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Do moral values change with the seasons?

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Moral values guide consequential attitudes and actions. Here, we report evidence of seasonal variation in Americans' endorsement of some—but not all—moral values. Studies 1 and 2 examined a decade of data from the United States (total N = 232,975) and produced consistent evidence of a biannual seasonal cycle in values pertaining to loyalty, authority, and purity ("binding" moral values)—with strongest endorsement in spring and autumn and weakest endorsement in summer and winter—but not in values pertaining to care and fairness ("individualizing" moral values). Study 2 also provided some evidence that the summer decrease, but not the winter decrease, in binding moral value endorsement was stronger in regions with greater seasonal extremity. Analyses on an additional year of US data (study 3; n = 24,199) provided further replication and showed that this biannual seasonal cycle cannot be easily dismissed as a sampling artifact. Study 4 provided a partial explanation for the biannual seasonal cycle in Americans' endorsement of binding moral values by showing that it was predicted by an analogous seasonal cycle in Americans' experience of anxiety. Study 5 tested the generalizability of the primary findings and found similar seasonal cycles in endorsement of binding moral values in Canada and Australia (but not in the United Kingdom). Collectively, results from these five studies provide evidence that moral values change with the seasons, with intriguing implications for additional outcomes that can be affected by those values (e.g., intergroup prejudices, political attitudes, legal judgments).

seasonality | moral foundations theory | ecology | emotion | anxiety

Significance

We report evidence that people's moral values change with the seasons. Analyses of a decade of data (232,975 questionnaire responses from 2011 to 2020) revealed a consistent seasonal cycle in Americans' endorsement of moral values pertaining to loyalty, authority, and purity (with stronger endorsement in spring and autumn and weaker endorsement in summer and winter). This seasonal cycle was partially explained by an analogous seasonal cycle in Americans' experience of anxiety. Similar seasonal cycles were observed in data from Canada and Australia (but not the United Kingdom). These findings have implications for attitudes and actions that can be affected by moral values, including intergroup prejudices, political ideologies, and legal judgments.

Moral values matter. These values—the principles that guide perceptions of good and bad and right and wrong—shape intergroup prejudices, political attitudes, legal judgments, and other consequential decisions (1–9). Yet moral values are malleable and vary depending on a person's immediate context (10–16). Might moral values also change with the seasons? Here, we present evidence that addresses this question and suggests that the answer is yes.

Seasons are characterized not just by cyclical changes in meteorological variables like sunlight and temperature, but also by changes in the natural and social ecologies that humans inhabit (17). These seasonal cycles have consequences for people's emotional states (e.g., anxiety, depression), cognitive performance (e.g., attention, memory), and attitudes of various kinds (e.g., color preferences; prosociality) (18–24). Given these broad effects on human psychological functioning, seasonal changes may be a nonobvious but nontrivial source of variation in people's moral values.

Many studies on moral values have been conducted within the framework of Moral Foundations Theory, which identifies five core moral principles that guide people's attitudes and judgments (25, 26). Two of these principles—pertaining to care (to not hurt others) and fairness (to provide equal treatment)—focus on individual rights and are referred to as "individualizing" values. Three other principles—pertaining to loyalty (to demonstrate devotion to one's ingroup), authority (to show respect for leaders), and purity (to practice cleanliness and piety)—focus on maintaining group cohesion and are referred to as "binding" values. The relative extent to which people endorse individualizing and binding moral values predicts a variety of important attitudes and judgments [e.g., politically conservative attitudes are associated with stronger endorsement of binding moral values (3, 27)].

Endorsement of binding moral values in particular is associated with the presence of threats in the local environment. This is purportedly because the group cohesion encouraged by binding moral values is adaptive when facing these threats (10, 28–30). Seasons are known to produce variation in specific kinds of threats associated with moral values [e.g., infectious diseases (31, 32)] and in emotions associated with the perception of threat [e.g., anxiety (20, 21)]. We were therefore attentive to the distinction between binding and individualizing moral values in the analyses reported below.

Across five studies, our analyses tested for seasonal cycles in people's endorsement of binding and individualizing moral values. Studies 1 and 2 examined moral value endorsement across 10 y and produced evidence of a biannual cycle in Americans' endorsement of binding—but not individualizing—moral values. Study 2 also provided some evidence that this effect was stronger in regions with greater seasonal variation

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in meteorological and ecological conditions. Study 3 replicated the primary finding in an additional year and, by statistically controlling for respondent characteristics, indicated that this seasonal cycle is unlikely to be a sampling artifact. Study 4 provided evidence supporting a partial explanation for the seasonal cycle in Americans' endorsement of binding moral values by showing that it was predicted by an analogous seasonal cycle in anxiety (an emotion related to threat perception). Study 5 tested the generalizability of these findings and found similar seasonal cycles in the moral values endorsed in Canada and Australia, but not the United Kingdom.

Study 1: Seasonal Variation in Moral Values across 2 Y

Since 2009, yourmorals.org has surveyed individuals' endorsement of moral values pertaining to care, fairness, loyalty, authority, and purity. We conducted exploratory analyses on a 2-y subset of these data (2017 to 2018) obtained from respondents in the United States (N = 72,286). We calculated mean endorsement of each moral value within each week across these 2 y and conducted harmonic regression analyses to test for evidence of seasonal cycles.

Results. Fig. 1 displays mean weekly endorsement of each moral value across the 2-y period, as well as harmonic regression lines depicting the seasonal component evident within each time series. (Full results are reported in *SI Appendix*).

Results showed substantial seasonal variation in endorsement of the binding moral values: The seasonal component explained 48%, 33%, and 34% of total variance in weekly mean endorsement of values pertaining to loyalty, authority, and purity, respectively ($ps < 0.001$). When data on these three values were combined into a single index of binding moral values, the seasonal component explained 39% of weekly variation ($P < 0.001$). For these binding moral values, seasonal variation was characterized by a biannual cycle: In both 2017 and 2018, mean endorsement was highest in spring (March) and autumn (September), and lowest in summer (June) and winter (December).

There was weak evidence of cyclical variation in endorsement of the individualizing moral values: The seasonal component explained 14% and 7% of total variance in values pertaining to care and fairness, respectively ($ps < 0.01$). When data on these two values were combined into a single index, the seasonal component explained 10% of weekly variation ($P < 0.001$). Endorsement of values pertaining to care showed a biannual cycle (similar to—but weaker than—the biannual cycle observed for binding moral values), whereas endorsement of values pertaining to fairness showed an inconsistent pattern of seasonal variation across the 2-y period.

In sum, the results of these exploratory analyses provide preliminary evidence that moral values change with the seasons—and suggest that binding moral values might be especially sensitive to seasonal cycles.

Study 2: Replicability of Seasonal Effects on Moral Values across Eight Additional Years

We conducted a preregistered replication of these results across eight additional years for which sufficiently ample data from the United States were available (2011 to 2016 and 2019 to 2020; N = 160,689). To do so, we created a standard biannual model with peaks and valleys matching the biannual cycle observed in study 1 and used regression analyses to test whether this standard biannual model predicted weekly variation in binding and individualizing moral values within each year. Additionally, we tested whether the magnitude of seasonal variation in moral values might be greater in US counties characterized by more extreme seasonal variation in meteorological variables.

Results. Fig. 2 shows mean weekly endorsement of binding moral values and individualizing moral values for the entire decade from 2011 to 2020. (This figure also includes harmonic regression lines depicting the seasonal components within each time series.) Mean weekly endorsement of binding moral values was predicted by the standard biannual model in seven of the eight additional years (and in both years that were included in study 1). Only in 2019 was this biannual cycle not evident (Table 1). In contrast, mean weekly endorsement of individualizing moral values was predicted by the standard biannual model in just one of these eight additional years (Table 1). A regression analysis revealed that the standard biannual model predicted weekly endorsement of binding moral values across the full 10 y of data, $\beta = 0.38$, $t(513) = 9.31$, $P < 0.001$. In contrast, an analogous analysis showed that the standard biannual model did not meaningfully predict weekly endorsement of individualizing moral values, $\beta = 0.05$, $t(513) = 5.23$, $P = 0.24$. Fig. 3 provides a succinct visual summary by combining all 10 y of data into a single calendar year, with harmonic regression lines depicting seasonal components for both binding and individualizing moral values. A biannual seasonal cycle is clearly evident for endorsement of binding moral values (but not for individualizing moral values).[*]

Additional regression analyses were conducted to test whether the magnitude of the biannual seasonal cycle in binding moral values was moderated by the extremity of seasonal differences in meteorological conditions (as indicated by measures of latitude, annual variability in temperature, and distance from a coast; methods and results reported in *SI Appendix*). These analyses also explored the possibility that any such moderation effects might be specific to just one part of the biannual seasonal cycle. For example, it is plausible that the summer decrease in binding moral value endorsement might be attributable to meteorological factors such as abundant sunshine, whereas the winter decrease might be attributable to nonmeteorological season-specific factors such as holidays. If so, then one might expect the summer decrease, but not the winter decrease, to be moderated by indicators of seasonal extremity. Results provided some evidence of moderation by seasonal extremity, and this evidence emerged primarily in analyses that focused on the summer component of the biannual seasonal cycle. Most notably, in US counties characterized by greater annual variation in temperature, there was a larger summer decrease in endorsement of binding moral values (*SI Appendix*, Table S6).

In sum, the results of study 2 provide more convincing evidence of a biannual seasonal cycle in endorsement of binding moral values (but not individualizing moral values). Additional results provided some evidence that one component of this seasonal cycle—the summer decrease—is more pronounced in places with more extreme seasons. Together, these results offer further evidence that Americans' moral values change with the seasons.

Study 3: Additional Replication Controlling for Variation in Respondents' Characteristics

An alternative explanation must be considered: Perhaps the apparent seasonal cycle in binding moral values is a sampling artifact, resulting from seasonally uneven sampling of respondents who were disposed to either weakly or strongly endorse binding moral values. For

[*]We conceptually replicated these findings using a large dataset of responses to an entirely different measure of moral value endorsement: the Moral Foundations Sacredness Scale. Full methods and results are reported in *SI Appendix*.

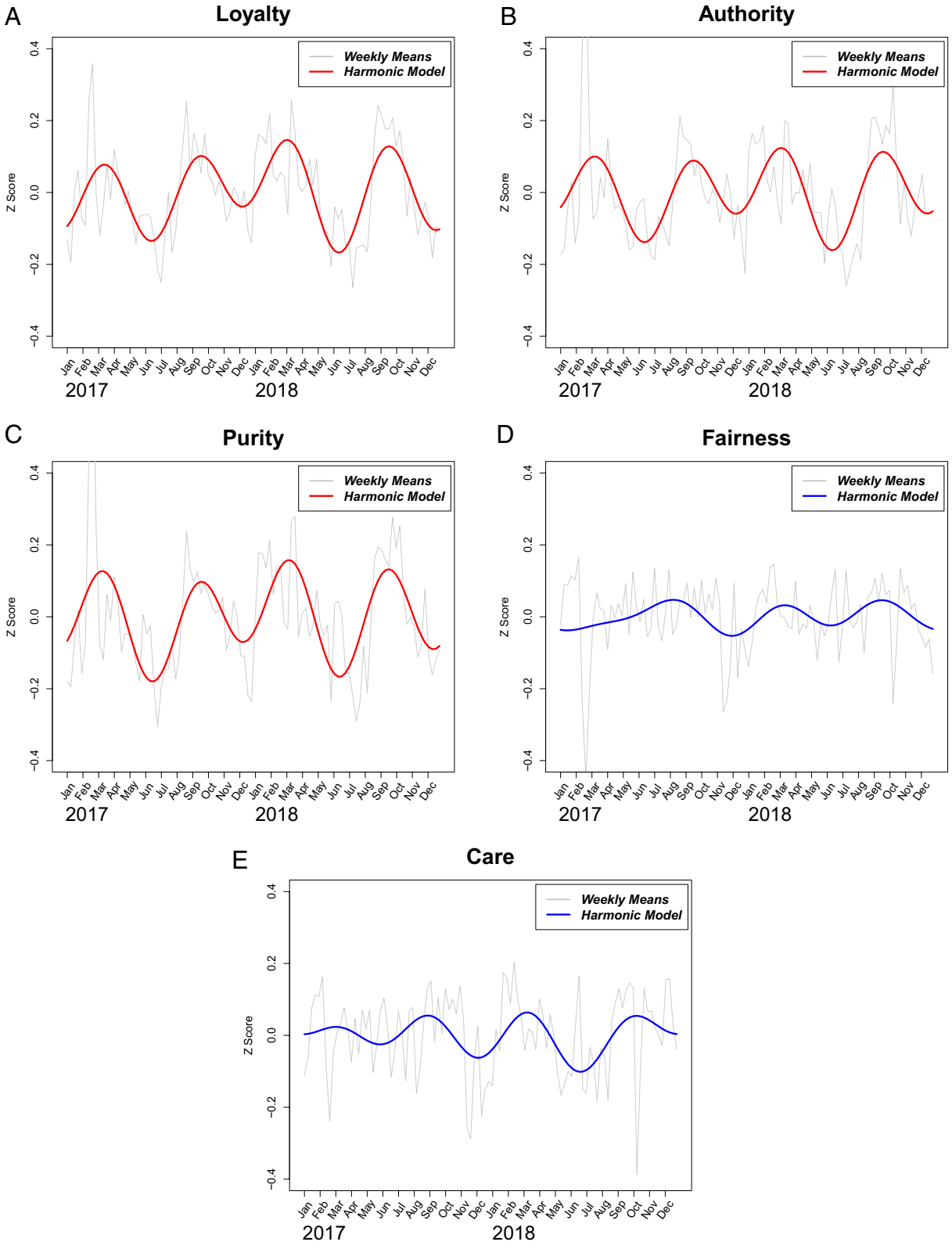

Fig. 1. Harmonic regression lines for loyalty (*A*), authority (*B*), purity (*C*), fairness (*D*), and care (*E*) moral values from 2017 to 2018. Detrended weekly means are shown in gray; fitted harmonic regression lines are shown in red (binding moral values) and blue (individualizing moral values). Standard scores are based on the SD at the individual level.

example, the findings summarized in Fig. 3 could emerge if people with liberal political attitudes (who less enthusiastically endorse binding moral values (3, 27) were relatively more likely to complete the survey in June and December, compared to March and September. To address this alternative explanation, we conducted analyses on an additional dataset (collected from US respondents from August 2021 to August 2022; $N = 24{,}199$) that included self-reported moral values as well as information about respondents' political orientation, gender, age, income, and religiosity. We tested for seasonal variation in these characteristics and controlled statistically for them when, once again, testing the replicability of the biannual cycle in endorsement of binding moral values.

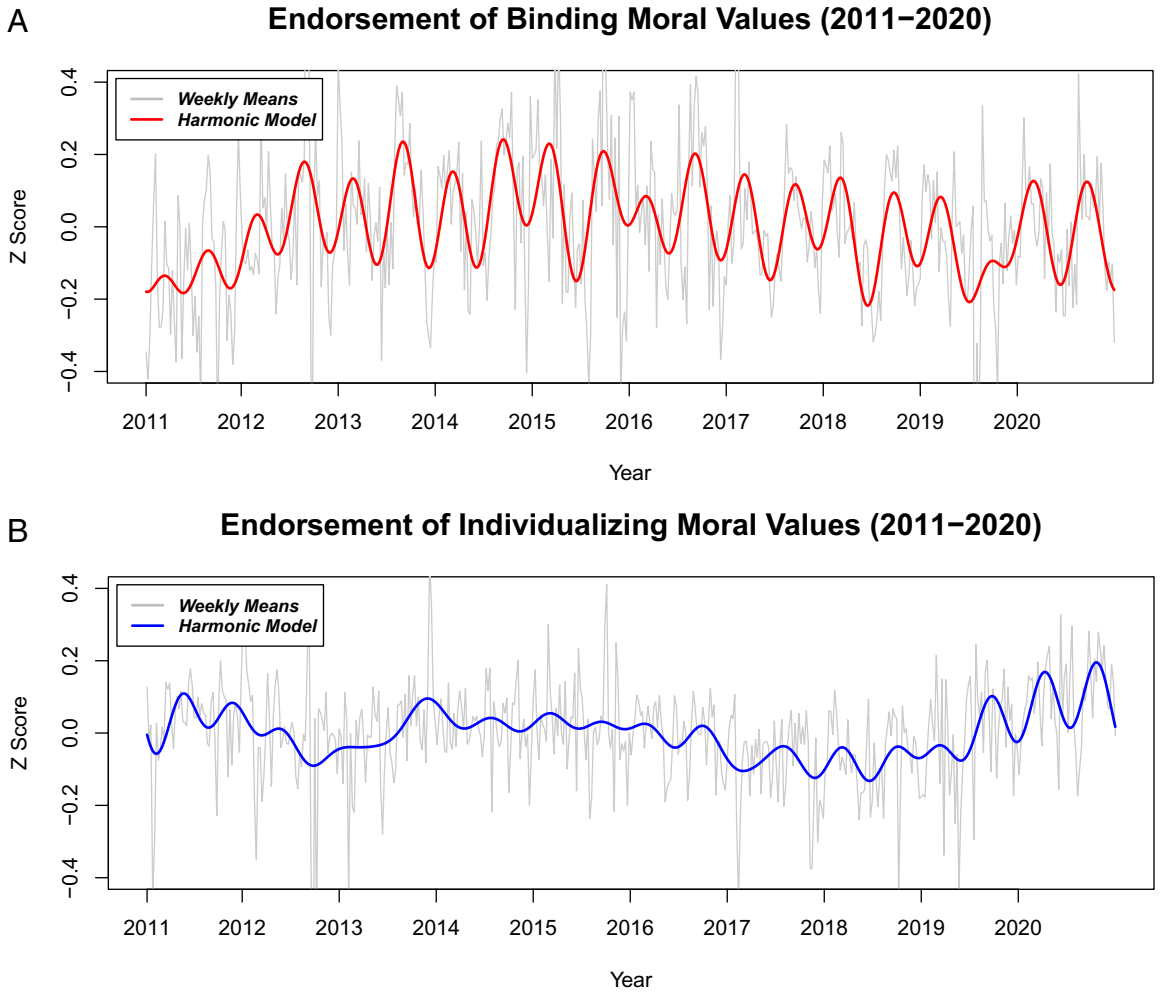

Fig. 2. Detrended binding (*A*) and individualizing (*B*) moral values across 515 weeks from 2011 to 2020. Detrended weekly means are shown in gray; fitted harmonic regression lines are shown in red (binding moral values) and blue (individualizing moral values). Standard scores are based on the SD at the individual level.

Results. Harmonic regression analyses showed evidence of weak cyclical variation in respondents' political orientation (β = 0.25, $t[49] = 1.84$, $P = 0.07$) and religiosity (β = 0.19, $t[49] = 1.32$, $P = 0.19$) and more substantial cyclical variation in gender, age, and income (gender: β = 0.43, $t[49] = 3.37$, $P < 0.01$; age: β = 0.55, $t[49] = 4.67$, $P < 0.001$; income: β = 0.45, $t[49] = 3.51$, $P < 0.001$). These results indicated female respondents were overrepresented in the spring, and older and wealthier people were overrepresented in summer and winter. Prior to controlling for these characteristics, mean weekly endorsement of binding moral values showed evidence

Table 1. Results of regression analyses using the standard biannual model to predict moral value endorsement across 10 y

	Overall	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Binding values	**0.38 (<0.001)**	**0.35 (0.01)**	**0.29 (0.04)**	**0.50 (<0.001)**	**0.61 (<0.001)**	**0.40 (0.003)**	**0.40 (0.003)**	**0.54 (<0.001)**	**0.56 (<0.001)**	0.01 (0.96)	**0.49 (<0.001)**
Loyalty	**0.37 (<0.001)**	**0.37 (0.01)**	0.23 (0.10)	**0.55 (<0.001)**	**0.64 (<0.001)**	**0.46 (<0.001)**	**0.39 (0.004)**	**0.60 (<0.001)**	**0.60 (<0.001)**	0.04 (0.77)	**0.46 (<0.001)**
Authority	**0.37 (<0.001)**	**0.38 (0.009)**	**0.28 (0.047)**	**0.49 (<0.001)**	**0.60 (<0.001)**	**0.39 (0.004)**	**0.34 (0.01)**	**0.50 (<0.001)**	**0.49 (<0.001)**	0.002 (0.99)	**0.51 (<0.001)**
Purity	**0.36 (<0.001)**	0.29 (0.05)	**0.33 (0.02)**	**0.44 (0.001)**	**0.57 (<0.001)**	**0.31 (0.03)**	**0.43 (0.001)**	**0.51 (<0.001)**	**0.53 (<0.001)**	−0.02 (0.90)	**0.45 (<0.001)**
Individualizing values	0.05 (.24)	0.03 (.84)	−0.27 (0.05)	−0.07 (0.62)	−0.14 (0.33)	0.12 (0.38)	**0.42 (0.002)**	0.19 (0.19)	0.23 (0.10)	0.20 (0.17)	0.20 (0.16)
Fairness	0.02 (.70)	−0.06 (0.67)	**−0.31 (0.02)**	−0.06 (0.69)	−0.20 (0.15)	0.16 (0.26)	**0.36 (0.009)**	0.04 (0.80)	0.25 (0.08)	0.10 (0.46)	0.23 (0.11)
Care	0.08 (.10)	0.10 (0.51)	−0.22 (0.11)	−0.08 (0.57)	−0.07 (0.64)	0.08 (0.58)	**0.36 (0.009)**	**0.31 (0.03)**	0.20 (0.16)	0.25 (0.08)	0.15 (0.30)

Note: Effects are presented as standardized beta coefficients, and *P*-values for each beta coefficient are presented in parentheses. Values in bold indicate a significant effect. The overall scores for binding moral values were calculated as the means of the scores for loyalty, authority, and purity, and the overall scores for individualizing moral values were calculated as the means of the scores for fairness and care.

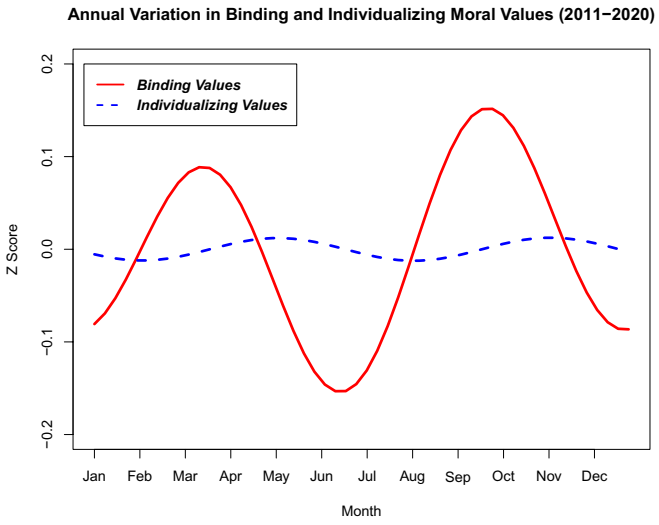

Fig. 3. Fitted harmonic regression lines for binding and individualizing moral values from 2011 to 2020 collapsed into a single calendar year. Standard scores are based on the SD at the individual level.

of the same biannual cycle documented in studies 1 and 2, albeit the effect was relatively weak and nonsignificant (β = 0.21, t[49] = 1.50, P = 0.14), and after statistically controlling for them—with weekly means adjusted for all covariates—the effect of the standard biannual model was stronger and statistically significant: β = 0.35, t(49) = 2.60, P = 0.01. Also replicating study 2, there was no evidence of a meaningful effect of the standard biannual model on endorsement of individualizing moral values, either before [β = 0.17, P = 0.24] or after [β = 0.02, P = 0.91] controlling for variation in sample characteristics. Inferentially identical findings also emerged when individual responses, rather than weekly means, were treated as the unit of analysis (*SI Appendix*).

These results provide additional evidence of a biannual cycle in endorsement of binding moral values and indicate that this seasonal cycle cannot be easily dismissed as a mere sampling artifact. Considered together, the results from studies 1 to 3 provide substantial evidence that Americans' moral values change with the seasons.

Study 4: Are Seasonal Cycles in Moral Values Attributable to Seasonal Cycles in Anxiety?

What might explain these seasonal changes in moral values? Based on research linking the perception of threat to endorsement of binding moral values (10, 28–30) and showing that anxiety—an emotion associated with the perception of threat—may also be seasonally variable (20, 21) we tested whether the biannual cycle in Americans' endorsement of binding moral values might be attributable to seasonal changes in Americans' experience of anxiety. We conducted analyses on two measures of anxiety: self-reported anxiety (questionnaire responses collected from 2013 to 2019; N = 90,431) and internet search frequencies for anxiety-related words (Google Trends data from 2011 to 2020). We conducted harmonic regression analyses to identify seasonal patterns in these anxiety measures and tested whether they statistically mediated the previously documented relationship between the standard biannual model and binding moral values.

Results. Harmonic regression analyses on mean weekly self-reported anxiety revealed a substantial seasonal component (β = 0.59, t[331] = 13.20, P < 0.001). Fig. 4 provides a visual summary of this seasonal component and shows a seasonal cycle similar to that observed for binding moral values in studies 1 to 3. Just as endorsement of binding moral values was predicted by the standard biannual model with peaks in March and September and valleys in June and December, so too was self-reported anxiety, β = 0.31, t(331) = 5.97, P < 0.001. Additional regression analyses showed that mean weekly self-reported anxiety predicted mean weekly endorsement of binding moral values (β = 0.23, t[331] = 4.36, P < 0.001) and, more weakly, individualizing moral values (β = 0.16, t[331] = 3.02, P < 0.01). A mediation analysis revealed a statistically significant indirect relationship between the standard biannual model and binding moral values through self-reported anxiety (β = 0.04, 95% CI [0.004, 0.09], P = 0.02). The direct relationship between the biannual model and binding moral values (β = 0.47, 95% CI [0.37, 0.58], P < 0.001) remained significant after controlling for the indirect effect (β = 0.43, 95% CI [0.33, 0.53], P < 0.001). Together these results indicate partial mediation.

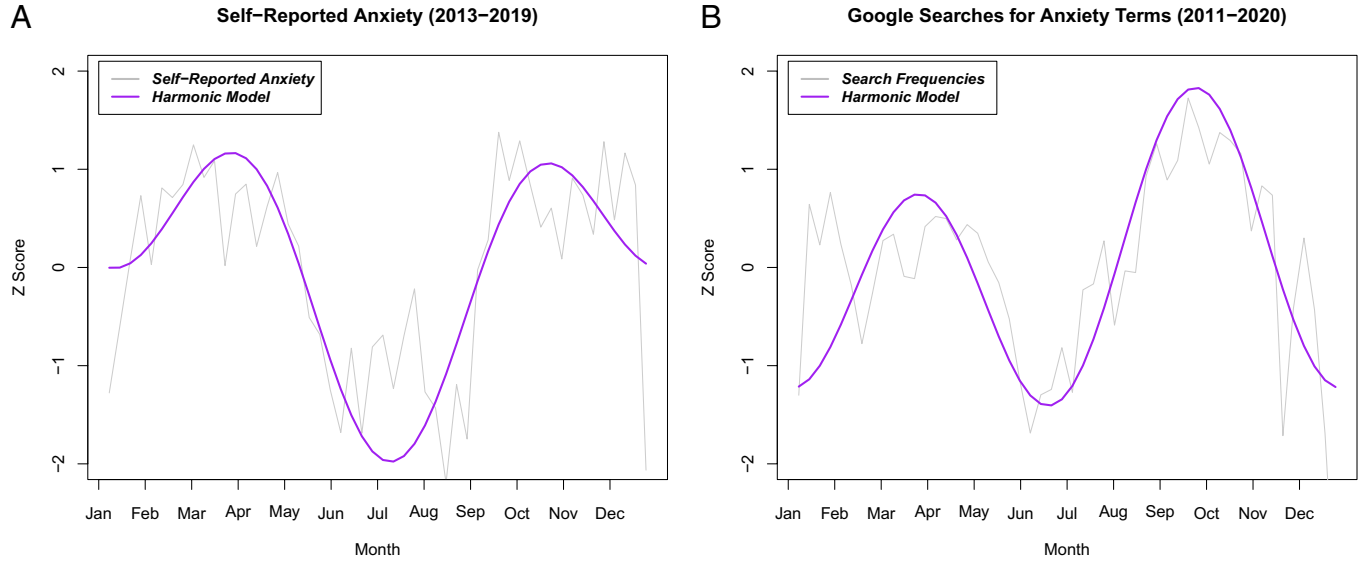

Fig. 4. Self-reported anxiety from 2013 to 2019 (*A*) and anxiety-related Google search frequencies from 2011 to 2020 (*B*) in the United States summarized in a single calendar year. Weekly means are presented in gray, and harmonic regression lines are presented in purple. Standard scores are based on the SD at the weekly level.

Analogous analyses were conducted on Google search frequencies for anxiety-related words and produced similar results. Harmonic regression analyses revealed a substantial seasonal component in these search frequencies, β = 0.69, $t(513) = 21.34$, $P < 0.001$ (Fig. 4), and this pattern of seasonal variation was predicted by the standard biannual model, β = 0.56, $t(513) = 15.24$, $P < 0.001$. Additional regression analyses showed that anxiety-related Google search frequencies predicted mean weekly endorsement of binding moral values (β = 0.31, $t[513] = 7.31$, $P < 0.001$), but not individualizing moral values, β = 0.05, $t[513] = 1.24$, $P = 9.22$. A mediation analysis revealed a statistically significant indirect relationship between the biannual model and binding moral values through anxiety-related Google search frequencies (β = 0.08, 95% CI [0.01, 0.15], $P = 0.02$); and the direct relationship between the biannual model and binding moral values (β = 0.38, 95% CI [0.29, 0.48], $P < 0.001$) remained significant after controlling for the indirect effect (β = 0.30, 95% CI [0.21, 0.40], $P < 0.001$), indicating partial mediation.[†]

Are these mediation effects specific to anxiety, or might seasonal cycles in binding moral values be explained by seasonal variation in negative emotions more broadly? To address this question, we conducted analyses on additional data from which we computed weekly mean values of self-reported depression and self-reported stress. Neither self-reported depression nor self-reported stress was positively correlated with endorsement of binding moral values. When including all three predictors in a single regression analysis, self-reported anxiety predicted binding value endorsement (β = 0.52, $P < 0.001$) but self-reported depression and stress did not (*SI Appendix*). We also conducted additional analyses on Google search frequencies for words connoting depression and anger. Results showed that depression-related search frequencies (but not anger-related search frequencies) were weakly related to endorsement of binding moral values. When all three search frequency indices were included in a regression analysis predicting binding values, anxiety significantly predicted binding values (β = 0.29, $P < 0.001$), but depression and anger did not (*SI Appendix*). These results suggest that seasonal variation in anxiety specifically—rather than negative emotions more generally—provides a partial explanation for seasonal changes in Americans' endorsement of binding moral values.

Study 5: Are Seasonal Cycles in Moral Values Evident in Other Countries Too?

The preceding studies all focused on moral values within one country—the United States (which had, by far, the largest sample of data available from yourmorals.org). To test the generalizability of the most consistent finding—a biannual cycle in endorsement of binding moral values—we examined changes in binding moral values in three additional countries for which smaller but reasonably ample data were available within the same 10-y time frame of studies 1 and 2 (2011 to 2020): Canada (N = 19,377), the United Kingdom (N = 16,825), and Australia (N = 8,595). Given the constraints imposed by these smaller samples, we combined responses from the entire 10-y period into a single calendar year prior to calculating mean weekly endorsement of moral values. We then used harmonic regression analyses to test for evidence of seasonal cycles within each country.

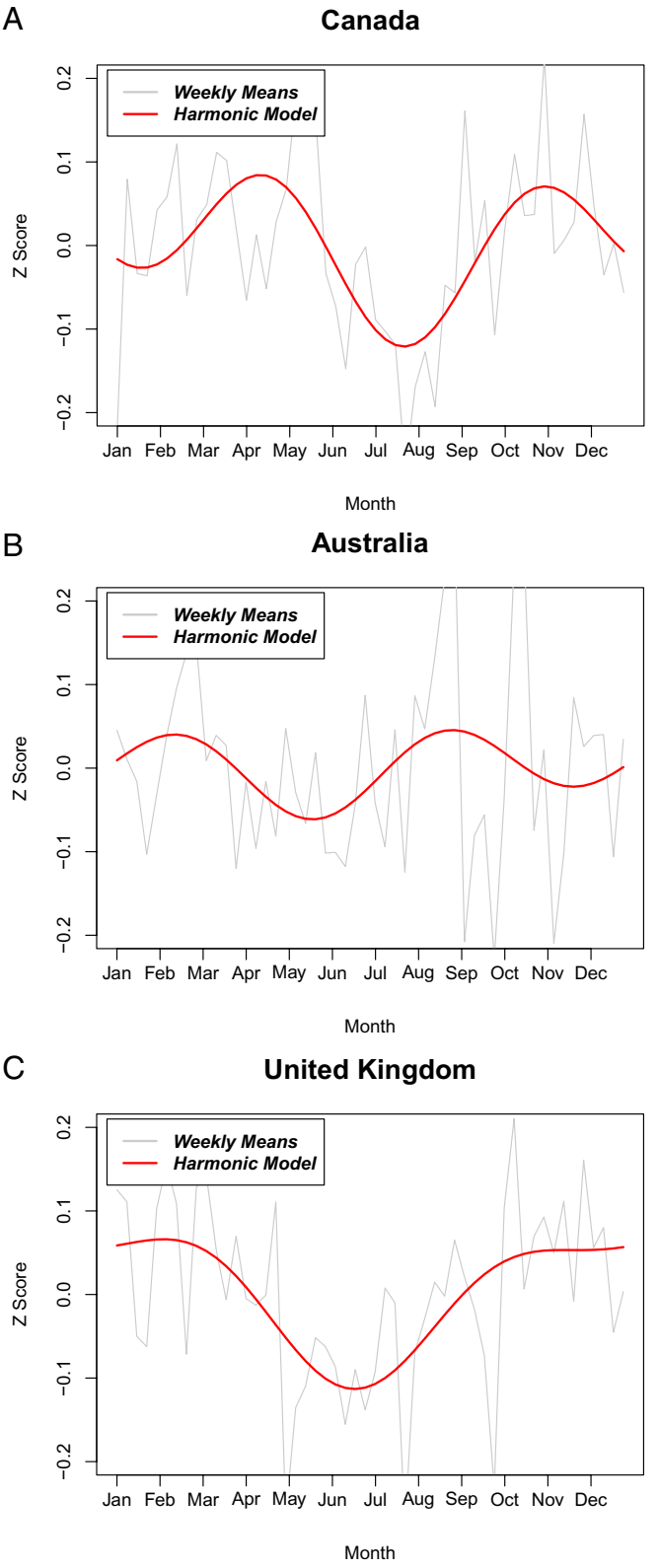

Fig. 5. Fitted harmonic regression lines (red) and raw weekly means (gray) for binding moral values in Canada (*A*), Australia (*B*), and the United Kingdom (*C*) from 2011 to 2020 summarized in a single calendar year. Standard scores are based on the SD at the individual level.

Results. Fig. 5 depicts, with harmonic regression lines, patterns of seasonal variation in binding moral values within each country.[‡] Results from Canada revealed substantial seasonal variation in

[†]We also conducted mediation analyses for individualizing moral values. A significant indirect effect of anxiety on individualizing moral values emerged for self-reported anxiety, β = 0.05, 95% CI [0.01, 0.10], $P = 0.01$, indicating partial mediation. However, no indirect effect of anxiety-related search frequencies on individualizing moral values was found (β = 0.02, 95% CI [−0.06, 0.09], $P = 0.69$).

[‡]We also analyzed variation in individualizing moral values in each of these countries. The results of these analyses are reported in *SI Appendix*.

binding moral values ($\beta = 0.59$, $t[50] = 5.20$, $P < 0.001$). As in the United States, Canadians' endorsement of binding moral values was characterized by a biannual cycle (with peaks and valleys occurring a few weeks later than in the United States). In Australia, binding moral values also exhibited a statistically significant seasonal component ($\beta = 0.29$, $t[50] = 2.13$, $P = 0.03$), and this seasonal variation too was characterized by a biannual cycle (with peaks and valleys a few weeks earlier than in the United States). Data from the United Kingdom also showed evidence of seasonal variation in binding moral values ($\beta = 0.60$, $t[50] = 5.21$, $P < 0.001$), but the pattern differed from those in the United States, Canada, and Australia. In the United Kingdom, binding moral values were characterized by an annual cycle (decreased endorsement in summer relative to spring and autumn, but no decrease in winter).

These results (especially results from Canada and Australia showing biannual cycles in endorsement of binding moral values) indicate that the patterns of seasonal variation observed in studies 1 to 3 are not merely idiosyncratic to the United States. These results (especially results from the United Kingdom) also indicate that patterns observed in the United States cannot be assumed to be universal. Different countries may exhibit different patterns of seasonal variation in moral values.

Discussion

These results provide evidence that people's moral values change with the seasons. Americans endorsed binding moral values—emphasizing purity, loyalty, and respect for authority—more strongly in spring and autumn, compared to summer and winter. (In contrast, Americans' endorsement of individualizing moral values—pertaining to care and fairness—showed no consistent seasonal pattern.) When treating individual persons as the unit of analysis, the biannual seasonal effect on individuals' endorsement of binding moral values was small [$\beta = 0.08$, $P < 0.001$], but, when aggregated across persons (i.e., when treating weekly mean values as the unit of analysis for the decade from 2011 to 2020), this effect explained approximately 14% of weekly variation in Americans' endorsement of binding moral values.

The biannual seasonal cycle in Americans' endorsement of binding moral values was partially attributable to an analogous seasonal cycle in anxiety. This finding buttresses other evidence of seasonal variation in anxiety (21), is consistent with previous research linking the perception of threat to endorsement of binding moral values (10, 28–30), and highlights the fact that different emotions have different consequences for people's attitudes and behaviors (33). Much previous research on seasonal affect has focused on sadness and depression (e.g., refs. 19 and 34); our findings suggest that it may be worthwhile to attend carefully to seasonal variation in anxiety and other emotions too.

What might explain the biannual seasonal cycle in Americans' anxiety? We suspect multiple season-specific factors might be implicated. Prior research has connected heightened springtime anxiety in Japan to an increased frequency of school and work-related life transitions (20). It is also possible that decreased anxiety in the summer might be attributable to pleasing meteorological and ecological circumstances (e.g., warm weather, abundant vegetation), whereas decreased anxiety in the winter might be more directly attributable to season-specific cultural phenomena (e.g., midwinter holidays such as Christmas). Previous research indicates that both pleasing weather and Christmas holidays can affect mood and behavior (19, 24); it is plausible that both might decrease anxiety too.

It is notable that a biannual seasonal cycle in endorsement of binding moral values was observed also in Canada and Australia, but that the magnitude and exact timing of this seasonal cycle differed in these countries. The relatively weak seasonal effect observed in Australian data is consistent with speculation (and results from study 2) that some seasonal effects may be less pronounced in geographical regions with less extreme seasonal variation in meteorological conditions. More broadly, given that latitude and other geographical variables affect the timing of seasonal changes in meteorological (and ecological) conditions, country-level differences in the exact timing of seasonal cycles in moral values might be partially explained by country-level differences in these geographical variables.

While our results document seasonal changes in people's moral values, several limitations remain to be addressed by future research. For instance, no biannual cycle was observed in the data from the United Kingdom—which instead showed evidence of a simpler seasonal cycle characterized by relatively low endorsement of binding moral values in the summer only (but not in the winter too, as in the United States, Canada, and Australia). An explanation for this difference remains unclear. Differences in wintertime cultural practices in the United States and Canada (compared to the United Kingdom) might plausibly offer a partial explanation. It is also worth noting that other seasonal phenomena—such as suicide rates—are also characterized by cross-national heterogeneity, with some countries showing biannual cycles and others showing annual cycles (35). It remains for future research to systematically investigate seasonal effects on moral values worldwide in order to more fully document, and understand, cross-national similarities and differences.

Future research will also be required to address other limitations. For example, although the findings—especially those from the United States—are based on large samples characterized by considerable diversity on some demographic variables, the respondents were all computer-literate and, as such, were not fully representative of diversity within national populations. Additionally, although these data were collected across many time points over multiple years, different respondents responded at different times. Previous research has used similar methods to examine temporal changes in people's attitudes and dispositions (36, 37), but in order to most rigorously assess the replicability of seasonal cycle documented here, it will be useful to employ longitudinal methods that assess the moral values endorsed by the same people across different seasons. It may also be informative to use naturalistic methods to assess temporal changes in moral values (e.g., examining language use on social media; 38).

If indeed people's moral values change with the seasons, these findings imply the possibility of additional seasonal cycles in the many consequential attitudes and actions that are associated with moral values. Since binding moral values emphasize group cohesion and conformity to group norms, seasonal variation in the endorsement of these values implies analogous seasonal variation in prejudices against people (e.g., immigrants) who are perceived to be outsiders or who fail to adhere to local norms (2, 4). People who more strongly endorse binding moral values are also more punitive (6), implying the potential for seasonal variation in legal decision-making. Further, given that moral values (and language conveying moral values) shape the persuasiveness of political messaging (1, 39), these findings suggest potential seasonal variation in the diffusion of political ideas.

Another intriguing implication is that the specific timing of important societal events might have unforeseen consequences for how people respond to those events. The timing of political elections (whether they are scheduled to occur in the summer or the autumn, for instance) might plausibly have some subtle effect on election results. Similarly, the timing of unexpected events—such

as disease outbreaks—might affect people's responses to them. During the COVID-19 pandemic, for example, Americans' moral values predicted social distancing behavior and vaccination rates (7, 8). If indeed American's moral values change with the seasons, one implication is that Americans' behavioral responses to future disease outbreaks might vary, depending on the specific seasons within which those outbreaks occur.

Materials and Methods

Study 1. We obtained data on moral value endorsement from yourmorals.org–a website that collected voluntary responses to a 30-item Moral Foundations Questionnaire (MFQ) containing five 6-item subscales assessing endorsement of moral values pertaining to care, fairness, loyalty, authority, and purity (3, 25). Items were presented to respondents in random order. Although the yourmorals.org website obtained MFQ responses from people in many countries worldwide, we limited analyses to data from the one country–the United States–that produced the largest sample sizes. For this initial exploratory study, we conducted analyses of just 2 y of US data: 2017 (N = 35,371) and 2018 (N = 36,915). These years were selected due to the fact that sample sizes were consistently large within each week. (The number of responses per week ranged from 245 to 3,879, with a median of 605.5.)

For each respondent who completed the questionnaire between 1 January 2017, and 31 December 2018, we calculated individual subscale scores (to assess endorsement of moral values pertaining to care, fairness, loyalty, authority, and purity). We also computed summary indices of respondents' endorsement of individualizing moral values (mean of their scores on the care and fairness subscales) and binding moral values (mean of their scores on the loyalty, authority, and purity subscales).[§]

Based on these responses from individual respondents, we computed seven means for each week of each year–weekly means for each of the five individual moral values and for each of the two summary indices. These computations resulted in time series data–with 104 weekly datapoints across 2 y–for each of the five individual moral values (care, fairness, loyalty, authority, and purity) and for the two summary indices (individualizing and binding moral values).

In order to test for seasonal cycles in these time series data, we first removed linear trends in each time series. We did this as follows: We assigned sequential whole numbers to each of the 104 wk across the 2 y (i.e., the first week in 2017 was assigned the number 1, the second week in 2017 was assigned the number 2, and so on), regressed the week number on the 104 datapoints within each time series, saved the residuals, and conducted all subsequent analyses on these saved residuals. (The same procedure was used in studies 2 to 5 to remove linear trends from time series data prior to analyses testing for seasonal cycles.)

To examine the seasonal component within each (detrended) time series, we employed harmonic regression analyses–using sine and cosine functions–to generate a fitted model of seasonal changes within each time series (40, 41). The harmonic modeling method was selected over Seasonal ARIMA (SARIMA) modeling given that the unit of analysis was weeks, and SARIMA models are designed for larger units of analysis (e.g., 12 mo, 4 seasons). We identified the percent of total variance attributable to each seasonal component by regressing the fitted harmonic model values on the weekly means within each time series.

Study 2. To test the replicability of results obtained in study 1, we conducted preregistered (https://osf.io/gv3r5) analyses on MFQ responses across eight additional years–2011, 2012, 2013, 2014, 2015, 2016, 2019, and 2020–for which the yourmorals.org website recorded substantial numbers of responses from the United States during most weeks. (Total N = 160,689 across these eight additional years.) Only seven responses were recorded across a 5-wk period in 2011, so those weeks were excluded. Across the remaining 411 wk within the 8-y dataset, the number of responses per week ranged from 6 to 1,946, with a median of 338). Weekly means on each MFQ subscale, and on the summary indices of individualizing and binding moral values, were calculated in the same way as in study 1.

[§]Reliability analyses across all 10 y of data (2011 to 2020) revealed high internal reliability for weekly estimates of individualizing moral values (α = 0.83) and binding moral values (α = 0.96).

In order to test for the presence of biannual cycles within the data for each year, we created a standard biannual model–with a stable amplitude, midline, and frequency–against which to compare the data. This standard biannual model was created by computing a value (y) for each sequentially numbered week (x) of each year, using the following equation:

$$y = \sin(x\frac{4\pi}{52}).$$

This formula produces a model defined by two peaks and two valleys each year. In order to ensure that the peaks and valleys of this standard biannual model correspond to the timing of the peaks and valleys observed for binding moral values in study 1 results (i.e., peaks occurring during the 13th and 39th weeks of the year; valleys occurring during the 26th and 52nd weeks of the year), the week number assigned to the first week of 2011 was set to 21, and subsequent weeks (including the five excluded weeks) were assigned sequentially increasing whole numbers. See *SI Appendix* for a visual depiction of this standard biannual model against which actual time series data were compared.

We conducted a series of regression analyses using this standard biannual model to predict variation in weekly means on each MFQ subscale and on the summary indices of individualizing and binding moral values. We conducted these regression analyses on data for each year separately. We then conducted regression analyses using the standard biannual model to predict variation in weekly means across all 10 y of data included in studies 1 and 2 (i.e., 515 wk from 2011 to 2020).

Study 3. In order to test whether the apparent biannual cycle in binding moral values was an artifact resulting from uneven sampling of respondents with different personal characteristics, we obtained an additional dataset from yourmorals.org. Respondents who reported that their current country was outside the United States were excluded. This dataset contained consistent responses from US respondents from 22 August 2021 to 2 August 2022 (N = 24,199). These respondents responded to a revised version of the Moral Foundations Questionnaire [the MFQ-2 (42)] which, instead of including a single subscale pertaining to fairness, included separate scales pertaining to two conceptually distinct facets of fairness (proportionality and equality). Items were presented to respondents in random order. Consequently, mean endorsement of individualizing moral values was calculated from subscale scores for care, proportionality, and equality. Mean endorsement of binding moral values was calculated according to the same methods as in studies 1 and 2 (from subscale scores for loyalty, authority, and purity). These respondents also provided information on five personal characteristics that could plausibly be related to their endorsement of moral values: their political orientation, gender, age, income, and religiosity. The particular phrasing of each of these measures and descriptive statistics are included in *SI Appendix*. For each week within the dataset, we calculated mean scores for each of these personal characteristics.

In addition to regression analyses predicting weekly mean endorsement of binding and individualizing moral values with the standard biannual model (as in study 2), we used harmonic regression analyses (the same procedures used in study 1) to identify seasonal patterns in respondents' personal characteristics (political orientation, gender, age, income, and religiosity). We also conducted additional analyses to test the predictive effect of the biannual model on moral values while statistically controlling for seasonal variation in respondents' personal characteristics. We did so as follows: We first conducted regression analyses predicting respondents' scores on indices of binding and individualizing moral values with a model that contained their political orientation, gender, age, income, and religiosity. We then subtracted moral value scores predicted by this model from respondents' actual moral value scores–thus creating, for all respondents, adjusted moral value scores from which variance associated with their personal characteristics was removed. We then used these adjusted moral value scores to calculate adjusted weekly mean scores for both binding and individualizing moral values and conducted regression analyses predicting these adjusted weekly mean scores with the standard biannual model.

Study 4. We obtained (from Project Implicit Health) a dataset containing responses to a 7-item self-report questionnaire [the anxiety subscale of the Depression, Anxiety, and Stress Scale (43)] collected during the years 2013 to 2019 from 90,431 respondents in the United States (This dataset included data from 333 wk. The median number of respondents per week was 268, ranging

from 19 to 1,201.) Items were presented to respondents in random order. Our analyses focused on this 7-item subscale measuring anxiety, on which respondents reported the amount of anxiety they had experienced over the preceding two wk. From these data, we computed weekly mean self-reported anxiety scores.

Data on internet search frequencies for anxiety-related words were obtained from Google Trends (which provides information on the temporal variation in the relative frequency of specific words and/or phrases searched on Google). Specifying 1 January 2011 to 31 December 2020, as the time span and the United States as the geographical location, we extracted data on the weekly frequencies of searches for two anxiety-related words: "anxiety" and "anxious." We then calculated the mean of these two frequencies to create a composite index of anxiety-related search frequencies for each week.[¶]

We used harmonic regression analyses (as in study 1) to identify seasonal cycles in the measures of self-reported anxiety and anxiety-related Google search frequencies and conducted additional regression analyses to test whether weekly means on these two anxiety measures were predicted by the standard biannual model (as in study 2). We conducted another set of regression analyses (using a bootstrapping method with 100,000 resamples) to test whether the relationship between the standard biannual model and weekly means on binding moral values was statistically mediated by self-reported anxiety and by anxiety-related Google search frequencies.

[¶]There were 333 wk for which we obtained data on both self-reported anxiety and anxiety-related Google search frequencies. Treating each week as the unit of analysis, the mean weekly scores on these two variables were positively correlated, r = 0.36, $P < 0.001$. When combining these scores into a single composite calendar year (n = 52 wk)—which increases the sample sizes from which mean weekly scores were calculated—the positive correlation was higher, r = 0.56, $P < 0.001$.

Study 5. From yourmorals.org, we obtained datasets containing MFQ responses from three additional predominantly English-speaking countries during the 10-y period from 2011 to 2020: Canada (N = 19,377), the United Kingdom (N = 16,825), and Australia (N = 8,595). Individuals' scores for binding and individualizing moral values were calculated as in previous studies. Given the relatively small sample sizes per week, prior to computing mean weekly scores, we combined all 10 y of scores from each country into a single prototypic 52-wk calendar year, based on the month and date within which data were obtained. Consequently, for each country, we created time series data–for indices of individualizing and binding moral values–with 52 weekly datapoints. (The median number of responses per week from which these weekly means were computed were as follows: Canada = 324; United Kingdom = 293; Australia = 151.)

We conducted harmonic regression analyses (as in study 1) to identify any seasonal cycles in the time series data obtained from each country.

Data, Materials, and Software Availability. Data obtained for this manuscript from yourmorals.org may be granted directly from the yourmorals.org team upon request through the following link: https://yourmorals.org/requestdata/register (44). Data on anxiety obtained from Google Trends and Project Implicit, regional data, and all code used to conduct analyses and generate figures presented in this paper and *SI Appendix* have been deposited on the Open Science Framework: https://osf.io/u38dr/?view_only=df349e7abfa74115865e856bf6c78aab (45).

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