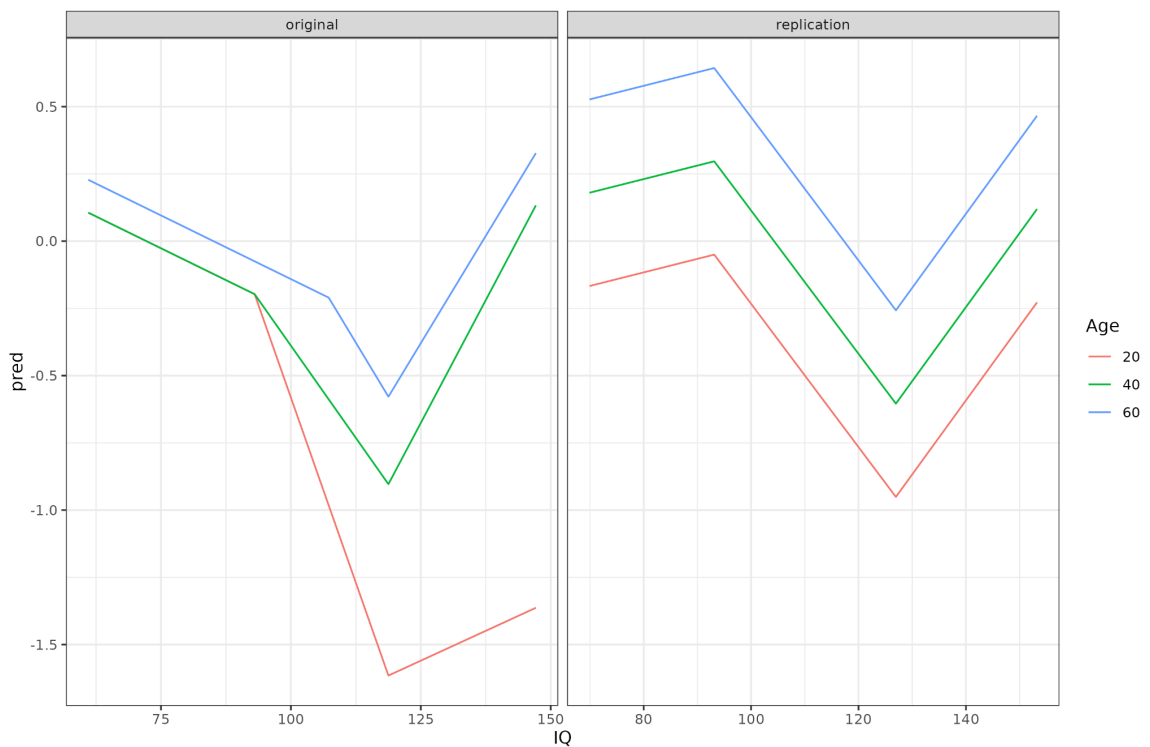


Figure 6. Model predictions for predicting conservatism from intelligence based on the multivariate adaptive regression splines algorithm, holding covariates constant at mean or modal values. Confidence intervals not possible. Data split by wave.

Fitting MARS to each wave alone reveals similarly shaped functions for intelligence. The breakpoints for the effect of IQ in the high end were 117 and 127. These differences may be due to sampling error between the datasets, or due to the different sample compositions due to the different sampling methods used.

MARS employs a penalty (regularization) parameter to fit the models. According to the package documentation “It’s usually best not to subvert the standard MARS algorithm by toying with tuning parameters such as thresh, penalty, and endspan.”. However, we decided to attempt to tune this parameter anyway. To do so, we used the built-in cross-validation feature, with 10-fold cross-validation repeated 10 times. The optimal penalty value was found to be about 8 (Figure S10). This resulted in a breakpoint for IQ at 125, which did not turn positive (as the models above), but beyond which IQ was not associated with conservatism for men. There was a female sex interaction such that the effect of intelligence was still negative for women in this high range, but less so that before the breakpoint. Figure 7 shows the results.



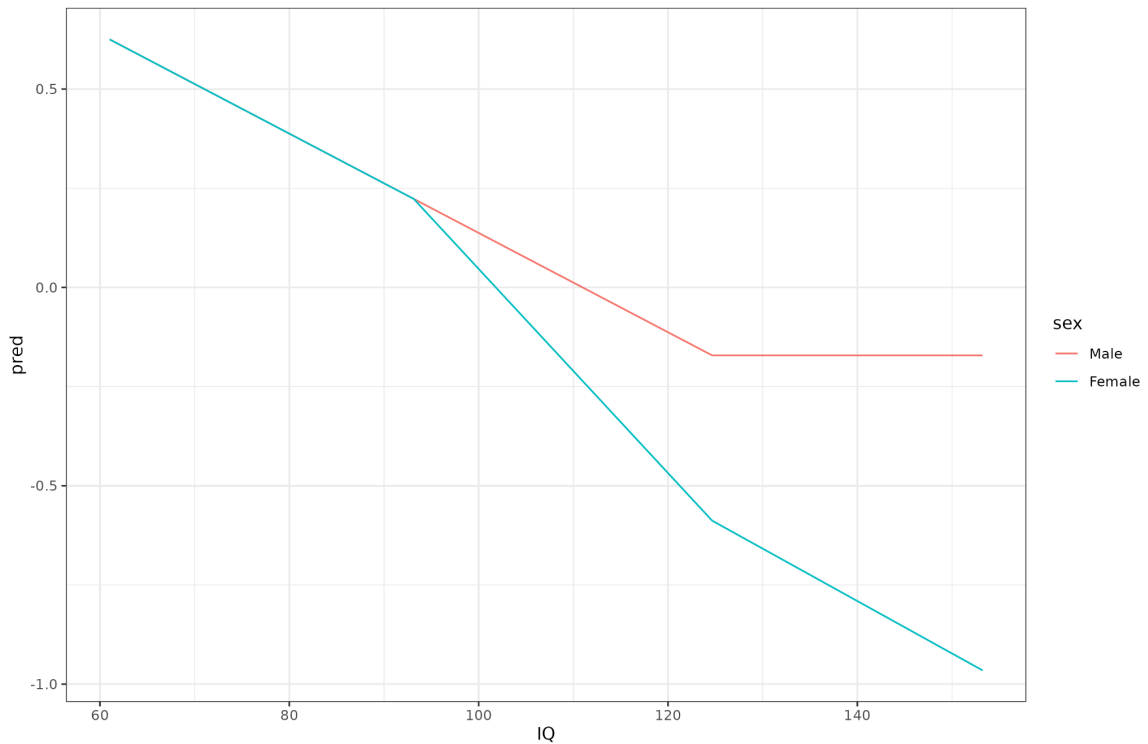


Figure 7. Model predictions for predicting conservatism from intelligence based on the multivariate adaptive regression splines algorithm, holding covariates constant at mean or modal values. Confidence intervals not possible. Penalty tuning used.

When we modeled each political question, we used natural splines to detect nonlinear effects of intelligence on individual political questions. As a robustness test, we did this also using MARS. Summarizing the results is difficult due to the presence of many terms in the models, but 25 of the 26 models included IQ in at least one term, 1 (4%) model included only a linear effect, and the remaining included either splines (breakpoints), interactions, or both. If we ignore the interactions, then of the remaining model, 5 included no linear effect, 10 (39%) included a linear effect, and the remaining 11 (42%) included nonlinear effects. Generally, then, there was pervasive evidence of nonlinear and interactive effects of intelligence.

## Discussion

We found pervasive evidence of the association of intelligence (proxied by vocabulary knowledge) on political opinions and political ideology. Furthermore, many of these associations were nonlinear or interactive in nature. We confirmed these results using both natural splines and the multivariate adaptive regression splines (MARS) algorithm. Overall, intelligence was mainly associated with lower conservatism, but we found intriguing evidence that this pattern seemingly becomes null or reverses at about 120 IQ.

These results have implications for current writings concerning the lack of conservative talent among elites in the United States (Cofnas, 2024a, 2024b; Hanania, 2021; Kirkegaard, 2022). The findings may in fact be interpreted as confirming a variant of the midwit or bell curve meme popular online, shown in Figure 8.

I'm gonna need a source for that

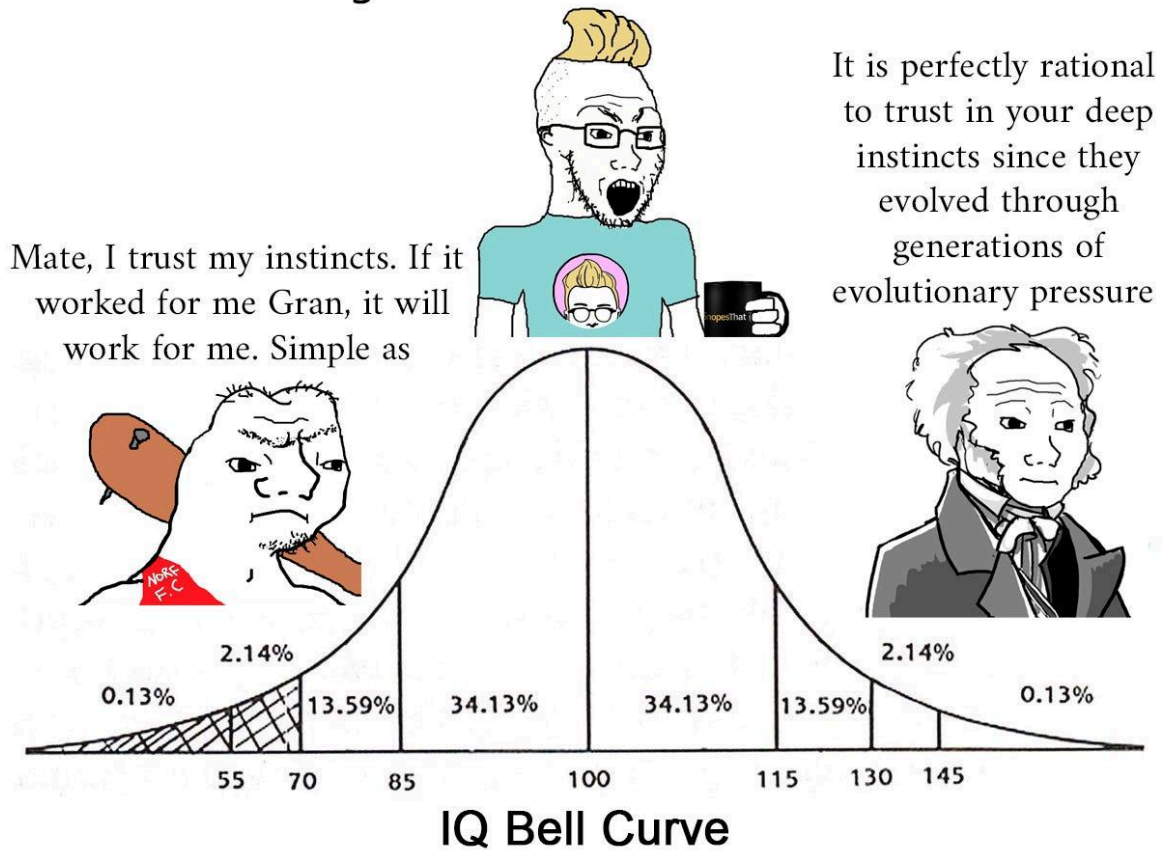


Figure 8. An example of the midwit or Bell Curve meme.

The purpose of the meme is to state that people of high and low intelligence may sometimes disagree with those in the middle. We did not find this exact pattern in the data because the breakpoints for the reversal of the effect was around 120. However, if one considers that people engaged in online political or scientific debates may have an average IQ around 115, the results align with the meme at least with regards to general conservatism and a few other opinions (refer back to Figure 2). There are a few other datasets with some political measures that produce support for this U-shaped pattern, but generally it is not found (S. Jensen, 2023).

Our results of pervasive associations between intelligence and political thinking or behavior replicate the prior literature (Carl, 2014, 2015a; Deary et al., 2008; Edwards et al., 2024; Heaven et al., 2011; Kirkegaard, 2022; Ludeke et al., 2017; Onraet et al., 2015). Most of this literature has found that social conservatism relates negatively (overall) to intelligence, a finding which we replicated. The results for economic conservatism (free market support) are more mixed and our results confirmed this (Jedinger & Burger, 2021). Our findings were mostly of negative associations, something supported in the meta-analysis as more recent studies tend to show more negative associations. One prior study found a U-shaped association with leftism and intelligence (the opposite results of this study), though this was questioned by a later study (Carl, 2015b; Solon, 2014).

The limitations of the current study include the following. First, we are unable to discern causality with the current cross-sectional dataset. Generally, however, reverse causality can be ruled out as intelligence is largely inherited (heritable) and causation of political ideology on intelligence is implausible. This, however, does not mean that the results aren't confounded by other variables. We used a small set of demographic controls as we did not want to control for potential mediators (something caused by intelligence which later cause political opinions). Two prior studies used a sibling design to examine the relationship between intelligence and polygenic scores thereof, and found that these also predicted within family (Ahlskog, 2023; Ahlskog & Oskarsson, 2023; Edwards et al., 2024). This pattern of results shows family-level confounding cannot explain most of the association. These facts taken together suggests that intelligence causes political beliefs. As the associations of intelligence with various political beliefs has changed over time, it suggests the nature of the causation depends on the political situation and cultural climate (Kirkegaard, 2022).

Second, we relied upon American online survey data, which is known to have certain biases (e.g., left-wing sampling bias, lack of Hispanic representation). It is not known to which degree this affected our results. Our general findings were in line with the prior literature, some of which is not based on online surveys, which suggests this wasn't a big concern. Still, there is a risk of collider bias for the right tail. This is because workers (paid survey takers) at Prolific make at 8-10 dollars an hour answering surveys online, a much lower salary than could be achieved elsewhere for American people of high intelligence. People of high intelligence who nevertheless take on this form of labor are likely to be deficient in other qualities that are attractive in workers. One chief such quality is mental health. As mental health has a negative association with conservatism, we can expect sampling bias in the high IQ range such that left-wingers are over-sampled (Bernardi, 2020; Kirkegaard, 2020a). We are not aware of any study that has examined this particular issue, but the broader topics of volunteer bias and non-random attribution or non-response and the resulting collider bias are well studied (Callahan et al., 2007; Lamp & MacKinnon, 2024; van Alten et al., 2024).

Third, we measured only vocabulary knowledge, as opposed to a full battery of diverse cognitive tests. This is mainly because measuring nonverbal or fluid ability online is difficult and expensive, as subjects do not pay sufficient attention to such tasks and they take longer (e.g., answering a single vocabulary question takes a few seconds, solving a figure matrix item may take a minute). Some of the prior literature has found that verbal abilities are more strongly related to political ideology than are non-verbal abilities. Our results, then, should be particularly clear (Ludeke et al., 2017). There is also the possibility that verbal tilt has biased our results, as verbal tilt itself seems to relate to socialism or lower conservatism (Kirkegaard, 2020b). If so, then the results may underestimate the reversal of intelligence's effect on political ideology. It should be said, however, that other research using the General Social Survey and the American National Election Studies datasets also used purely vocabulary tests (the GSS Wordsum, 10-item test), which were most shorter and less reliability than the current study.

### **Supplementary materials**

High quality figures, data and R code needed to reproduce the study are found in the OSF repository at <https://osf.io/tbqzw/>. Additionally, the R notebook is available at [https://rpubs.com/EmilOWK/IQ\\_nonlinear\\_politics](https://rpubs.com/EmilOWK/IQ_nonlinear_politics).

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## Appendix



Figure S1. Strength of evidence for spline models over linear models for predicting

individual political belief.

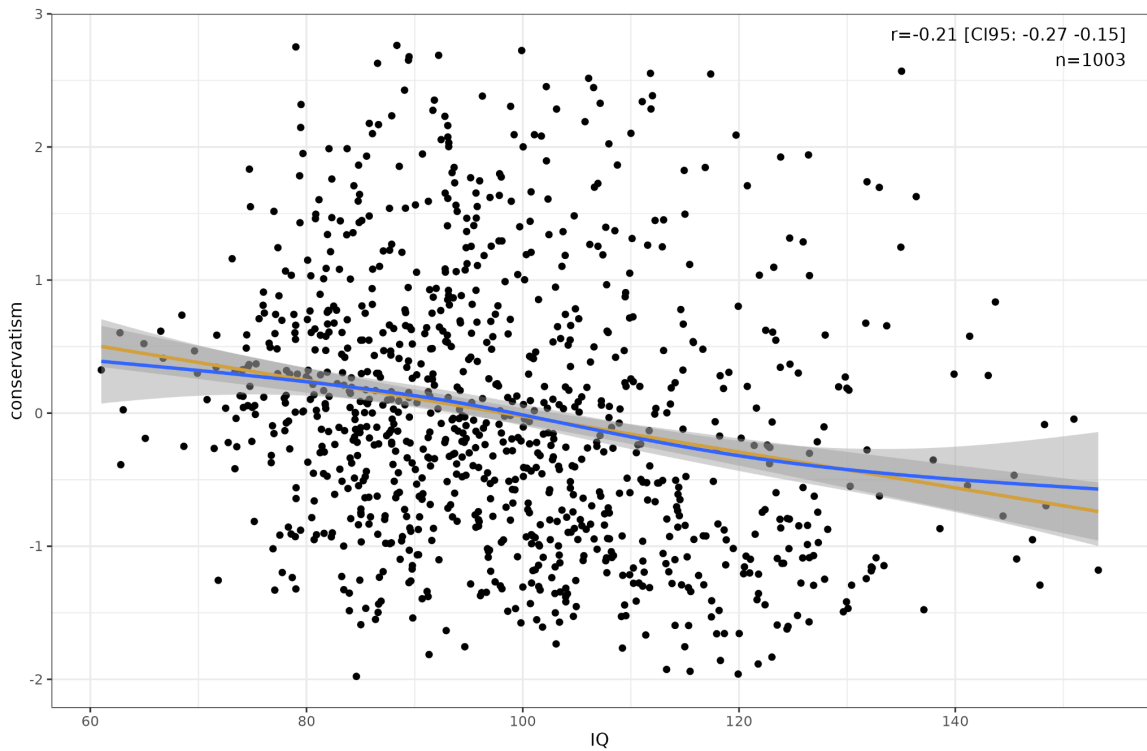


Figure S2. Scatterplot of intelligence and conservatism without covariates. Smoothed line from a general additive model (default of `geom_smooth()` in `ggplot2`).

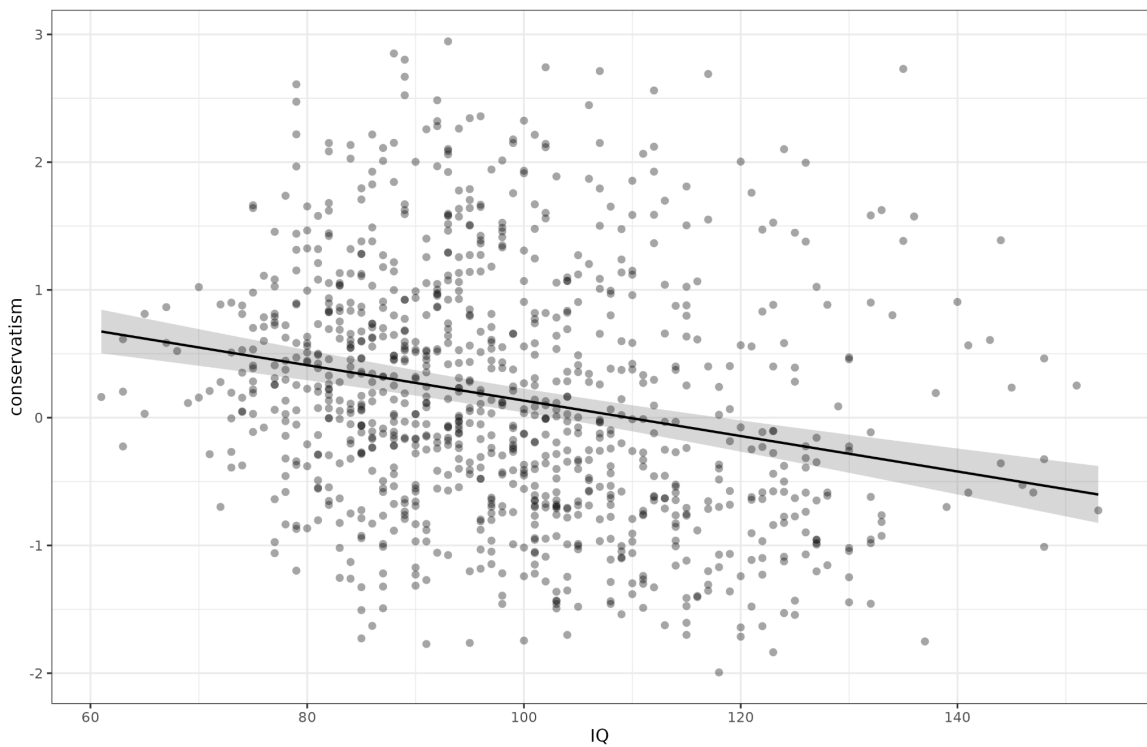


Figure S3. Model predictions for predicting conservatism from intelligence based on a linear model for intelligence, holding covariates constant at mean or modal values. Error



bar shows 95% confidence interval. The model include controls for age, sex, and ethnicities. Data points are partial residuals.

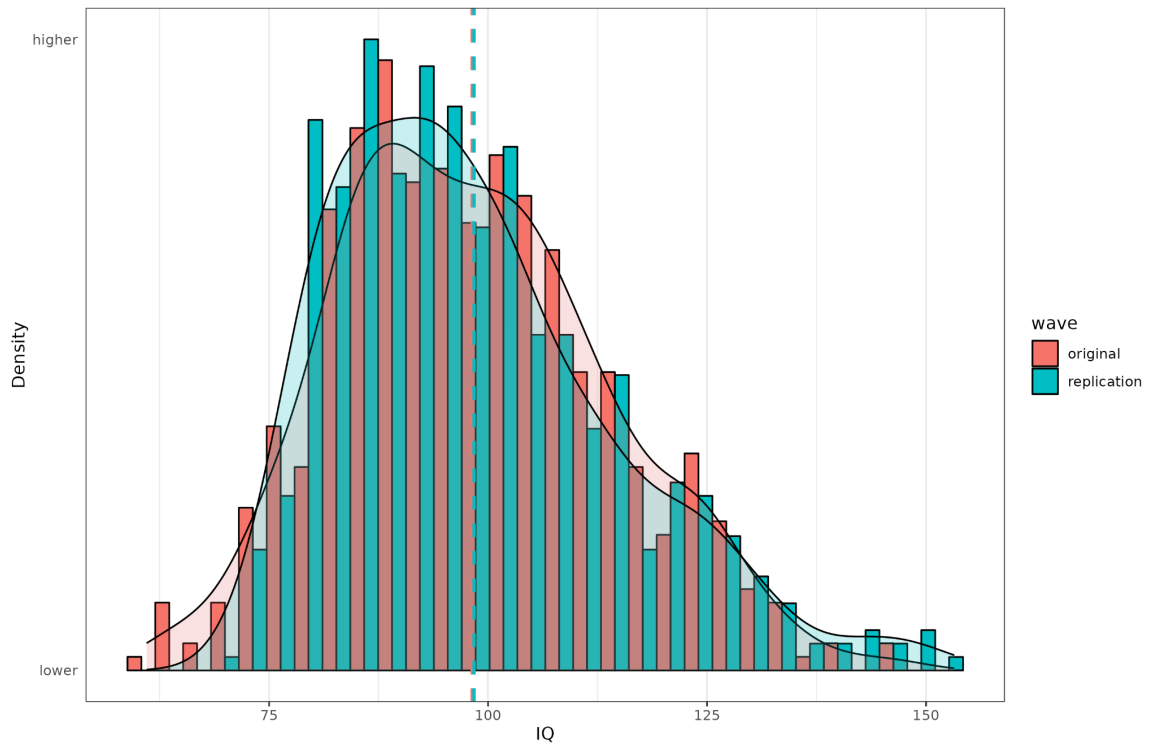


Figure S4. Distribution of vocabulary IQ by wave.

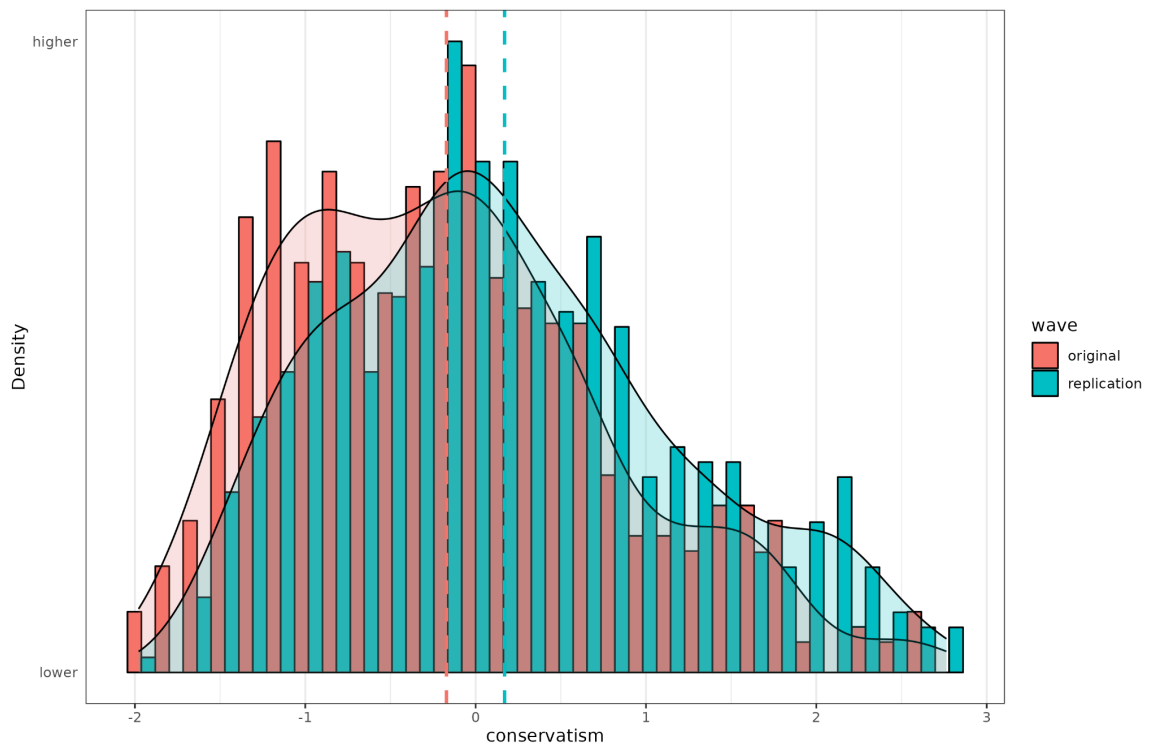


Figure S5. Distribution of conservatism by wave.

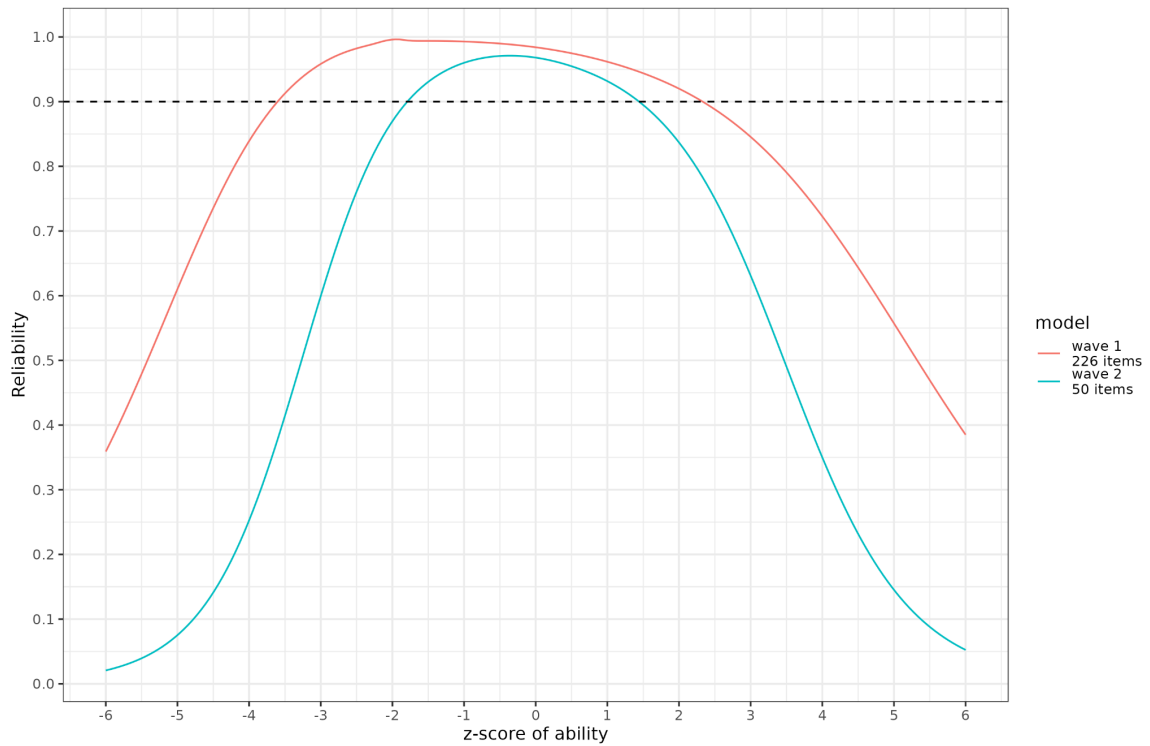


Figure S6. Vocabulary test reliability distribution by wave.

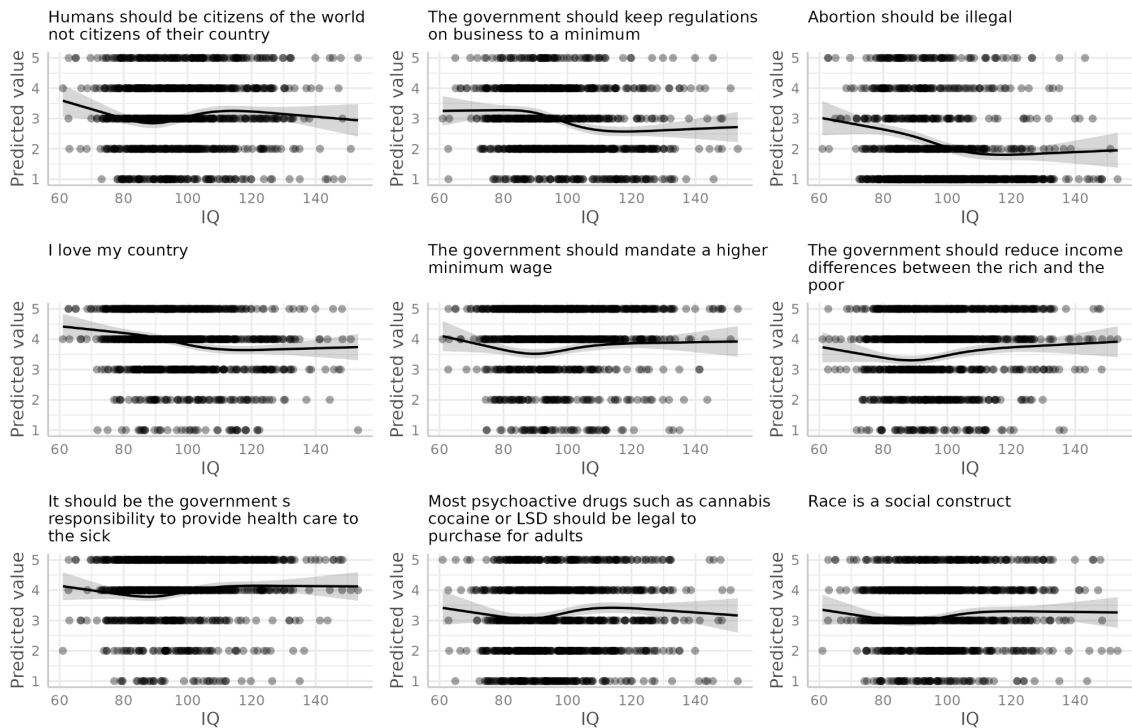


Figure S7. Nonlinear effects of intelligence on specific political opinions. Scatterplots of the 10-18th models with strongest evidence of nonlinearity. Error bars are 95% confidence intervals. Models include controls for age, sex, and ethnicity.

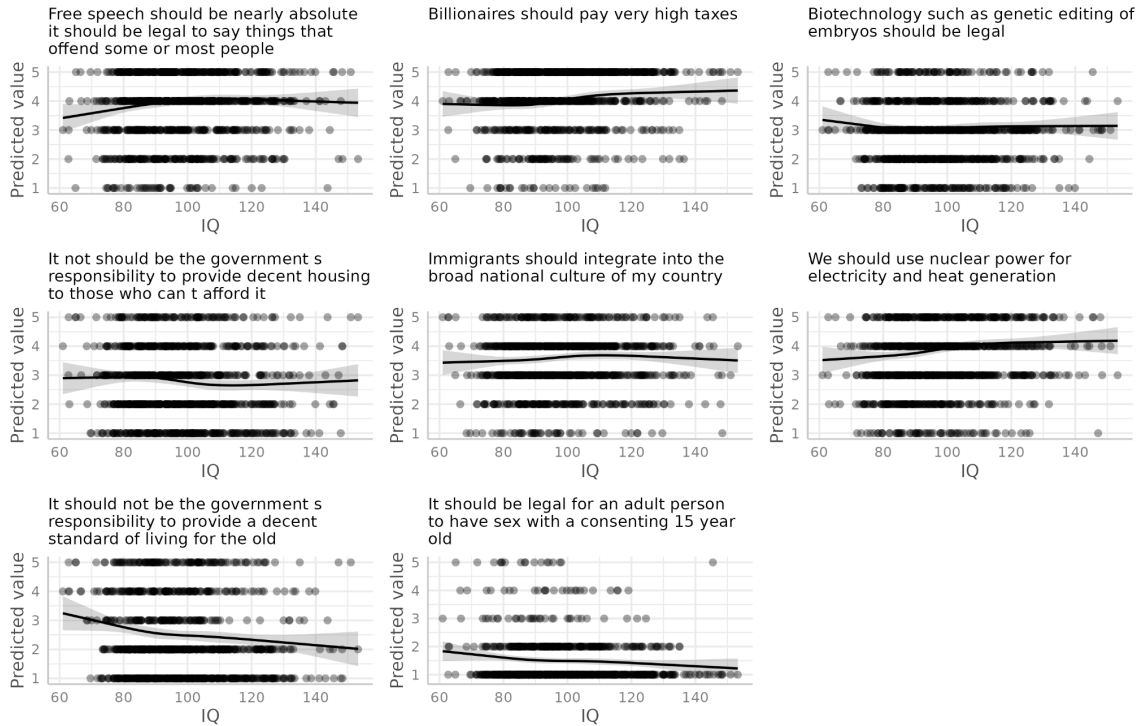


Figure S8. Nonlinear effects of intelligence on specific political opinions. Scatterplots of the 19-26th models with strongest evidence of nonlinearity. Error bars are 95% confidence intervals. Models include controls for age, sex, and ethnicity.

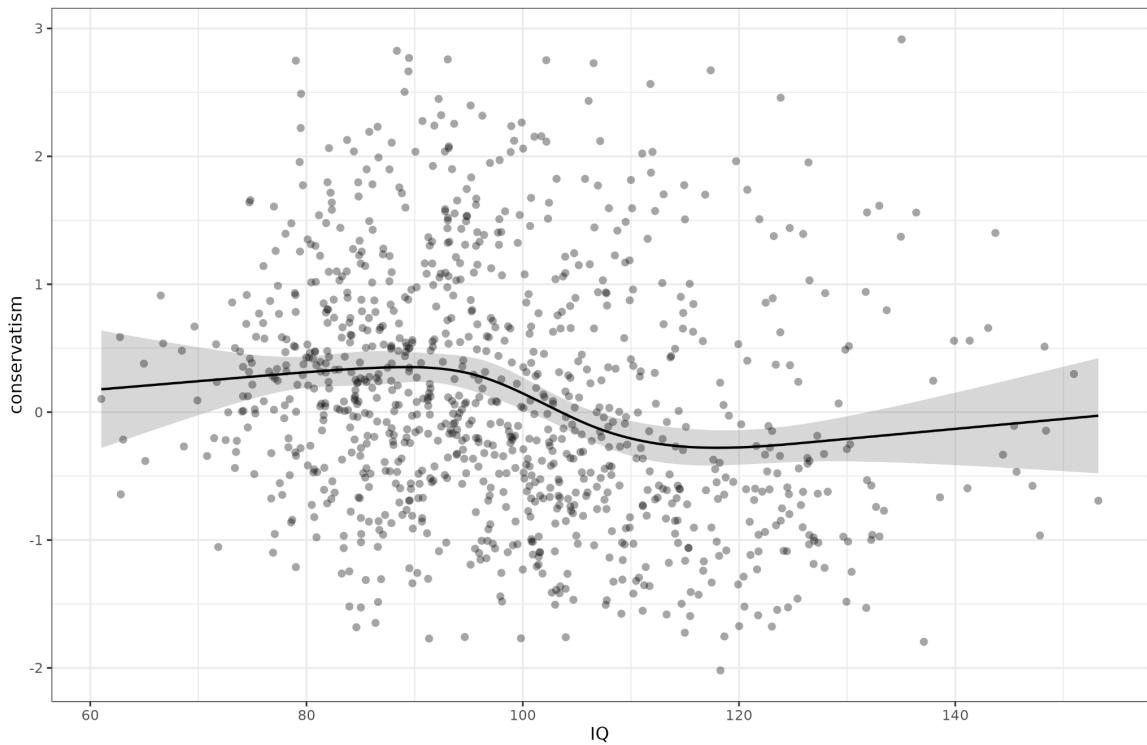


Figure S9. Model predictions for predicting conservatism from intelligence based on a spline model for intelligence, holding covariates constant at mean or modal values. Error

bar shows 95% confidence interval. The model include controls for age, sex, but not ethnicities. Data points are partial residuals.

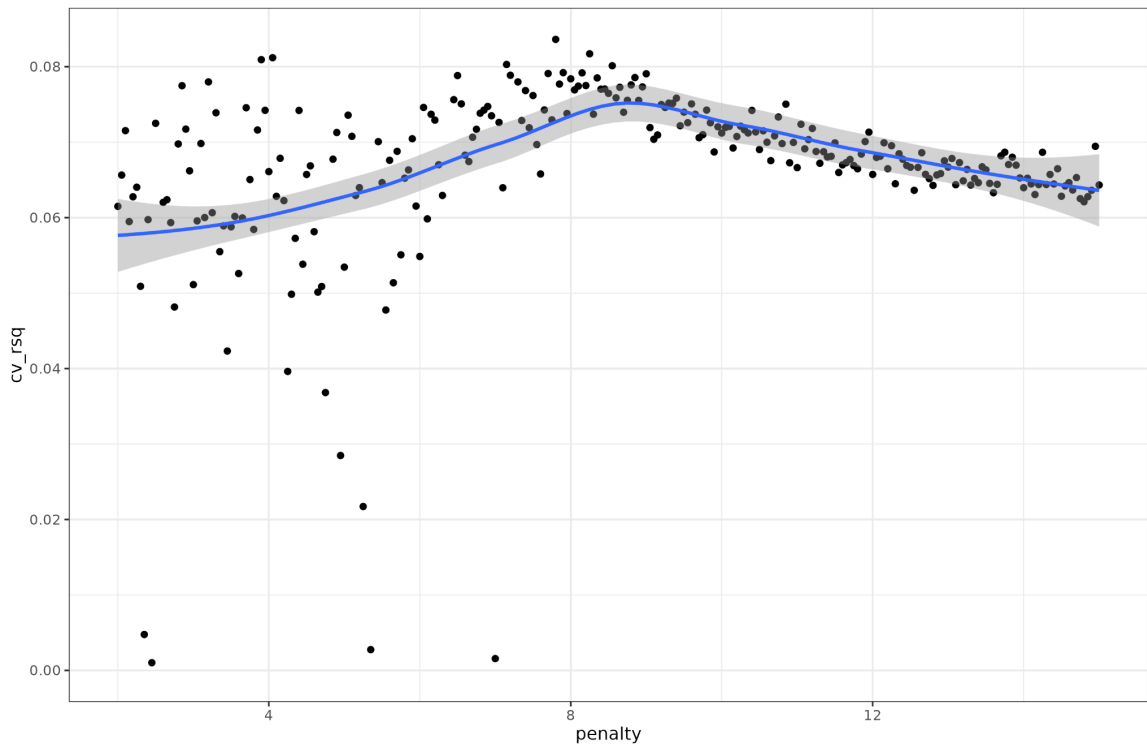


Figure S10. MARS algorithm penalty optimization.

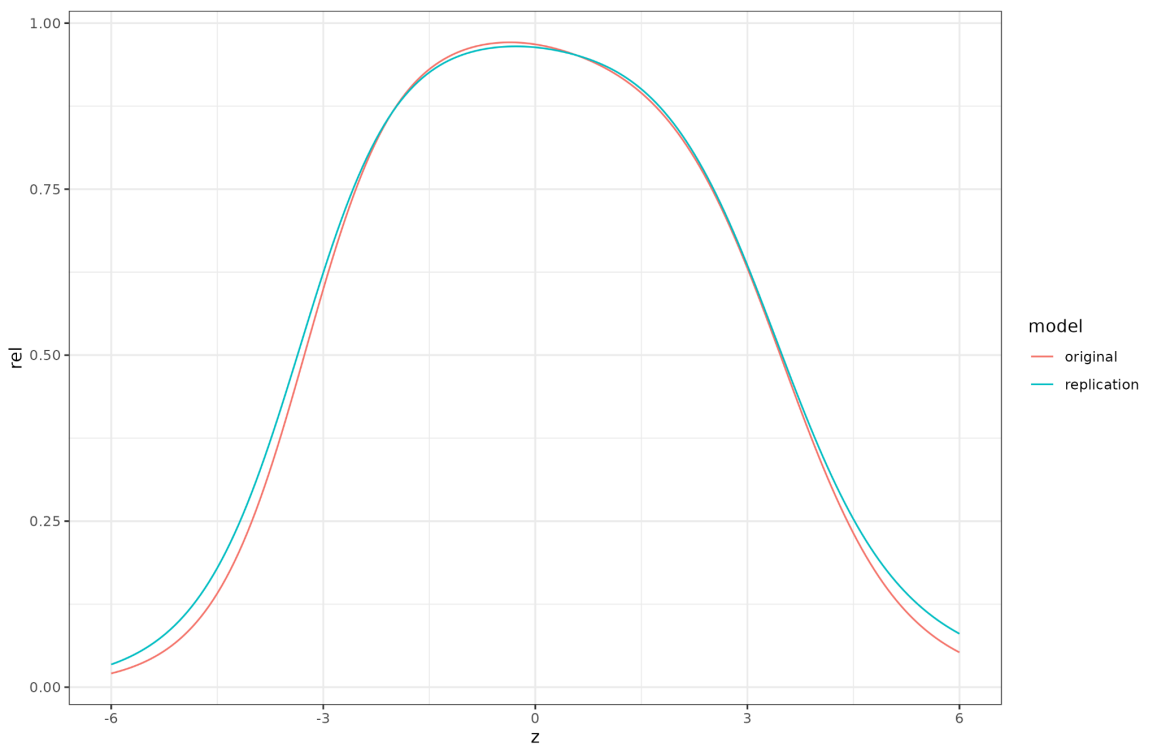


Figure S11. Reliability function replication for the 50-item abbreviated test.

<b>Political belief</b>	<b>IQ std beta</b>	<b>IQ std beta se</b>	<b>Demo rsq</b>	<b>Linear rsq</b>	<b>Linear model p</b>
The government should keep regulations on business to a minimum	-0.21263	0.03148	0.0029	0.04577	0
The government should reduce income differences between the rich and the poor	0.11311	0.03114	0.05473	0.06619	0.00027
Large companies should be controlled by the state not private actors	-0.05647	0.03039	0.10851	0.11071	0.06195
The government should mandate a higher minimum wage	0.07136	0.03124	0.05657	0.06056	0.02179
It should be the government s responsibility to provide health care to the sick	0.09997	0.03139	0.04274	0.05147	0.0014
It should not be the government s responsibility to provide a decent standard of living for the old	-0.12072	0.0318	0.01352	0.02667	0.00014
It should be the government s responsibility to provide a decent standard of living to the unemployed	0.16005	0.03145	0.02375	0.04762	0
It not should be the government s responsibility to provide decent housing to those who can t afford it	-0.07317	0.03209	0.00458	0.00877	0.02203
I think that the United Nations should have more political power	0.04982	0.03202	0.01177	0.01319	0.11789

I would support an increase in immigration to my country	0.2323	0.03119	0.01188	0.06325	0
Humans should be citizens of the world not citizens of their country	0.06042	0.03181	0.02337	0.02592	0.05637
Military spending should be increased	-0.29952	0.02973	0.06307	0.14919	0
Immigrants should integrate into the broad national culture of my country	0.05341	0.03112	0.06587	0.0677	0.08459
I love my country	-0.18217	0.0297	0.11937	0.15069	0
It is important to honor our national history and heritage	-0.19833	0.03074	0.05279	0.09001	0
My country should try to influence the values of other nations	-0.11391	0.03168	0.02214	0.03375	0.00031
Race is a social construct	0.08176	0.03172	0.02578	0.03129	0.00967
Biotechnology such as genetic editing of embryos should be legal	0.01753	0.03119	0.06417	0.06353	0.57199
Billionaires should pay very high taxes	0.14544	0.03145	0.02846	0.04801	0
We should use nuclear power for electricity and heat generation	0.14719	0.02963	0.1345	0.15465	0
Abortion should be illegal	-0.21312	0.0312	0.0198	0.06289	0
Christianity should be the state religion	-0.36516	0.02968	0.02377	0.15219	0
Free speech should be nearly absolute it should be legal to say things that offend some or most people	0.08389	0.0311	0.06271	0.06859	0.00679

Most psychoactive drugs such as cannabis cocaine or LSD should be legal to purchase for adults	0.07252	0.03166	0.03084	0.03497	0.02144
It should be legal for an adult person to have sex with a consenting 15 year old	-0.09244	0.03175	0.02229	0.02959	0.00348
Feminism is good for women	0.2322	0.03099	0.02403	0.07537	0

Table S1. Summary statistics for linear models of IQ.