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The loosening of American culture over 200 years is associated with a creativity–order trade-off

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Supplemental Materials

The Loosening of American Norms Over Time is Associated with a Creativity-Order Tradeoff

Our supplemental materials contain several aspects of this research program that we could not describe in the main text due to space limitations. First, we describe how we selected our tightness and looseness indices from the initial lists provided by word2vec. Next, we summarize why we selected our historical strength of norm proxies (religiosity rates, executions, laws passed by congress, supreme court cases heard, and profanities), and show plots of these proxies over time. We then describe our central dependent measures of order (crime, high school attendance, adolescent pregnancy, household debt) and creativity (patent applications, trademark applications, baby naming conformity, film production), and discuss why we chose these variables. Finally, we present our effects without controlling for individualism-collectivism, GDP per capita, and the monotonic effect of time.

Supplementary Discussion

Full List of Words Provided by Word2Vec and Refinement Process

We used the computational algorithm word2vec¹ to develop rich, ground-up indices of “tightness” and “looseness.” Specifically, we used a word2vec mapping of words appearing in the Google News dataset to a 300-dimensional space and stored the vector coordinates for 8 words associated with tightness (comply, conform, constrain, prevent, obey, oblige, restrain, and uniformity), and 8 words associated with looseness (allow, autonomy, choose, create, freedom, leeway, variability, unique) that we developed through discussions between authors and reviews of the existing tightness-looseness literature and measures²⁻³. Then, after taking the mean vector coordinates for all tightness words and all looseness words, we extracted the 50 words that co-occurred most often with our tightness word-set, and the 50 words that co-occurred most often with our looseness word-set.

However, these 50-word indices (see Table S1) were not finished products. Many words in these indices did share face validity with tightness (e.g. “compel,” “confine”) and looseness (e.g. “modify,” “diverse”), but other words were idiosyncratic (e.g. “heroic dragon slayers”), or not conceptually related to the strength of norms (“stylize”). Other words appeared twice in slightly different forms (e.g. “confine/confines”).

In order to refine these indices and produce final word-lists of equal length, we instructed a hypothesis-blind colleague who was trained in tightness-looseness theory to read through the complete word lists and indicate which words were valid indicators of tightness and looseness. We did not include compounds of multiple words (“applied_evenhandedly”) because these compounds would be used extremely rarely in the Google Books Database, producing floor effects. This colleague selected 23 words that were indicative of tightness and 21 words that were indicative of looseness. After removing three words that were nearly duplicates (“confines” duplicated “confine”; “empowers” duplicated “empower”; “prevents” duplicated “prevent”) this left 21 words indicative of tightness and 20 words indicative of looseness. Finally, in order to produce word lists of an even length, we randomly selected one tight word (“legislate”) to exclude from our analyses. This left 20 “tight” words and 20 “loose” words in our analyses.

For the sake of comprehensiveness, Tables S2 and S3 replicate our central analyses while including “legislate” in our tightness index. Results with this alternative 21-word tightness index

are virtually identical to the results reported in the main text, which is unsurprising given that this alternative index is highly correlate with our 20-word index ($r = .99$).

Convergent measures over time

There are several limitations to using linguistic trends to measure cultural change. Increasing numbers of loose words in books could reflect popular literary trends that did not correspond to actual cultural change. For example, books about breaking rules could have become popular even though the strength of social norms did not otherwise change. The Google Books Corpus is also susceptible to problems related to improper scanning and encoding of ngrams and increasing publication of scientific literature throughout the 20th century⁴. In light of these limitations, we sought to establish the validity of our measure by searching for convergent data that would be indicative of a tight society and might therefore correlate with our linguistic index.

We first analyzed rates of religiosity in the United States. Religiosity has been linked to tightness in past research^{2,5} and research on Christianity and other moralizing religious belief systems show how these religions often function as systems of strong norms via the belief in a moralizing watchful god⁶, their rigid hierarchical structure⁷, and their emphasis on tradition and self-regulation⁸. This research suggests that years with higher religious belief would also have stronger norms.

We also analyzed yearly rates of Supreme Court cases, laws passed by the United States government, and execution rates over time. Cross-cultural research on the strength of norms argues that one key component of tight systems is the strict enforcement of rules and institutional punishment of deviance. Studies across nations², American states³, and traditional societies⁹ have each revealed a close connection between institutional authority and the strength of norms. We selected court cases, laws passed, and executions because they represented this institutional authority in slightly different ways: Supreme Court cases reflect the level at which society regulates its constitution. The passage of laws indicates the extent to which society regulates its legal code and how laws are enforced. Executions indicate the extent to which society punishes those that break its most serious laws. Therefore, we expected each of these measures of societal regulation to covary with the strength of norms such that years with strong norms would have more active regulation.

Finally, we analyzed rates of profanity in American television shows. We expected years with high rates of looseness to have the highest rates of profanities, which reflect norm violations⁵. More information about these variables is given in the method section of our main text. We registered each of these predictions at <https://osf.io/x2uzn/> prior to gathering data and running analyses.

As reported in the main text, 4 of our 5 convergent measures correlated with our linguistic measure of the strength of norms, offering further support that our measure was measuring realistic norm change across the United States. Below, Figure S1 visually displays the change in these convergent measures over time.

Further discussion of dependent variables

Our analysis includes four indicators of society-level creativity (patent applications, trademark applications, feature film production, and baby naming conformity) and four indicators of society-level order (household debt, crime rate, adolescent pregnancy rate, and high school enrollment rate). In the main text, space limitations prevented us from comprehensively

discussing why we chose these indicators, and summarizing how creativity and order have been measured in past literature. Below, we include an in-depth discussion of these issues.

Measuring society-level creativity

Generally speaking, past research has defined creativity in terms of novelty, divergent thinking, and productivity, and past individual-level measures of creativity reflect these elements (see Table S4). For this study's society-level indicators of creativity, we sought measures that also related to novelty, divergent thinking, and productivity, but at the societal level. Below, we describe how the measures we used satisfied these components.

Patent and trademark applications. Patent and trademark applications reflect original ideas and innovative discoveries at the societal level. By definition, patents and trademarks require divergent thinking and novelty, since they represent new solutions to old problems. Patents and trademarks also represent a form of productivity. The American states with the most patent and trademark applications have also had the highest levels of trait openness to experience¹⁴, and past cross-cultural research has found that state-level strength of norms is a strong predictor of state-level patent and trademark applications³. Therefore, measuring patent and trademark applications was not only appropriate because these measures indicate divergent thinking, novelty, and productivity; it also allowed us to replicate past cross-cultural research from a historical perspective.

Feature film production. It is no accident that film production is known as the “creative industry.” Feature films not only represent novelty through new ideas and stories, they also encourage divergence in the way that they question and explore prevailing norms and attitudes. This is especially true within the United States, where films have often made political and social statements that directly question the status quo¹⁵. Therefore, the number of films released in a given year not only represents a face valid measure of creative productivity. It indirectly indicates the public's receptivity to new and divergent ideas.

Baby naming conformity. Baby naming conformity, by definition, represents a measure of divergent thinking. Just as subjects in creativity tasks must generate unique and non-traditional solutions to problems, non-conformist baby names represent unique and non-conformist cultural products. Baby naming conformity is also a useful measure of creativity because it captures an entire population's orientation towards novelty and divergence. Whereas feature film production and patent/trademark applications are only means of creative expression for middle- and upper-class individuals, baby naming conformity applies equally to people of all classes. Past research has treated baby naming conformity as a measure of collectivism¹⁶, and so all analyses in our paper controlled for yearly fluctuations in collectivism.

Measuring society-level order

Several past studies have measured order at the societal level. Some of this work has operationalized order via the extent that people follow prescribed norms and avoid dangerous risk. Common measures in these studies have been credit card debt levels³, gambling prevalence¹⁷, and contraceptive use prevalence¹⁷. Other studies have measured societal order through the extent that institutions effectively enforce norms and people follow laws. Common measures in these studies have been the number of crimes per capita and the number of incarceration rates per capita^{2,3}. Not all of the measures discussed above were available historically for our own analyses. However, they provided a template with which to select historically available data.

Household debt. Household debt reflects how people are spending their money, with overspending resulting in greater household debt. Past research within individuals has established overspending as a classic self-control failure¹⁸, and cross-cultural research has commonly used household debt and credit card debt as societal indicators of non-normative risk-taking^{3,17}. Household debt not only represents societal disorder because it indicates unhealthy overspending, it also leads to bankruptcy, real estate foreclosure, and other financial indicators of poor societal regulation.

Crime. Crime is a commonly used index in past studies on societal order, since it reflects the extent that people are following a society's laws^{1,3}. Nevertheless, yearly fluctuations in crime are conceptually related to several other factors, including but not limited to police presence, incarceration rates, and changing legal norms and definitions.

Adolescent pregnancy. Adolescent pregnancy hinges critically on how conscientiously couples use contraceptives, especially in out-of-wedlock relationships (which the US Department of Health and Human Services estimates to characterize 89% of adolescent pregnancy). There are many influences on contraception use, including but not limited to accessibility, education, religion, and life history strategy¹⁹. However, contraceptive use is also critically tied to self-regulation, particularly in adolescents: indeed, longitudinal panel studies have revealed strong negative correlations between adolescent self-regulation and contraceptive use, even controlling for parent and peer influences, and demographic and contextual factors²⁰. Because adolescent pregnancy rates have been correlated with pathogen prevalence and collectivism in past research¹⁹, we replicated our analyses on adolescent pregnancy controlling for these factors.

High school enrollment rate. High school enrollment also indicates self-regulation and norm abidance in three important ways. First, children's self-regulation is highly predictive of school success^{21,22}, which will influence future enrollment rates. In prospective studies, children who show better self-control and ability to delay gratification at a young age will, on average, perform better in the classroom—and to inevitably stay in school—than children who are less able to self-regulate²¹. Second, children's self-regulation is highly related to their susceptibility to disruptive behavior and juvenile crime, which often result in expulsion from school²²⁻²³. Finally, children's enrollment in school is reflecting of parenting strategies. We theorized that more children would leave school in years where parents adopted more permissive (compared to more order-focused and restrictive) parenting strategies.

Correlations without controlling for other factors

For the sake of comprehensiveness, we report our order and creativity analyses without controlling for individualism-collectivism, GDP per capita, and the monotonic effect of time. Correlations should be interpreted with caution, since both sets of variables have monotonic trends that create temporal autocorrelation. Positive correlations indicate a positive relationship between order and the strength of norms.

Supplementary Tables

Supplementary Table 1.
Full Word-Lists Recommended by Word2Vec

Tight Words	Loose Words
Restrain	Allow
Prevent	Freedom
Comply	Create
Constrain	Variability
Uniformity	Autonomy
Adhere	Openness
Enforce	Leeway
Proscribe	Flexibility
Abide	Broadmindedness
Dictate	Transformatory
Circumscribe	Customize
Impose	Subjectivities
Uphold	Modify
Discourage	Limitless
Compel	Empower
Forbid	Adaptiveness
Confine	Pluralism
Govern	Personalize
Prohibit	Encourage
Preclude	Diverse
Behave_decently	Consociational
Preempt	Unfetter
Prevents	Heroic_dragon_slayers
Interfere	Coexist_harmoniously
Supersede	Gravatars
Protect	Adaptive
Applied_evenhandedly	Alcornites
Satisfy	Incorporate
Preclude	Eternalize
Pre_empty	Re-articulate
Animeon_DCD.com_reserves	Stylize
Violate	Broaden_horizons
Confines†	Truest_expression
Legislate*	Infantilise
Forestall	Select
Abided	Enforcing_habeas_corpus
Fulfill	Develop
Rigidly_enforce	Utilize
Impinge	Empowers†

Dissuade	Disempowers
Rein	Transcend
Accede	Unite
Derogate	Secular_therapists
Analogize	Embrace
Younger_sea_lions	Musicians_poets_storytellers
Foreswear	Rescue

Note. Words comprising our final index have been bolded. Strings with underscores represent multiple words that co-occurred frequently enough for word2vec to label them as a single lexical unit. Stars indicate words that were included in our alternative index. Daggers indicate duplicate words with slightly different word forms (“prevent” and “prevents”).

Supplementary Table 2.

Correlations between Alternative Strength of Norms Index and Convergent Measures

Variable	Correlation
Religion	$\tau = .78, p < .001$
Executions	$\tau = -.16, p < .001$
Laws Passed by Congress	$\tau = .56, p < .001$
Profanities	$\tau = -.83, p < .001$

Supplementary Table 3.

Correlations between Alternative Strength of Norms Index and Dependent Variables

Variable	Correlation
Crime	$\tau = -.69, p < .001$
Enrollment	$\tau = .52, p < .001$
Adolescent Pregnancy	$\tau = -.43, p < .001$
Household Debt	$\tau = -.69, p < .001$
Patents	$\tau = -.71, p < .001$
Trademarks	$\tau = -.65, p < .001$
Feature Film Production	$\tau = -.41, p < .001$
Baby Naming Conformity	$\tau = .17, p = .03$

Supplementary Table 4. Previous Creativity Measurement Tasks

Task	Description
Remote Associations Test ¹⁰	Subjects view three seemingly unrelated words and must think of a fourth word that completes the association. This task requires the test subject to think about non-traditional word meanings, which taps divergent thinking.
Alternative Uses Task ¹¹	Subjects are prompted to think of as many possible uses for a common household item (usually a brick or paperclip). Creativity is scored by originality (i.e. how rare the response is), fluency (i.e. the sum of responses), flexibility (i.e. the number of different categories of uses), and elaboration (i.e. the detail provided). As such, this task measures creativity both through novelty (originality), divergent thinking (flexibility & originality), and productivity (fluency).
Dunker Candle Problem ¹²	In the Dunker Candle Problem, test subjects must use a candle, a book of matches, and a box of thumbtacks to attach the lighted candle to a corkboard so that the candle does not drip onto the floor. To complete the task, subjects must empty the box of thumbtacks, use the thumbtacks to nail the box to the wall, put the candle on the box, and light the candle with the match. The task taps divergent thinking by prompting non-traditional uses of the thumbtack box.
Alien Drawing Task ¹³	Subjects must draw an alien creature that they encounter on a far-away planet. The task is scored based on (a) how dissimilar subjects' alien drawing are from earth creatures, and (b) the extent that participants took earth creatures in mind when making their drawing. The task therefore requires both novelty (generating a new lifeform) and divergent thinking (generating a creature that is dissimilar to creatures on earth).

Supplementary Table 5.

Correlations between Strength of Norms and Order Without Covariates

Variable	Correlation
Crime	$\tau = -.47, p < .001$
Enrollment	$\tau = -.98, p < .001$
Adolescent Pregnancy	$\tau = .58, p < .001$
Household Debt	$\tau = -.99, p < .001$

Supplementary Table 6.

Correlations between Strength of Norms and Creativity Without Covariates

Variable	Correlation
Patents	$\tau = -.86, p < .001$
Trademarks	$\tau = -.97, p < .001$
Feature Film Production	$\tau = -.05, p = .45$
Baby Naming Conformity	$\tau = .45, p < .001$

Supplementary Table 7.

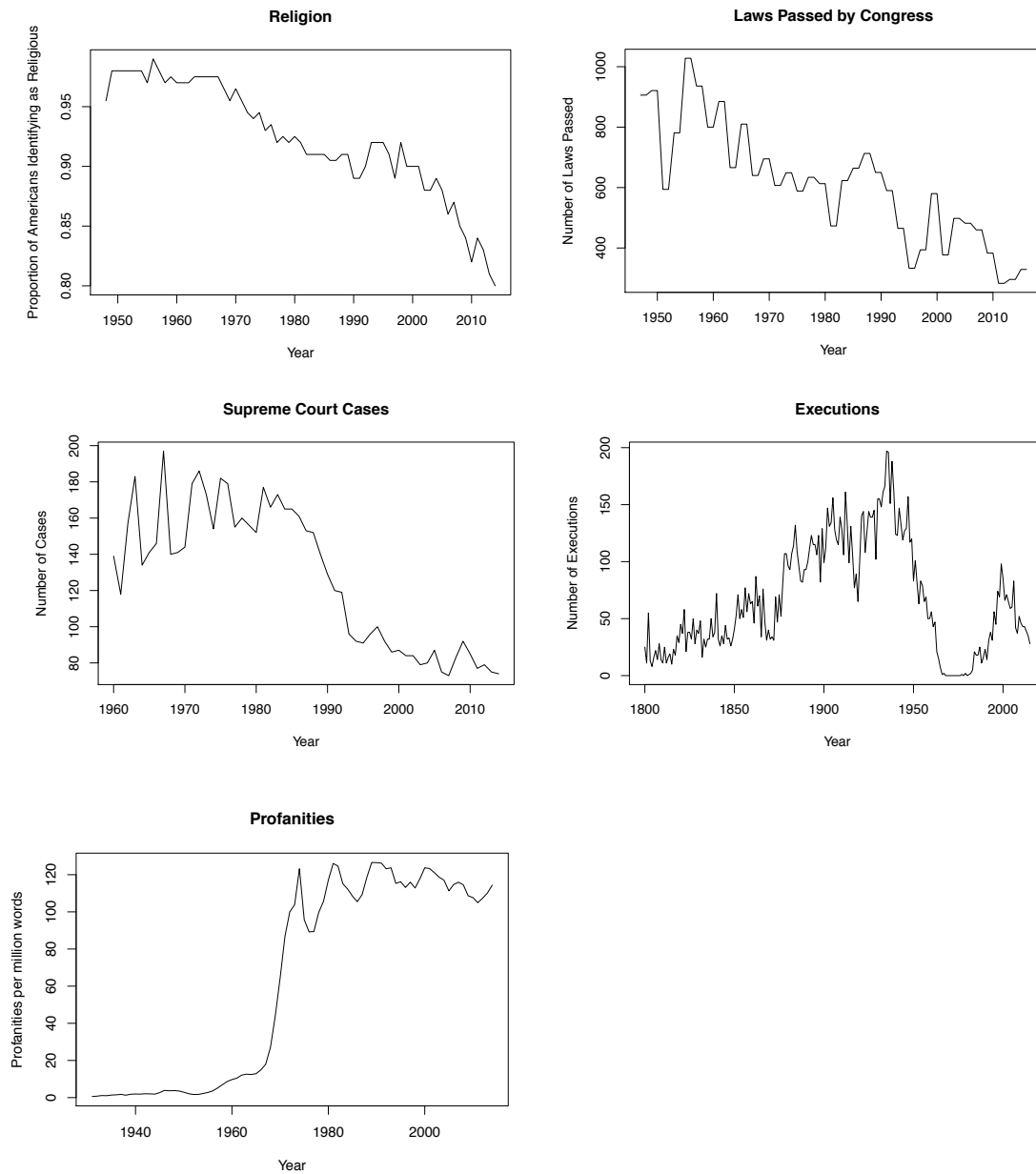
Granger Tests of Predictive Causality at 1-Year and 5-Year Lags

Variable	1-Year	5-Year
Trademark Applications	$F(1, 37) < 1$	$F(5, 29) < 1$
Patent Applications	$F(1, 37) = 1.45$	$F(5, 29) < 1$
Feature Films Produced	$F(1, 69) = 5.27^*$	$F(5, 61) = 1.43$
Baby Name Conformity	$F(1, 69) < 1$	$F(5, 61) = 2.07^\dagger$
Household Debt	$F(1, 37) < 1$	$F(5, 29) < 1$
Crime Rates	$F(1, 37) = 3.09^\dagger$	$F(5, 29) = 2.00$
Adolescent Pregnancy Rate	$F(1, 37) < 1$	$F(5, 29) < 1$
High School Enrolment	$F(1, 27) < 3.16^\dagger$	$F(1, 19) = 1.32$

† Significant at $p = .10$

* Significant at $p = .05$

Supplementary Figures



Supplementary Figure 1. Rates of religious belief, laws passed by congress, Supreme Court cases heard, execution rates, and profanities in the United States over time.

Supplemental References

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