

Supplementary Materials for

As diversity increases, people paradoxically perceive social groups as more similar

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Open access to material, data, code, figure, and pre-registration at *here*.

Supplementary Information

0. Study 0 Mental map of stereotype content model: an illustration	3
1. Study 1 stereotype dispersion and ethnic diversity in 46 nations	7
2. Study 2 stereotype dispersion and ethnic diversity in 50 states in the US	11
3. Study 2 demographics of online American participants	12
4. Study 2 stereotype dispersion by ethnic group	16
5. Study 2 multilevel regression and state random effects	20
6. Study 2 mediation analysis	22
7. Study 3 derivation of diff-in-diff estimator	23
8. Study 3 robustness check	32
9. Stereotype dispersion and well-being	34
10. Stereotype dispersion and positivity	36
11. Ingroup favoritism	37
12. Diversity perception accuracy	38

0. Study 0 mental map of stereotype content model: an illustration

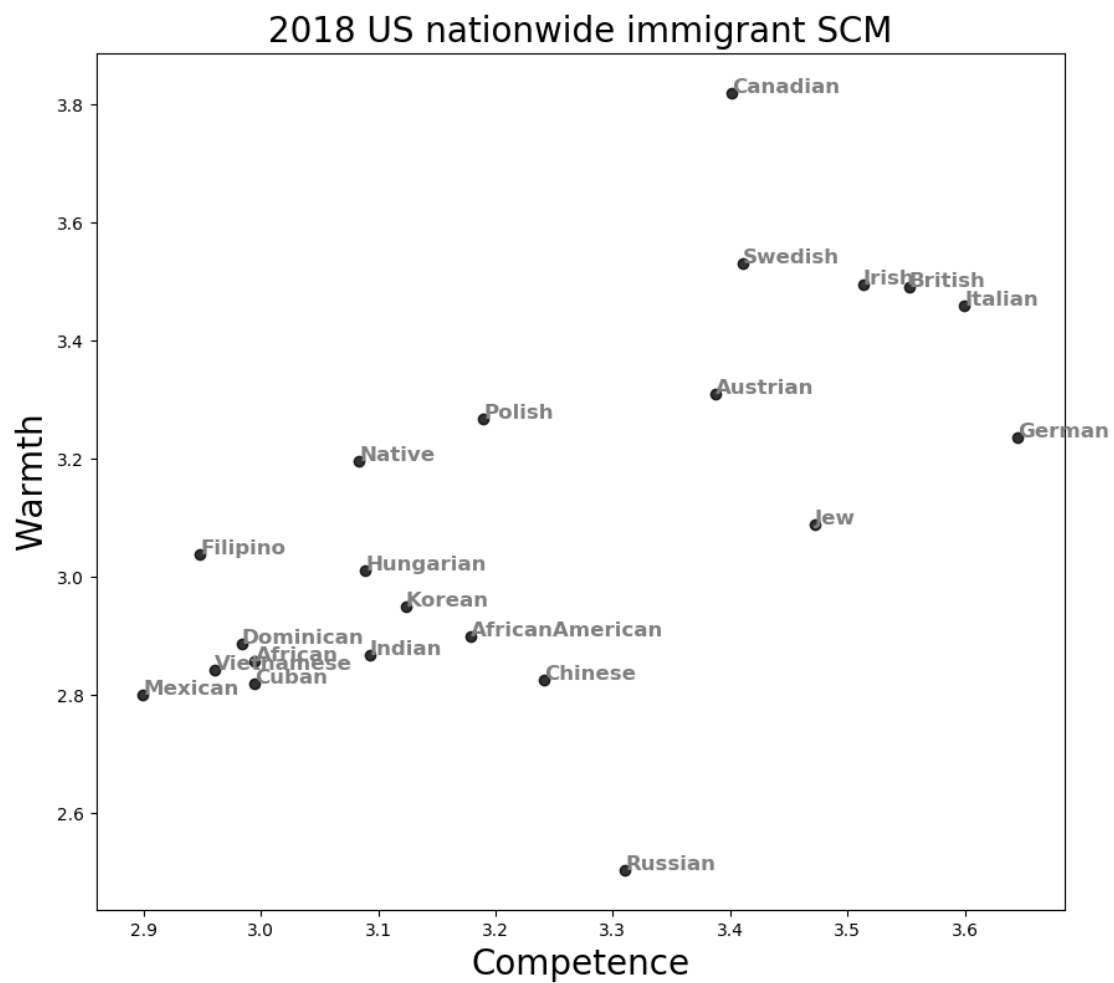


Fig.S 1 – Stereotype content model in the US

Note. American online participants ($N = 1502$) gave ratings on perceived competence and warmth of the 20 largest immigrant groups in the United States. Each dot represents how an immigrant groups is perceived by individuals in that society. The main analysis rests (Euclidean norm) on similar stereotype content maps, but varies at the level of responses and social groups. See main text for details.

1. Study 1 stereotype dispersion and ethnic diversity in 46 nations

Table.S 1 – Stereotype dispersion and ethnic diversity in 46 nations

Country	Stereotype dispersion	Ethnic diversity	GDP	GINI	Year	Country	Stereotype dispersion	Ethnic diversity	GDP	GINI	Year
Afghanistan	0.7481	0.7693	612.0697	34.4	2014	Japan	0.6622	0.0119	37217.6487	30.2	2005
Armenia	0.8941	0.1272	3614.7000	34.6	2017	Jordan	0.7961	0.5926	3992.8671	39.3	2013
Australia_w	0.8110	0.0929	42742.9990	33.1	2009	Kazakhstan	0.6676	0.6171	7713.6000	28	2017
Belarus	0.6468	0.3222	4986.5000	22.8	2017	Kenya_w	0.6876	0.8588	1335.0646	42.1	2014
Belgium	0.6747	0.5554	36967.2829	26.3	2005	Lebanon	1.4327	0.1314	8406.2852	38	2013
Bolivia_w	0.7620	0.7396	1776.8665	46.1	2009	Malaysia	0.8795	0.588	8513.6295	43.9	2008
Canada	0.6224	0.7124	46596.3360	31.3	2008	Mexico	0.9445	0.5418	7986.7984	46.1	2005
Chile	1.1177	0.1861	10243.3282	47.9	2009	NewZealand_w	0.8681	0.3969	28200.9419	32	2009
China	0.6498	0.1538	7683.5000	51.5	2014	Norway	0.8208	0.0586	102910.4350	24.6	2013
Costa Rica	0.7239	0.2368	4697.0111	44.4	2005	Pakistan	0.6587	0.7098	1272.4411	35.7	2013
Denmark	1.1910	0.0819	62425.5392	25.3	2014	Peru	0.4995	0.6566	4166.0934	48.4	2009
Egypt	0.7201	0.1836	3213.3892	47.2	2013	Portugal	1.0489	0.0468	22780.0585	35.3	2007
England	0.9866	0.1211	46523.2655	34	2008	Russia	0.9784	0.2452	8748.4000	42.1	2017
Finland	0.9580	0.1315	49914.6186	25.5	2014	South Africa	0.3909	0.7517	5414.6343	58	2005
Georgia	0.7594	0.4923	3865.8000	40.4	2017	South Korea	0.6597	0.002	18639.5222	30.2	2005
Germany	0.8458	0.1682	34696.6209	28.2	2005	Spain	1.1565	0.415	35578.7362	32.4	2008
Greece	1.1896	0.1576	31997.2820	32.6	2008	Sweden	1.0426	0.06	59180.1990	25.8	2014
HongKong	0.7134	0.062	26649.7508	40.9	2005	Switzerland_w	0.8436	0.5314	69672.0047	29.6	2009
India	0.6149	0.4182	1345.7702	48	2010	Turkey	0.6946	0.32	12542.9357	40.4	2013
Iran	0.7827	0.6684	5424.3100	37.9	2014	Uganda	0.8970	0.9302	647.0108	38.9	2009
Iraq	0.6060	0.3689	6925.2240	34.5	2013	Ukraine	0.9856	0.4737	2185.7000	25	2017
Israel_w	0.4289	0.3436	20611.1793	36.6	2005	US_w	0.7510	0.4901	48373.8788	37	2010
Italy_w	0.8397	0.1145	31959.2622	32.5	2005	Uzbekistan	0.4984	0.4125	2110.6000	35.2	2017

Note. See calculations and data source in the main text for each variable. *w* denotes aggregate results from multiple regions (e.g., French, German, and Italian Canton in Switzerland) or multiple samples (e.g., students and adults in Italy) in one country. Year denotes data collection time for stereotype content model research (Fiske et al., 2002).

Fig.S 2 – Stereotype dispersion in 46 nations

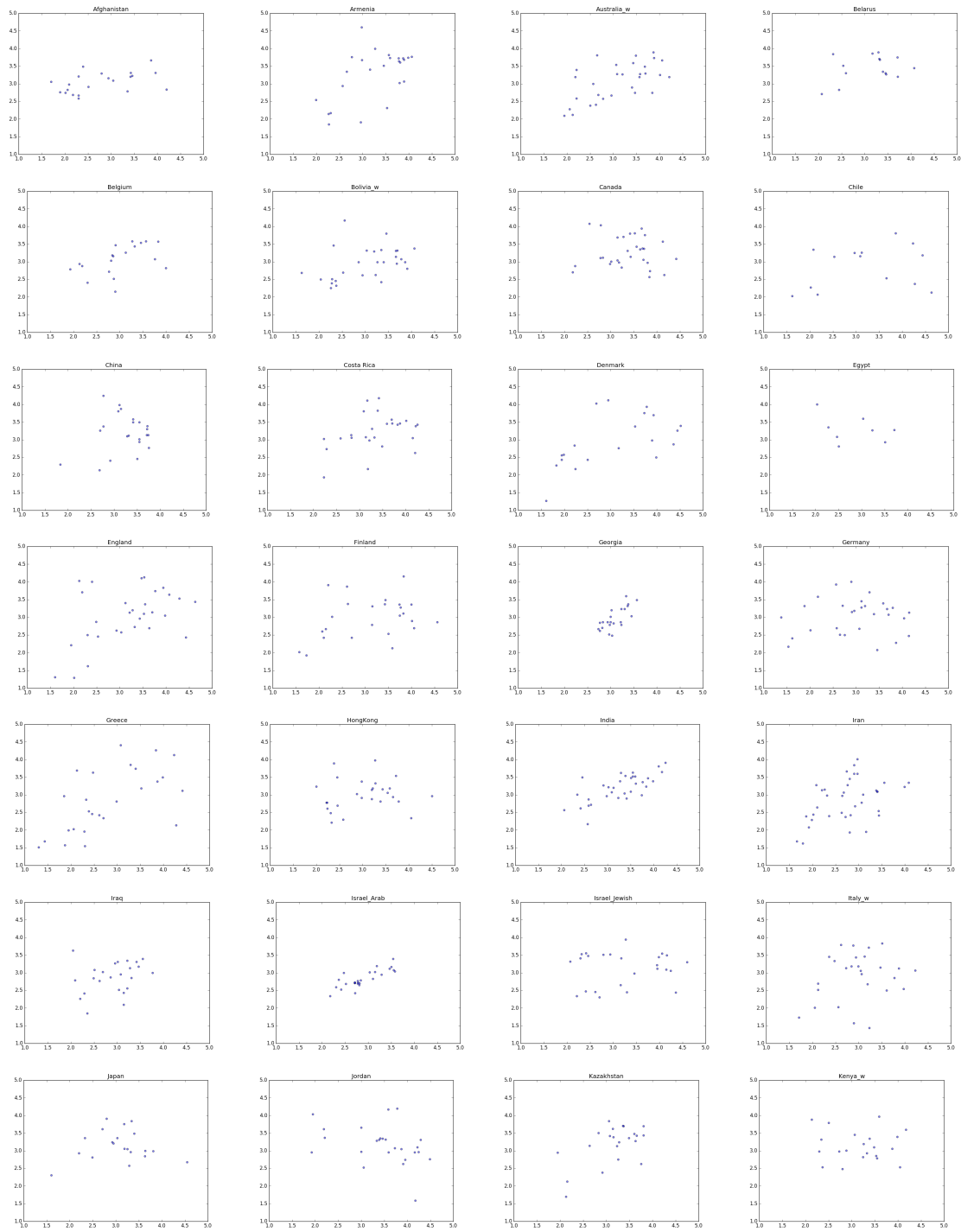
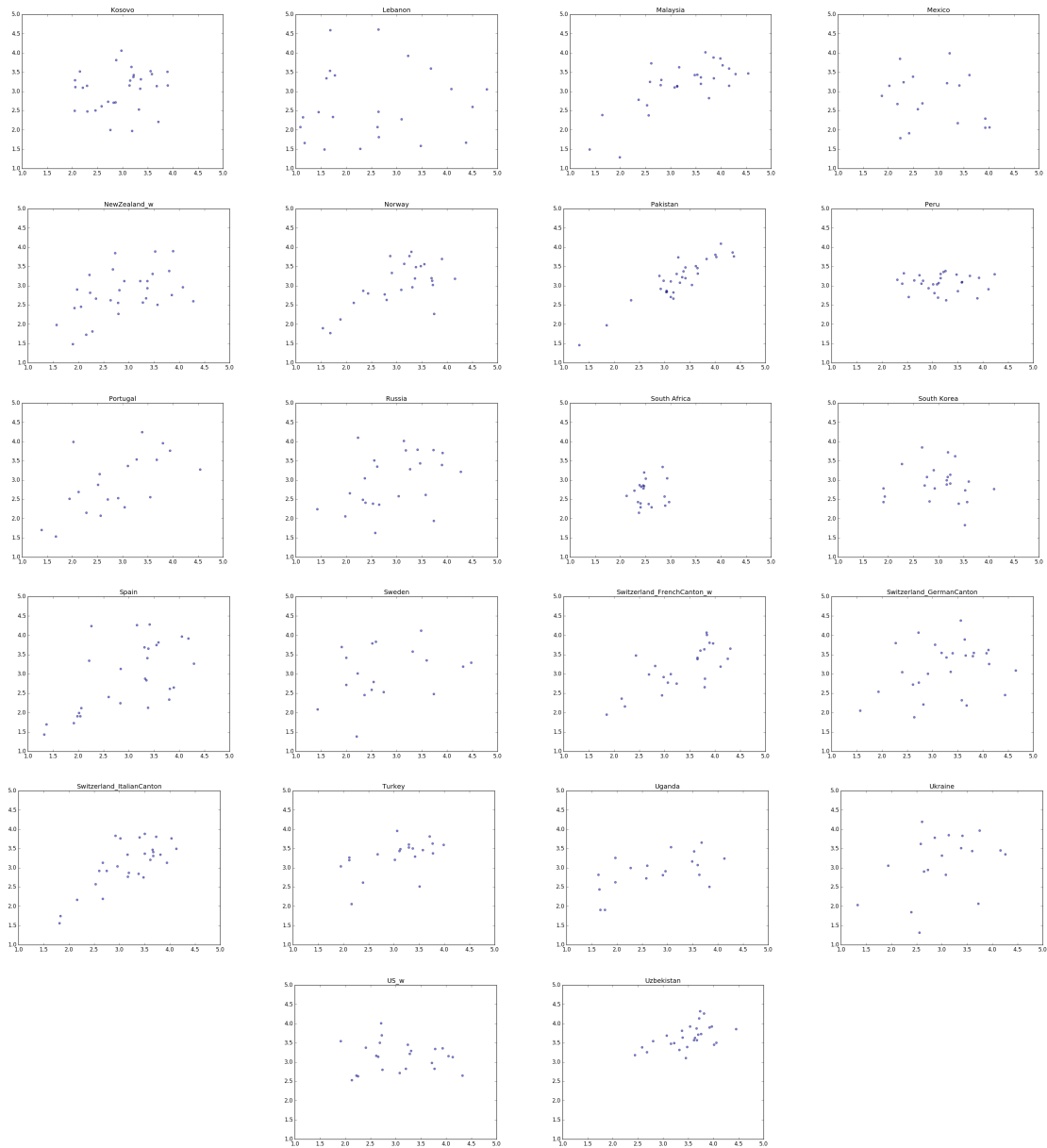


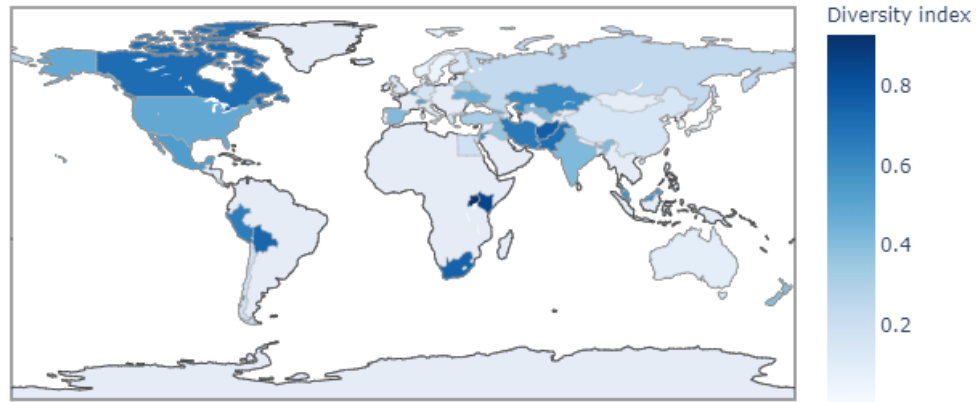
Fig.S 3 – Stereotype dispersion in 46 nations cont.



Note. Visualization of stereotype content map in each country, warmth on the x-axis and competence on the y-axis, scale range [1,5], continuous. *w* denotes aggregate results from multiple regions (e.g., French, German, and Italian Canton in Switzerland) or multiple samples (e.g., students and adults in Italy) in one country. For sample size, sample feature, group label, clustering analysis, and other detail information in online data file or Durante et al. (2017). Zoom in to see figure titles.

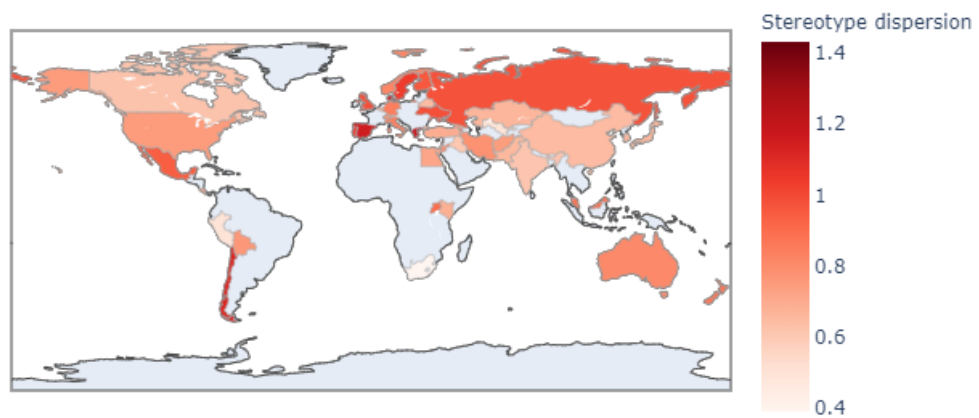
Fig.S 4 – Geographical world heatmap showing inverse relations between diversity and dispersion.

2003 Alesina Diversity Index by Country



(a) Ethnic diversity in 46 nations and regions

2000-2018 Social Group Stereotype Dispersion by Country



(b) Stereotype dispersion in 46 nations and regions

Note. Heatmaps plotting country-level stereotype dispersion and ethnic diversity. The upper figure indicates diversity, with darker blue showing higher diversity. The lower figure indicates stereotype dispersion, with darker red showing larger dispersion. Gray areas indicate no data.

2. Study 2 stereotype dispersion and ethnic diversity in 50 states in the US

Table.S 2 – Stereotype dispersion and ethnic diversity in 50 states in the US

State	Stereotype dispersion	Ethnic diversity	Perceived diversity	GDP	GINI	State	Stereotype dispersion	Ethnic diversity	Perceived diversity	GDP	GINI
Alabama	0.238	0.435	3.700	204201	0.4847	Montana	0.413	0.184	2.400	46478	0.4667
Alaska	0.169	0.508	3.688	50542	0.4081	Nebraska	0.447	0.182	2.846	118945	0.4477
Arizona	0.404	0.276	3.700	304357	0.4713	Nevada	0.471	0.378	4.267	148216	0.4577
Arkansas	0.425	0.330	3.400	121275	0.4719	New Hampshire	0.431	0.100	2.710	77843	0.4304
California	0.260	0.426	4.387	2619639	0.4899	New Jersey	0.406	0.417	4.167	576228	0.4813
Colorado	0.323	0.214	3.529	323762	0.4586	New Mexico	0.218	0.290	3.903	93242	0.4769
Connecticut	0.302	0.305	3.935	257038	0.4945	New York	0.199	0.449	4.133	1500152	0.5129
Delaware	0.214	0.434	3.467	70927	0.4522	North Carolina	0.578	0.428	3.633	518378	0.478
Florida	0.300	0.352	4.067	930375	0.4852	North Dakota	0.516	0.176	2.550	53328	0.4533
Georgia	0.363	0.501	3.800	532657	0.4813	Ohio	0.494	0.283	3.333	624372	0.468
Hawaii	0.150	0.760	4.000	84904	0.442	Oklahoma	0.401	0.407	3.300	181480	0.4645
Idaho	0.403	0.113	2.767	68616	0.4503	Oregon	0.415	0.208	2.935	227032	0.4583
Illinois	0.415	0.365	3.833	796906	0.481	Pennsylvania	0.497	0.282	3.333	723962	0.4689
Indiana	0.565	0.235	2.867	345207	0.4527	Rhode Island	0.502	0.246	3.867	57507	0.4781
Iowa	0.529	0.130	2.767	186200	0.4451	South Carolina	0.401	0.452	3.938	210876	0.4735
Kansas	0.344	0.227	3.333	154806	0.455	South Dakota	0.422	0.238	3.300	48652	0.4495
Kentucky	0.522	0.201	2.839	195527	0.4813	Tennessee	0.643	0.337	3.387	332094	0.479
Louisiana	0.544	0.485	3.938	237598	0.499	Texas	0.233	0.326	3.967	1601517	0.48
Maine	0.519	0.086	2.400	59475	0.4519	Utah	0.476	0.150	2.933	157404	0.4263
Maryland	0.503	0.530	4.065	380805	0.4499	Vermont	0.356	0.085	2.533	31292	0.4539
Massachusetts	0.455	0.279	3.879	505689	0.4786	Virginia	0.332	0.446	3.968	491221	0.4705
Michigan	0.508	0.332	3.867	486874	0.4695	Washington	0.305	0.315	4.100	476934	0.4591
Minnesota	0.432	0.235	3.438	338746	0.4496	West Virginia	0.544	0.110	2.633	72569	0.4711
Mississippi	0.365	0.498	3.467	109034	0.4828	Wisconsin	0.696	0.211	3.333	314247	0.4498
Missouri	0.419	0.278	3.375	297074	0.4646	Wyoming	0.400	0.118	2.567	37925	0.436

Note. See calculations and data source in the main text for each variable. All data collected in July, 2018.

Fig.S 5 – Stereotype dispersion in 50 states

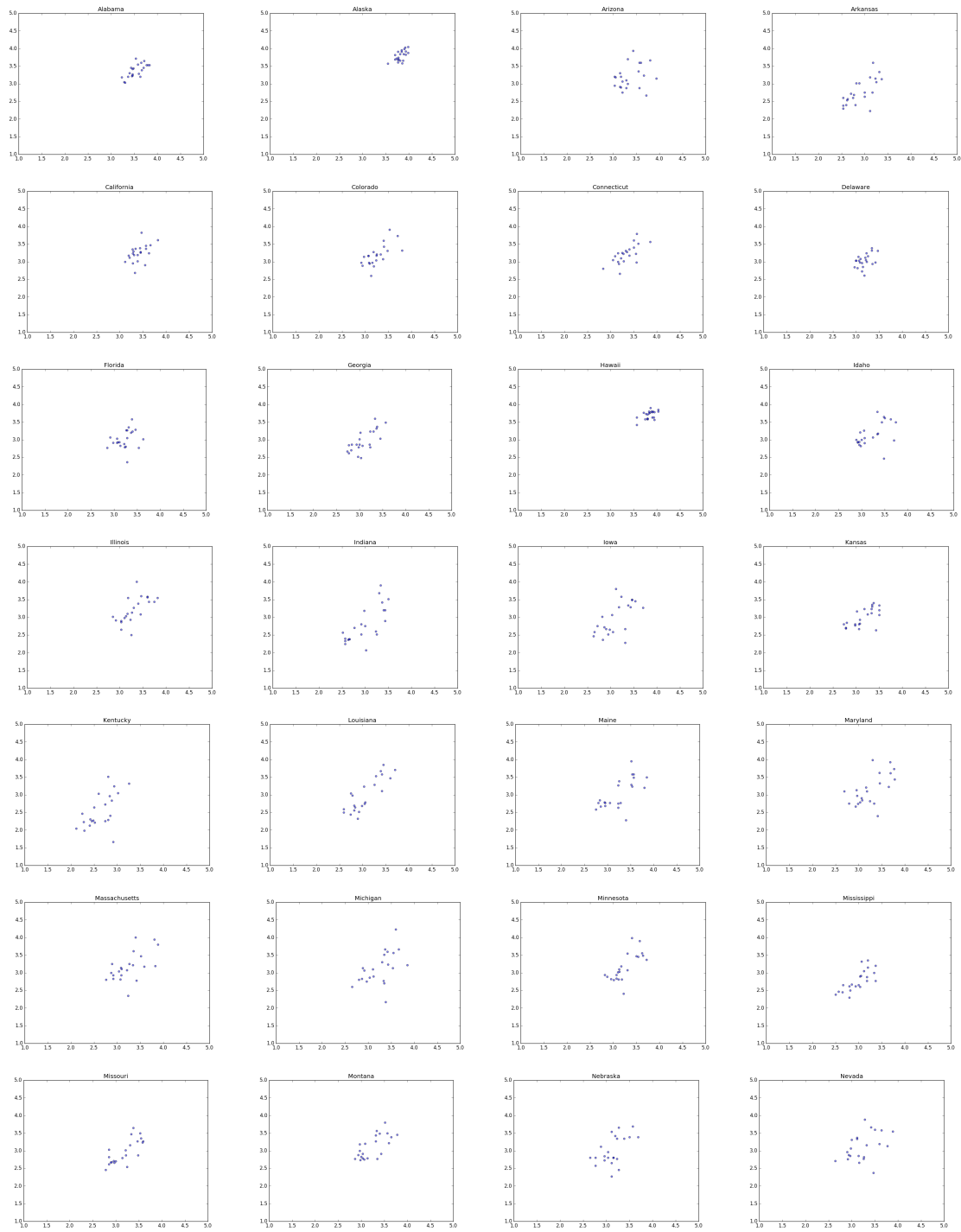


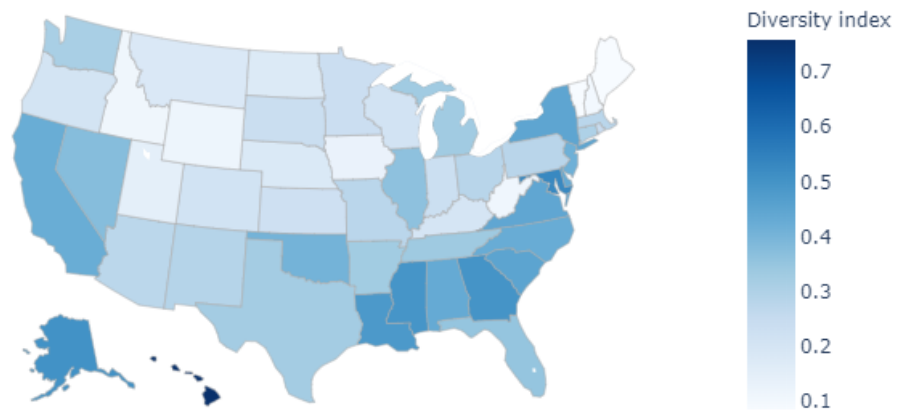
Fig.S 6 – Stereotype dispersion in 50 states cont.



Note. Visualization of stereotype content map in each state in the US, warmth on the x-axis and competence on the y-axis, scale range [1,5], continuous. Participants from each state evaluated 20 immigrant groups on perceived warmth and competence, see main text for details (Methods) and group labels for each dot in each state in online data. Zoom in to see figure titles.

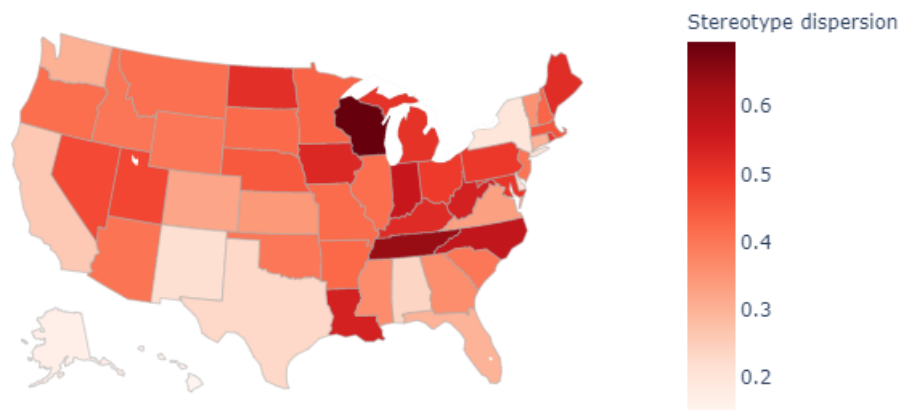
Fig.S 7 – Geographical US heatmap showing inverse relations between diversity and dispersion.

2010 Immigrant Diversity by State



(a) Immigrant diversity in 50 states in the US

2018 Immigrant Stereotype Dispersion by State



(b) Stereotype dispersion in 50 states in the US

Note. Heatmaps plotting state-level stereotype dispersion and ethnic diversity. The upper figure indicates diversity (the most recent available year), with darker blue showing higher diversity. The lower figure indicates stereotype dispersion, with darker red showing larger dispersion.

3. Study 2 demographics of online American participants

Table.S 3 – US study participant demographic information

State	N	Gender (% female)	Age (mean)	Years of living	Education level	Social ladder	Household income	Area of residence	Ancetry immigrant
Alabama	30	0.23	36	25	4.2	6.5	4.2	47% Big city	33% Mexican 20% African American
Alaska	30	0.27	29	21	4.7	6.4	4.7	40% Big city	40% Native American 30% African American
Arizona	30	0.37	35	21	3.8	4.9	3.8	40% Suburbs	23% Mexican 23% German
Arkansas	30	0.47	37	23	3.4	4.7	3.4	43% Town or small city	27% Irish 20% German
California	30	0.4	35	27	3.9	5.1	3.9	37% Suburbs	17% Irish 13% German; Italian
Colorado	30	0.33	33	20	4.2	5.5	4.2	43% Suburbs	40% German
Connecticut	30	0.4	30	23	4.2	5.6	4.2	43% Town or small city	23% African American 23% Native American
Delaware	30	0.4	31	18	3.8	5.4	3.8	47% Suburbs	33% German 20% African American
Florida	30	0.43	35	24	4.4	5.5	4.4	53% Suburbs	23% British 23% African American
Georgia	30	0.47	33	24	3.9	5.1	3.9	53% Suburbs	17% British 17% African American
Hawaii	30	0.33	31	20	4.8	7.2	4.8	60% Big city	47% Native American 43% African American
Idaho	30	0.6	35	23	3.8	4.7	3.8	40% Suburbs	23% German 23% British
Illinois	30	0.4	36	28	4.3	5.2	4.3	50% Suburbs	30% Native American 23% German
Indiana	30	0.37	33	23	3.7	4.6	3.7	43% Town or small city	27% British 23% German
Iowa	30	0.43	35	22	3.7	4.6	3.7	43% Town or small city	43% German
Kansas	29	0.55	36	24	4.2	5.5	4.2	41% Big city	28% German 28% Native American
Kentucky	30	0.57	37	29	3.1	4.2	3.1	43% Town or small city	30% German 27% British
Louisiana	30	0.4	35	32	3.7	5	3.7	40% Town or small city	20% German 20% African American
Maine	30	0.5	34	24	3.7	4.6	3.7	47% Town or small city	23% British 13% German; Italian; Irish
Maryland	30	0.43	33	25	3.8	5.1	3.8	47% Suburbs	30% German 13% South Korean
Massachusetts	30	0.37	34	25	4.3	5.3	4.3	47% Suburbs	23% German 17% Other

Table.S 4 – US study participant demographic information cont.

State	N	Gender (% female)	Age (mean)	Years of living	Education level	Social ladder	Household income	Area of residence	Ancestry immigrant
Michigan	30	0.43	31	27	3.6	4.7	3.6	47% Suburbs	37% German
Minnesota	30	0.43	35	30	3.7	4.3	3.7	43% Suburbs	53% German
Mississippi	30	0.67	33	22	4	5	4	50% Town or small city	23% British 13% African; Native American
Missouri	30	0.43	34	28	3.6	5	3.6	37% Big city	37% German 20% Native American
Montana	29	0.45	35	14	4.3	5.2	4.3	53% Town or small city	33% German 17% British
Nebraska	13	0.54	31	21	4.2	4.5	4.2	46% Big city	69% German
Nevada	30	0.37	36	14	3.5	4.3	3.5	67% Big city	33% German
New Hampshire	30	0.37	36	26	4	5.3	4	40% Town or small city	33% British 27% Italian
New Jersey	30	0.3	38	31	3.7	5.3	3.7	47% Suburbs	17% Native American
New Mexico	30	0.27	35	24	4.7	6.1	4.7	63% Big city	43% Mexican
New York	30	0.3	32	24	4.7	6.5	4.7	57% Big city	23% African American 20% Native American
North Carolina	30	0.47	40	22	3.4	4.5	3.4	37% Suburbs	27% British 20% German
North Dakota	20	0.4	35	18	4	4.9	4	55% Town or small city	40% German
Ohio	30	0.37	31	24	3.8	4.4	3.8	53% Suburbs	33% German
Oklahoma	30	0.47	36	27	3.6	4.3	3.6	33% Suburbs	30% British 23% German
Oregon	30	0.6	40	21	3.5	3.7	3.5	43% Town or small city	37% German 20% British
Pennsylvania	30	0.43	33	26	3.5	4.3	3.5	37% Town or small city	40% German
Rhode Island	30	0.33	36	23	3.6	4.8	3.6	70% Town or small city	23% Irish 20% Italian
South Carolina	30	0.53	35	23	4.3	4.7	4.3	40% Town or small city	37% German
South Dakota	30	0.37	32	20	4.2	6.2	4.2	43% Town or small city	33% African American 27% German
Tennessee	30	0.6	39	28	3.5	4.4	3.5	43% Suburbs	37% German 23% British
Texas	30	0.27	34	25	4.2	6	4.2	47% Big city	33% Native American
Utah	30	0.37	37	23	3.9	4.4	3.9	60% Suburbs	30% German 27% British
Vermont	30	0.43	33	20	4.4	4.8	4.4	37% Town or small city	27% German 17% British; Italian
Virginia	30	0.57	33	23	3.9	5	3.9	43% Suburbs	23% German 13% African American
Washington	30	0.53	34	21	3.6	5	3.6	47% Big city	23% German
West Virginia	30	0.33	34	21	4.3	5.6	4.3	47% Town or small city	27% German 27% African American
Wisconsin	30	0.53	35	29	3.6	4.7	3.6	37% Town or small city	70% German
Wyoming	30	0.33	34	23	3.9	5.4	3.9	53% Town or small city	33% British

Note. See variable manipulations in the main text Methods section.

4. Study 2 stereotype dispersion by ethnic group

An alternative explanation for less stereotype dispersion in diverse states is group identity. In more diverse states, we could have drawn more minority group participants, whereas in less diverse states, we might have collected more majority group participants. Therefore, both diversity and group identity may associate with stereotype dispersion. Table below provides descriptive statistics on stereotype dispersion ratings by immigrant group. We did not observe clear patterns. Spearman's rank correlation coefficient, $\rho(48) = -.051, p = .816$, also showed null relationship between group membership and stereotype dispersion. Moreover, in the main model, we observed the effect conditional on group membership. Accordingly, we rule out this explanation.

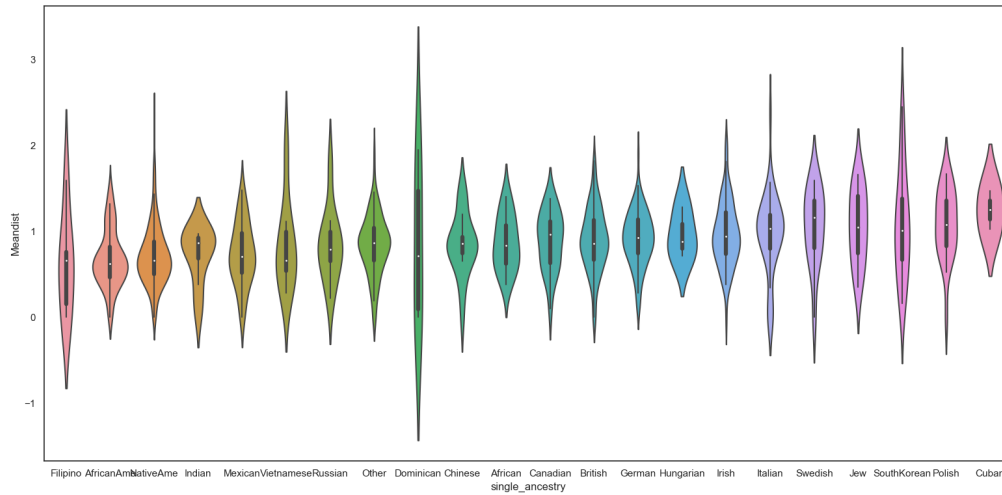
Table.S 5 – Stereotype dispersion by immigrant group.

Ancestry immigrant	Stereotype dispersion	N
Mexican	0.7782 (.393)	71
German	0.9136 (.363)	369
British	0.9093 (.363)	215
Italian	0.9719 (.430)	87
Canadian	0.9150 (.350)	34
Irish	0.9779 (.324)	115
Russian	0.8541 (.391)	14
Filipino	0.8628 (.614)	9
Chinese	0.8588 (.354)	20
Australian	0.8255 (.302)	2
Indian	0.6940 (.323)	9
Hungarian	0.9975 (.218)	5
Cuban	1.1028 (.339)	3
Dominican Republican	0.7831 (.739)	6
Swedish	1.0295 (.422)	16
South Korean	1.0847 (.629)	19
Vietnamese	0.8365 (.520)	8
Polish	1.0338 (.422)	27
African	0.8514 (.309)	17
African American	0.6875 (.338)	144
Native American	0.7211 (.359)	162
Jew	1.0680 (.415)	12
Other	0.8439 (.350)	107

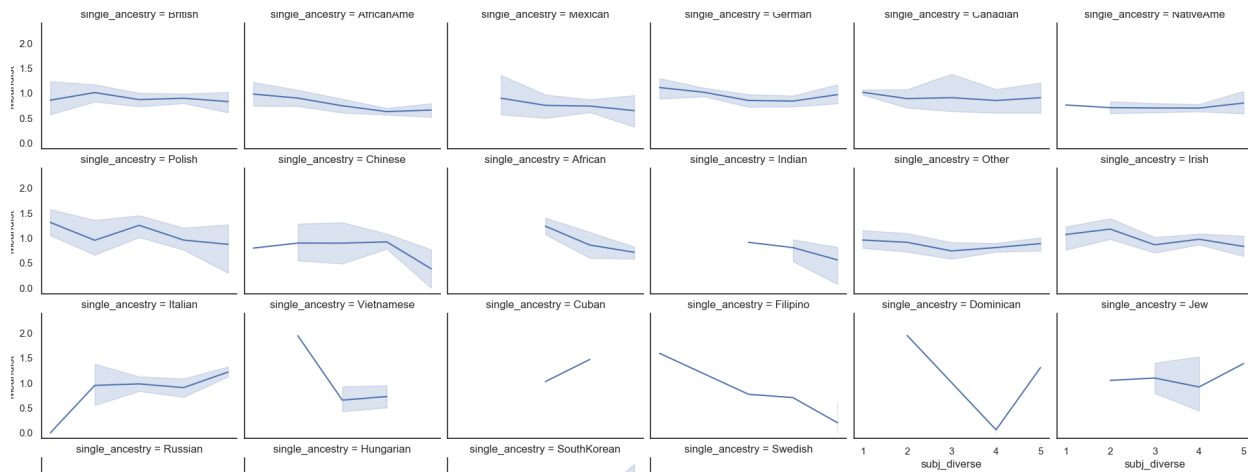
Note. For each participant, we have their self-report immigrant ancestry data. If multiple groups were selected, we used their first selected ancestor as the proxy for their own ethnicity. *N* therefore denotes participants' self-report ethnicity. For stereotype dispersion, we calculated average and standard error within each ethnicity.

Here we provide more visual inspections. Using data from study 2, we plotted stereotype dispersion by immigrant group, and the relationship between perceived diversity and stereotype dispersion by immigrant group.

Fig.S 8 – Majority-minority dynamics: Stereotype dispersion by immigrant group in Study 2



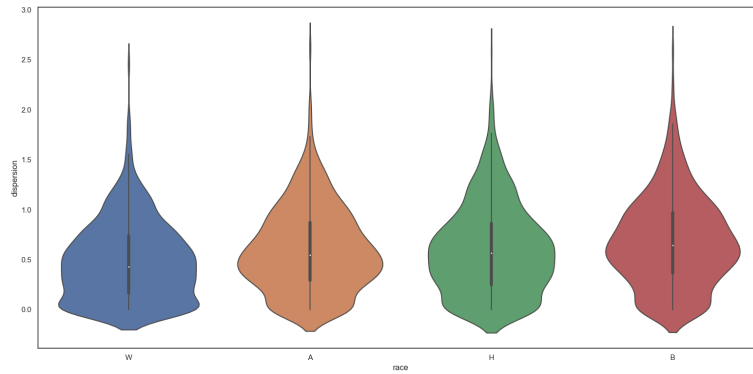
(a) Stereotype dispersion by immigrant group



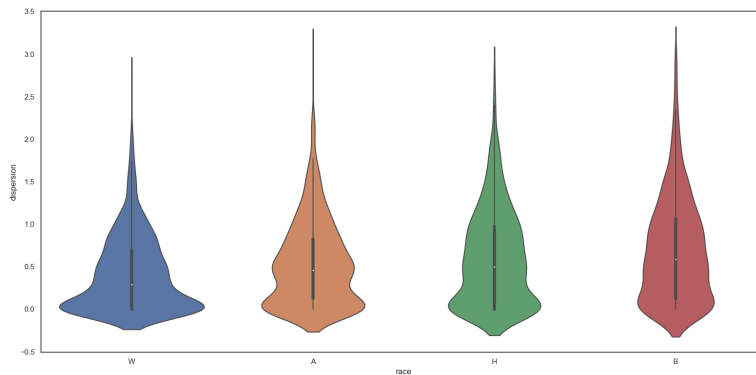
(b) Relation between perceived diversity and stereotype dispersion by immigrant group

Here we provide visual inspections using data from study 3. We plotted stereotype dispersion by race group, and the relationship between perceived diversity and stereotype dispersion by race group.

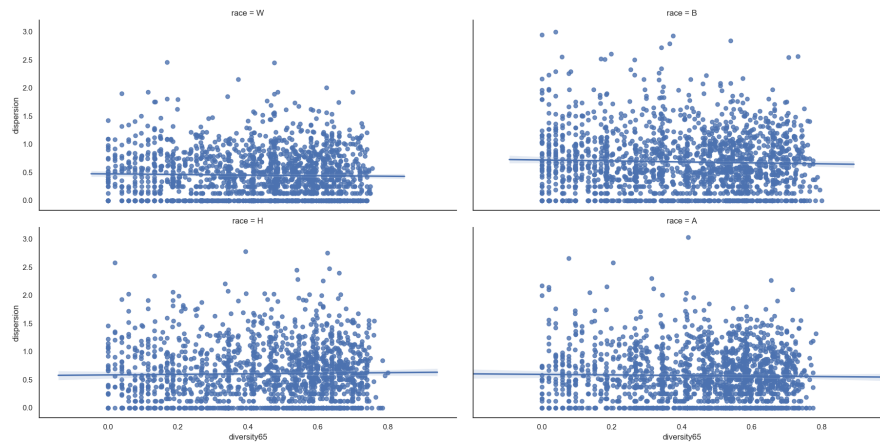
Fig.S 9 – Majority-minority dynamics: Stereotype dispersion by race group in Study 3



(a) Stereotype dispersion by race in high school



(b) Stereotype dispersion by race in college



(c) Relation between perceived diversity and stereotype dispersion by race, high school and college

5. Study 2 multilevel regression and state random effects

Below we show the main model output for Study 2. GDP is denoted in unit 10^7 . We included ancestry variable in the actual model, but for space concern, omit reporting here, see online data for details. Area of living is tested as continuous and discrete variable, results remain unchanged. Continuous variables are centered and discrete variables are factorized.

Therefore, state diversity effect should be interpreted as: for participants living in states with same levels of inequality (.465) and wealth (37305), for one-unit increase in state diversity, we expect to see .282 decrease in stereotype dispersion.

Likewise, individual perceived diversity should be interpreted as: within participants who are the same gender (female), with similar age (34yrs), similar socio-economic backgrounds (some college degree, social ladder 5 out of 9, annual income 30k to 50k), live in the same type of areas (suburbs of a big city or small city), have similar frequency of contact with other groups (3.81 out of 5), and within the same ancestry immigrant groups (out of 20 groups), those who perceived more diversity showed less stereotype dispersion; 1-unit increase in micro-diversity corresponds to .034 to .031 decrease in stereotype dispersion.

On Hawaii. Hawaii appears to be an outlier in terms of levels of diversity. We therefore examined the regression model excluding Hawaii. The state-level fixed effect holds without Hawaii ($b = -.246$, 95% CI [-.470, -.022], $p = .037$), and the individual-level fixed effect also holds without Hawaii ($b = -.031$, 95% CI [-.052, -.010], $p = .004$). Comparing to the whole dataset, the magnitude decreased slightly on state fixed effects, but almost no change on individual effects.

Table.S 6 – Mixed-effects multiple regression

	Model 1: state diversity	Model 2: perceived diversity	Model 3: both
Intercept	.870***(.014)	0.838***(.045)	.839***(.045)
Fixed effects			
Model 1 variables			
state diversity	<i>-.282**(.102)</i>		<i>-.046 (.092)</i>
	<i>-.040**(.014)</i>		<i>-.006 (.012)</i>
state gini	1.612†(.819)		1.329†(.687)
state gdp	<i>-.821*(.393)</i>		<i>-.716*(.285)</i>
Model 2 variables			
perceived diversity		<i>-.034***(.010)</i>	<i>-.031**(.011)</i>
		<i>-.037***(.011)</i>	<i>-.034**(.012)</i>
age		<i>-.000 (.001)</i>	<i>-.000 (.001)</i>
gender		<i>.079***(.020)</i>	<i>.078***(.200)</i>
education		<i>-.010 (.009)</i>	<i>-.010 (.009)</i>
social ladder		<i>-.033***(.007)</i>	<i>-.033***(.007)</i>
income		<i>.025**(.008)</i>	<i>.025**(.008)</i>
years living		<i>-.000 (.000)</i>	<i>-.000 (.000)</i>
living area		<i>.008 (.010)</i>	<i>.006 (.010)</i>
contact frequency		<i>.003 (.010)</i>	<i>.002 (.010)</i>
Random effects			
intercept	.004 (.066)	.002 (.049)	.002 (.042)
residual	.140 (.375)	.131 (.362)	.131 (.362)
Number of observations			
state-level	50	50	50
individual-level	1471	1458	1458

Note. Statistical significance level: † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. Given state and perceived diversity are on different scales, we also standardized these independent variables. Italicized texts in state diversity and perceived diversity are standardized results, for comparison purposes.

Fig.S 10 – Individual perceived diversity predicts individual stereotype dispersion, random effects.

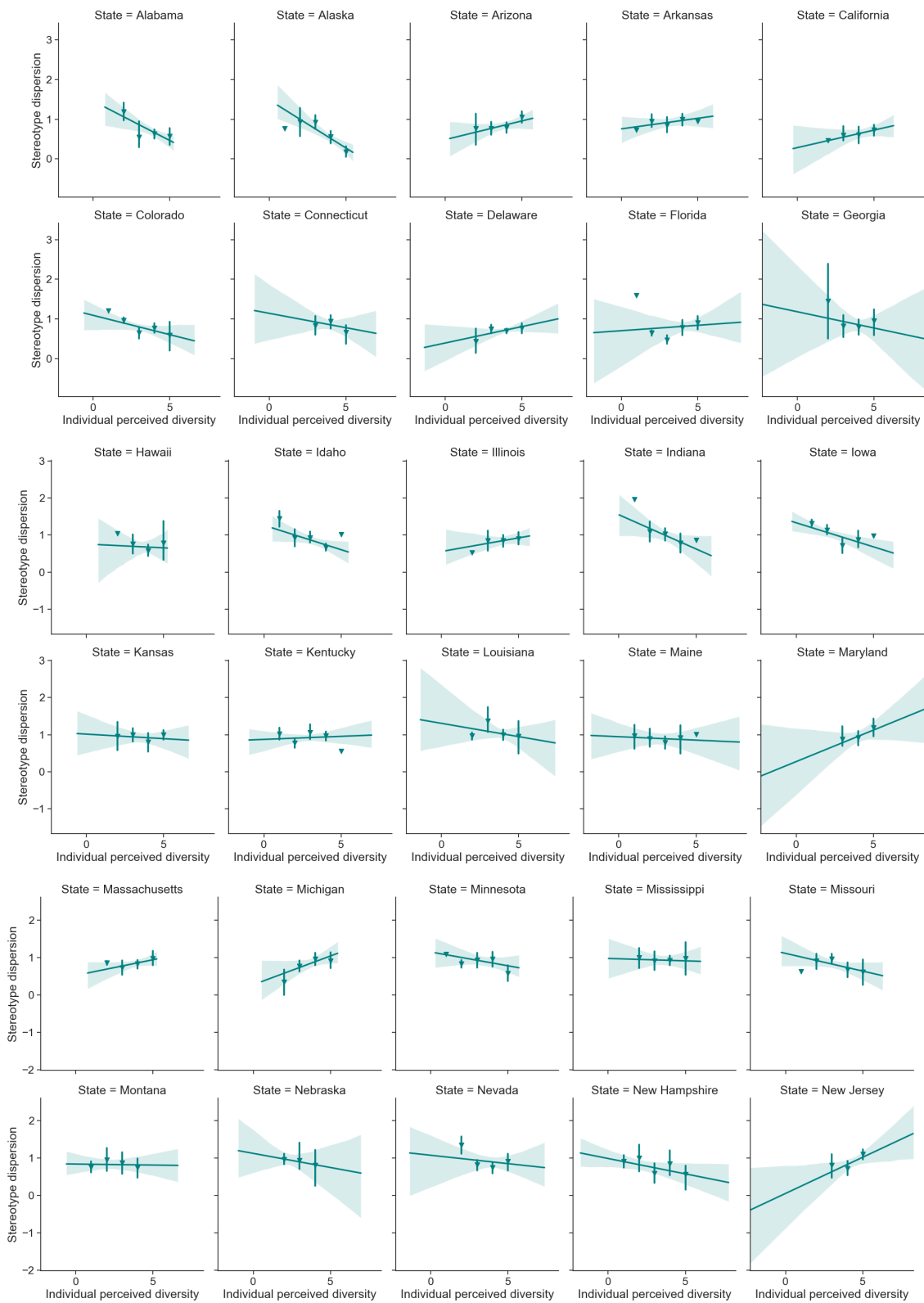
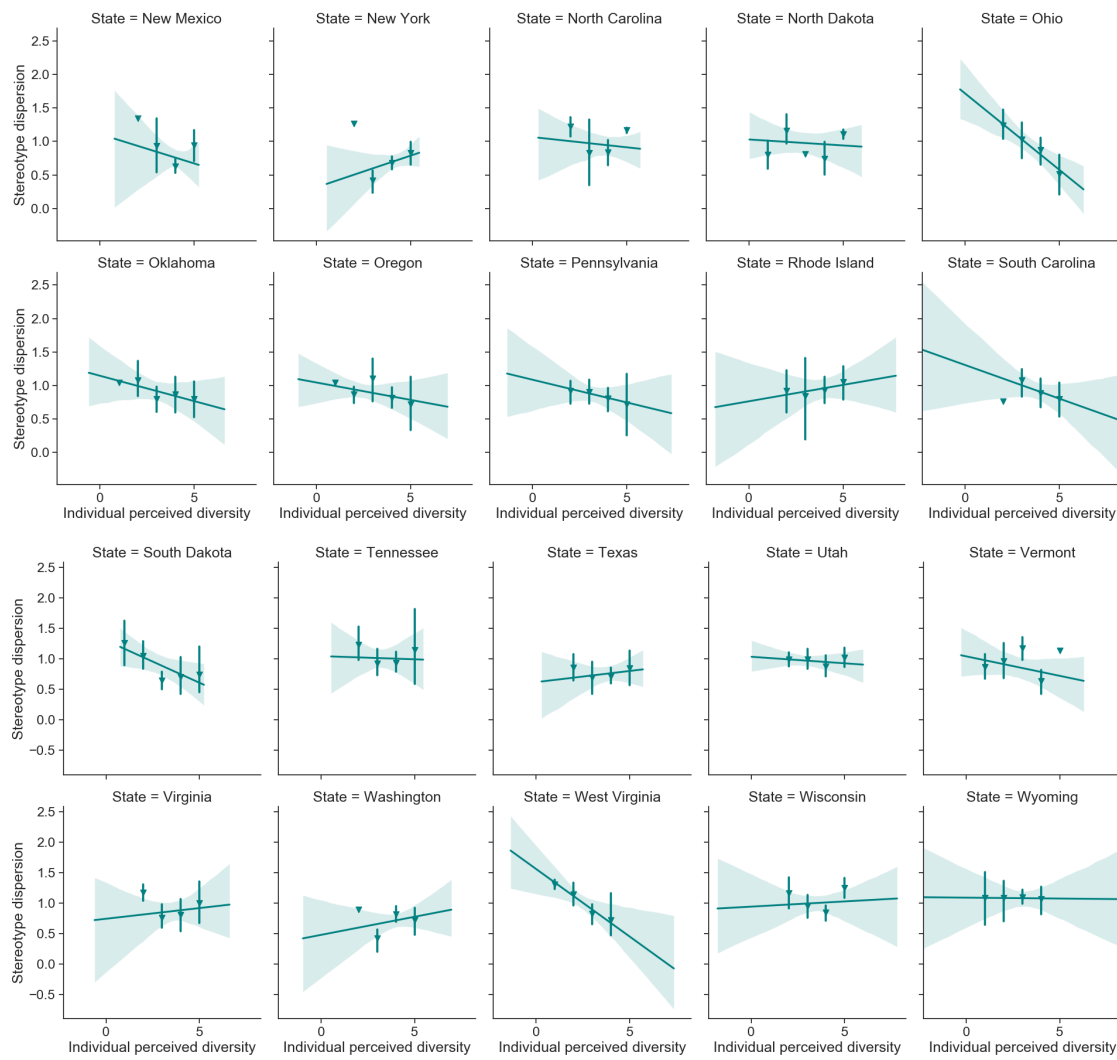


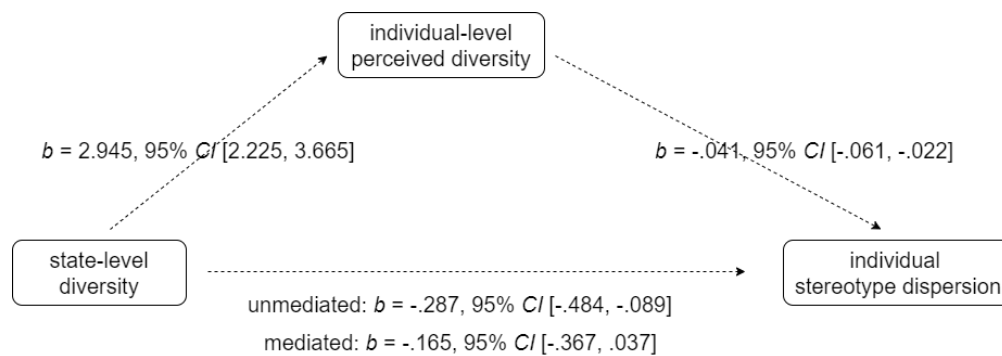
Fig.S 11 – Individual perceived diversity predicts individual stereotype dispersion, random effects contd.



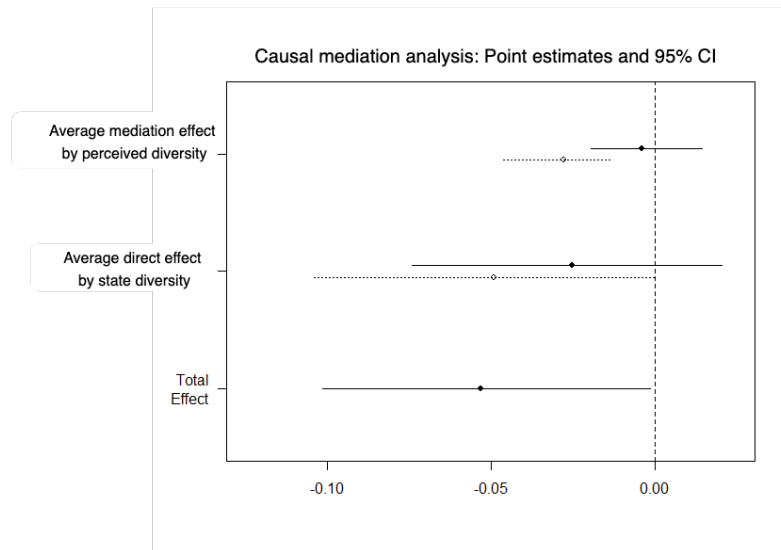
Note. Visualization of perceived diversity effects on individual stereotype dispersion, per state. Interpret with caution, more descriptive than inferential, given unstable estimates from small sample size per state.

6. Study 2 mediation analysis

Mediation SI-1 Mediation effects of perceived diversity between contextual diversity and stereotype dispersion. First, LSEM mediation analysis (Kenny & Baron, 1986) indicates that perceived diversity statistically accounted for the observed tendency for individuals who live in diverse states display less stereotype dispersion. Individuals in diverse states high tendency to report less stereotype dispersion ($b = -.287, 95\%CI[-.484, -.089]$) was reduced ($b = -.164, 95\%CI[-.367, .037]$) after accounting for their perceived diversity. See path figure below.



Mediation SI-2 Next, Causal Mediation Analysis (Imai, 2010) using R mediation package (Tingley, et al., 2017), under sequential ignorability assumption, we found that on average the contextual diversity decreases participants stereotype dispersion by .02 (with a 95% confidence interval of [-.03, -.01]) because of heightened individual-level perceived diversity. Because the total causal effect of contextual diversity was -.05 ([-.10, .00]) and the direct effect was -.04 ([-.09, .01]), we conclude that about 28% of the total effect was mediated through the perceived diversity mechanism.



More on the computation: In this analysis, we examined whether state-level diversity influences individual-level perceived diversity which in turn influences stereotype dispersion.

Specifically, to estimate the average causal mediation effects, we first fitted regression models for the mediator and the outcome. The mediator (individual-level subjective diversity) is modeled as a function of the treatment (state-level macro diversity; dichotomized into 0 or 1 with 0 indicates low diversity group and 1 indicates high diversity group) and any relevant pretreatment covariates (i.e., age, gender, socio-economic status, and living area). The outcome is modeled as a function of the mediator, the treatment, and the pretreatment covariates.

Based on the mediator model, we then generated two sets of predictions for the mediator, one under the treatment (predicted values of perceived diversity in high diversity states) and the other under the control (predicted values of perceived diversity in low diversity states).

Next, the outcome model is used to make potential outcome predictions. For example, suppose we are interested in estimating the average causal mediation effects under the treatment (high diversity states). First, the outcome (stereotype dispersion) is predicted under the treatment using the value of the mediator predicted in the treatment condition (predicted perceived diversity under high diversity states). Second, the outcome is predicted under the treatment condition but now uses the mediator prediction from the control condition (predicted perceived diversity if they were assigned in low diversity states, which is counterfactual).

The average treatment effect is then computed as the average difference between the outcome predictions using the two different values of the mediators. In other words, this would correspond to the average difference in stereotype dispersion from fixing the treatment status but changing the level of perceived diversity between the level predicted after being exposed to high versus low diversity states. Then, we used nonparametric bootstrap with 100 samples to compute statistical uncertainty of the effect.

7. Study 3 derivation of diff-in-diff estimator

$$y_{i,t} = \alpha + \beta_1 T_t + \beta_2 D_{i,t} + \beta_3 (T_t * D_{i,t}) + \gamma X_{i,t} + \varepsilon_{i,t} \quad (1)$$

T_t is binary, 1 if college; 0 if high school.

$D_{i,t}$ is continuous $\in [0,3]$, perceived diversity.

$d_{i,1}$ if in college; $d_{i,0}$ if in high school.

When $T_t = 0, D_{i,0} = d_{i,0}$, the stereotype dispersion of student i when in high school with $d_{i,0}$ perceived diversity, is:

$$y_{i,0} = \alpha + \beta_2 d_{i,0} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (2)$$

When $T_t = 0, D_{i,1} = d_{i,1}$, the stereotype dispersion of student i when in high school with $d_{i,1}$ perceived diversity, is:

$$y_{i,0} = \alpha + \beta_2 d_{i,1} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (3)$$

When $T_t = 1, D_{i,0} = d_{i,0}$, the stereotype dispersion of student i when in college with $d_{i,0}$ perceived diversity, is:

$$y_{i,1} = \alpha + \beta_1 + \beta_2 d_{i,0} + \beta_3 d_{i,0} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (4)$$

When $T_t = 1, D_{i,1} = d_{i,1}$, the stereotype dispersion of student i when in high school with $d_{i,0}$ perceived diversity, is:

$$y_{i,1} = \alpha + \beta_1 + \beta_2 d_{i,1} + \beta_3 d_{i,1} + \gamma X_{i,t} + \varepsilon_{i,t} \quad (5)$$

The difference between Eq (4) and Eq (2) represents time trends, for students who have same levels of perceived diversity ($d_{i,0}$), how likely are the stereotype dispersion have been changed due to the fact that they went to college, which is $\beta_1 + \beta_3 d_{i,0}$.

Likewise, the difference between Eq (5) and Eq (3) represents time trends for students with perceived diversity ($d_{i,1}$), which is $\beta_1 + \beta_3 d_{i,1}$.

To attenuate individual or group baseline difference, by subtracting the above two terms gives us $\beta_3(d_{i,1} - d_{i,0})$. This is the change in stereotype dispersion of student i when he or she has changed perceived diversity from d_0 to d_1 .

The coefficient of β_3 is thus our main quantity of interest, the difference-in-difference estimator.

8. Study 3 robustness check

Table.S 7 – diff-in-diff, robust check with multiple pre-high school diversity (standardized results are italicized)

	high school (1)	high school (2)	3-block at 13 (1)	3-block at 13 (2)	high school at 13 (1)	high school at 13 (2)
Intercept (female, average income, Asian)	.565*** (.021)	.556*** (.025)	.583*** (.017)	.580*** (.020)	.586*** (.020)	.581 (.023)
Fixed effects						
Step 1 variables						
perceived diversity : college	<i>-.155** (.054)</i>	<i>-.116** (.055)</i>	<i>-.111* (.052)</i>	<i>-.045 (.053)</i>	<i>-.110* (.052)</i>	<i>-.062 (.054)</i>
	<i>-.032* (.011)</i>	<i>-.024* (.011)</i>	<i>-.025* (.012)</i>	<i>-.001 (.403)</i>	<i>-.023* (.011)</i>	<i>-.013 (.246)</i>
perceived diversity	.029 (.037)	.012 (.037)	-.020 (.033)	.067* (.034)	-.022 (.034)	-.048 (.035)
college	.035 (.025)	.017 (.025)	.018 (.021)	-.004 (.022)	.015 (.023)	-.007 (.024)
Step 2 variables						
male	.065*** (.014)	.065*** (.014)		-.028** (.011)		.065*** (.014)
income		-.014*** (.004)		-.000 (.001)		-.014*** (.004)
race Black		.094*** (.020)		.093*** (.020)		.094*** (.020)
race Hispanic		.021 (.020)		.020 (.020)		.020 (.020)
race White		-.012*** (.020)		-.124*** (.020)		-.121*** (.020)
Random effects						
high school state intercept	.004 (.061)	.002 (.041)	.004 (.061)	.002 (.042)	.004 (.061)	.002 (.042)
subject intercept	.096 (.310)	.089 (.298)	.096 (.310)	.089 (.298)	.096 (.310)	.089 (.298)
residual	.134 (.367)	.136 (.369)	.135 (.367)	.136 (.369)	.135 (.367)	.136 (.367)
Number of observations						
state-level	49	49	49	49	49	49
subject-level	3735	3586	3730	3581	3732	3583
number of obs	6463	6233	6451	6222	6445	6216

Table.S 8 – diff-in-diff, robust check with multiple pre-high school diversity, cont.

	high school (1)	high school (2)	3-block at 6 (1)	3-block at 6 (2)	first-grade (1)	first-grade (2)
Intercept (female, average income, Asian)	.565*** (.021)	.556*** (.025)	.589*** (.016)	.583*** (.020)	.588*** (.017)	.578*** (.021)
Fixed effects						
Step 1 variables						
perceived diversity : college	-.155** (.054)	-.116** (.055)	-.062† (.054)	-.026 (.053)	-.102* (.052)	-.060 (.052)
perceived diversity	-.032* (.011)	-.024* (.011)	-.013† (.246)	-.006 (.620)	-.023* (.011)	-.013 (.253)
college	.029 (.037)	.012 (.037)	-.041 (.033)	-.084* (.034)	-.030 (.033)	-.050 (.033)
Step 2 variables						
male	.035 (.025)	.017 (.025)	.012 (.021)	-.008 (.021)	.014 (.022)	-.003 (.022)
income	.065*** (.014)	.065*** (.014)	.066** (.014)	.066** (.014)	.066*** (.014)	.066*** (.014)
race Black	-.014*** (.004)	-.014*** (.004)	-.014*** (.004)	-.014*** (.004)	-.014*** (.004)	-.014*** (.004)
race Hispanic	.094*** (.020)	.094*** (.020)	.095*** (.020)	.095*** (.020)	.094*** (.020)	.094*** (.020)
race White	.021 (.020)	.021 (.020)	.021 (.020)	.021 (.020)	.021 (.020)	.021 (.020)
Random effects						
high school state intercept	-.012*** (.020)	-.012*** (.020)	-.123*** (.020)	-.123*** (.020)	-.121*** (.020)	-.121*** (.020)
subject intercept	.004 (.061)	.002 (.041)	.003 (.059)	.002 (.040)	.004 (.060)	.002 (.041)
residual	.096 (.310)	.089 (.298)	.097 (.311)	.089 (.299)	.097 (.311)	.090 (.300)
Number of observations	.134 (.367)	.136 (.369)	.135 (.367)	.136 (.369)	.134 (.366)	.135 (.368)
state-level	49	49	49	49	49	49
subject-level	3735	3586	3721	3574	3724	3575
number of obs	6463	6233	6432	6204	6412	6183

Table.S 9 – diff-in-diff estimations with inverse probability weighted and unweighted data.

	unweighted		weighted	
Intercept (female, average income, Asian)	.565*** (.021)	.556*** (.025)	.570*** (.020)	.413*** (.038)
Fixed effects				
Step 1 variables				
perceived diversity : college	-.155** (.054)	-.116* (.052)	-.136** (.047)	-.094* (.048)
perceived diversity	.029 (.037)	.012 (.037)	.023 (.034)	.007 (.034)
college	.035 (.025)	.017 (.025)	.030 (.022)	.009 (.022)
Step 2 variables				
male		.065*** (.014)		.067*** (.013)
income		-.014*** (.004)		-.012*** (.003)
race Black		.094*** (.020)		.106*** (.017)
race Hispanic		.021 (.020)		.027 (.018)
race White		-.012*** (.020)		-.116*** (.017)
Random effects				
high school intercept	.004 (.061)	.002 (.041)	.079 (.282)	.073 (.270)
subject intercept	.096 (.310)	.089 (.298)	.003 (.056)	.001 (.036)
residual	.134 (.367)	.136 (.369)	.125 (.354)	.127 (.356)
Number of observations				
state-level	49	49	49	49
subject-level	3735	3586	3773	3618
number of obs	6463	6233	7546	7236

Note. Regression analyses with inverse probability weighting. We assume missing values are missing at random conditional on observed covariates: gender and race. Both weighted and unweighted analyses are present in the table, giving same conclusions.

Table.S 10 – robustness check: placebo outcomes

	stereotype dispersion	bright future	life as failure	enjoy life
Intercept	.565*** (.021)	.030 (.040)	1.448*** (.028)	4.286*** (.032)
Fixed effects				
perceived diversity : college	-.155** (.054)	.014 (.128)	-.062 (.087)	.228* (.099)
perceived diversity	.029 (.037)	-.036 (.079)	.126* (.054)	-.201** (.062)
college	.035 (.025)	-.011 (.060)	-.228*** (.040)	-.275*** (.046)
Random effects				
high school state intercept	.004 (.061)	.002 (.041)	.002 (.609)	.002 (.048)
subject intercept	.096 (.310)	.131 (.362)	.088 (.297)	.168 (.410)
residual	.134 (.367)	.853 (.924)	.371 (.609)	.463 (.680)
Number of observations				
state-level	49	49	49	49
subject-level	3735	3772	3772	3770
number of obs	6463	6071	6071	6068

Note. In wave 1, on a scale from 1 (strongly agree) to 4 (disagree). In wave 5, on a scale from 0 (never) to 4 (all the time). All responses rescaled.

- Wave 1: You feel your future is limited. Wave 5: You felt hopeful about the future.
- Wave 1: All in all, I am inclined to feel that I am a failure. Wave 5: You thought your life had been a failure.
- Wave 1: On the whole, I am satisfied with myself. Wave 5: You enjoyed life.

We explored how stereotype dispersion, the mental maps on participants' heads relate to general attitudes in this section. Longitudinal survey in wave 5 asked 18 general attitudes. We report statistics below. The items, on a scale from 0 (totally disagree) to 10 (totally agree), include:

- If I had to do all over again, I would choose to attend (name of most recent college attended).
- My college experience has made me a better person.
- My college experience has made me more tolerant of other racial and ethnic groups.
- My college experience has improved my relationships with other racial and ethnic groups.
- I am very satisfied with the friends and acquaintances I made at college.
- My college experiences have prepared me for the future.
- College has given me a sense of mastery of the subjects I studied.
- College has better prepared me to deal with the real world.
- I am satisfied with the courses I took at college.
- I am satisfied with the professors I had at college.
- I am satisfied with the quality of instruction I received at college.
- I would recommend (name of most recent college attended) to a friend or relative as a place to attend college.
- I am likely to contribute to (name of most recent college attended)'s future fund raising efforts.
- How much interaction have you had over the past four years with members of the following group: whites? blacks? hispanics? asians? 0 (no interaction) to 10 (great deal of interaction).
- How do you see (name of most recent college attended)'s commitment to racial and ethnic diversity on campus? is diversity emphasized: 1 (way too little) to 3 (just enough) to 5 (way too much).

Table.S 11 – Relations between stereotype dispersion, at college senior years, and other general attitudes

	attend college	better person	tolerant other race	improve relations other race	happy with college friends
Intercept (female, average income, Asian)	7.976*** (.142)	8.815*** (.099)	7.601*** (.147)	7.254*** (.155)	8.434*** (.102)
Fixed effects					
stereotype dispersion	-.360** (.100)	-.207** (.073)	-.196† (.103)	-.206* (.101)	-.226** (.077)
male	-.005 (.110)	-.110 (.080)	-.434*** (.113)	-.272* (.110)	-.215* (.084)
income	.027 (.029)	.009 (.021)	-.072* (.030)	-.095** (.029)	.009 (.022)
race Black	-.022 (.152)	-.149 (.110)	-.275 . (.157)	-.183 (.153)	-.056 (.117)
race Hispanic	.378* (.156)	.034 (.114)	-.095 (.162)	.037 (.158)	.093 (.120)
race White	.485** (.148)	.107 (.108)	.148 (.153)	.128 (.149)	.204† (.084)
Random effects					
high school state intercept	.091 (.302)	.024 (.156)	.097 (.312)	.204 (.451)	.014 (.120)
residual	6.139 (2.478)	3.255 (1.804)	6.542 (2.558)	6.101 (2.488)	3.667 (1.915)
Number of observations					
state-level	49	49	49	49	49
number of obs	2202	2202	2200	2202	2202

Table.S 12 – Relations between stereotype dispersion, at college senior years, and other general attitudes cont.

	prepared for future	mastery of subjects	deal real world	satisfied with courses	satisfied with professors
Intercept (female, average income, Asian)	7.757*** (.101)	7.203*** (.102)	6.873*** (.118)	7.192*** (.097)	7.250*** (.101)
Fixed effects					
stereotype dispersion	-.190* (.076)	-.338*** (.078)	-.067 (.083)	-.259*** (.074)	-.402*** (.071)
male	-.108 (.083)	-.348*** (.085)	.082 (.091)	-.249** (.081)	-.270*** (.078)
income	-.011 (.022)	.022 (.022)	-.008 (.024)	-.010 (.021)	-.007 (.020)
race Black	.377** (.115)	.166 (.118)	.215† (.126)	.274* (.112)	-.038 (.108)
race Hispanic	.432*** (.119)	.462 (.122)	.292* (.129)	.578*** (.115)	.418*** (.111)
race White	.274* (.113)	.355 (.115)	.295* (.122)	.619*** (.109)	.474*** (.105)
Random effects					
high school state intercept	.017 (.130)	.013 (.113)	.067 (.258)	.012 (.110)	.043 (.207)
residual	3.562 (1.888)	3.753 (1.937)	4.194 (2.048)	3.338 (1.827)	3.115 (1.765)
Number of observations					
state-level	49	49	49	49	49
number of obs	2201	2202	2201	2202	2201

Table.S 13 – Relations between stereotype dispersion, at college senior years, and other general attitudes cont.

	satisfied with college quality	recommend college to friends	contribute fund raise	interact with Whites
Intercept (female, average income, Asian)	7.347*** (.090)	8.070*** (.130)	6.120*** (.172)	8.578*** (.095)
Fixed effects				
stereotype dispersion	-.360*** (.070)	-.328*** (.090)	-.321** (.120)	-.316*** (.062)
male	-.289*** (.077)	-.013 (.098)	-.209 (.121)	-.144* (.067)
income	.007 (.020)	.032 (.026)	.057† (.034)	.074*** (.018)
race Black	.238* (.107)	-.354*** (.136)	-.311† (.182)	-.070 (.097)
race Hispanic	.481*** (.110)	.318* (.140)	.038 (.187)	.567*** (.097)
race White	.508*** (.105)	.402** (.133)	.088 (.177)	1.086*** (.092)
Random effects				
high school state intercept	.003 (.052)	.087 (.295)	.151 (.388)	.073 (.270)
residual	3.082 (1.756)	4.942 (2.223)	8.763 (2.960)	2.972 (1.724)
Number of observations				
state-level	49	49	49	49
number of obs	2202	2201	2199	2776

Table.S 14 – Relations between stereotype dispersion, at college senior years, and other general attitudes cont.

	interact with Blacks	interact with Hispanics	interact with Asians	college commitment to diversity
Intercept (female, average income, Asian)	5.937*** (.117)	4.972*** (.129)	7.847*** (.137)	.413*** (.038)
Fixed effects				
stereotype dispersion	-.194* (.079)	-.467*** (.087)	-.569*** (.087)	.036*** (.011)
male	-.618*** (.087)	-.364*** (.096)	-.009 (.095)	.075*** (.021)
income	-.054* (.023)	-.061* (.025)	-.015 (.025)	-.019*** (.005)
race Black	2.842*** (.121)	1.141*** (.133)	-2.106*** (.133)	.160*** (.029)
race Hispanic	.505*** (.125)	2.080*** (.137)	-1.864*** (.137)	.060* (.030)
race White	.058 (.119)	-.024 (.131)	-1.289*** (.131)	-.132*** (.021)
Random effects				
high school state intercept	.082 (.286)	.098 (.314)	.166 (.408)	.001 (.038)
residual		5.990 (2.448)	5.976 (2.445)	.284 (.533)
Number of observations				
state-level	49	49	49	49
number of obs	2276	2776	2276	2769

9. Stereotype dispersion and well-being

Table.S 15 – Stereotype dispersion and well-being in Study 2

		Life satisfaction		
Intercept		3.616***(.030)	3.616***(.031)	3.616***(.030)
Fixed effects				
stereotype dispersion		-.147*(.069)		
perceived diversity			.110***(.025)	
state diversity				.188 (.217)
Random effects				
state intercept		.010 (.100)	.013 (.114)	.012 (.108)
residual		1.016 (1.008)	1.003 (1.002)	1.017 (1.009)
Number of observations				
state-level	50		50	50
individual-level	1471		1471	1471

Note. See variables and interpretations in the main text. Statistical significance level: † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

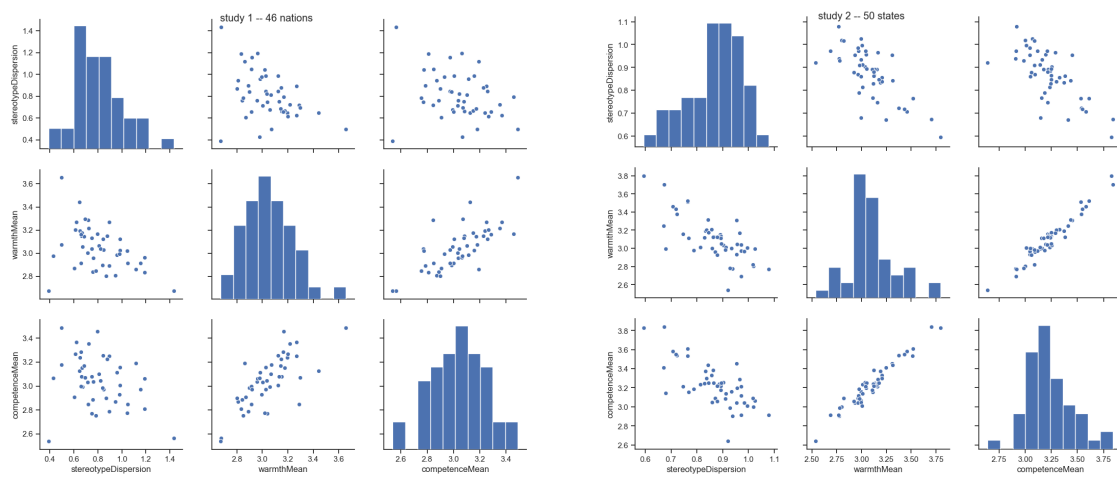
Table.S 16 – Stereotype dispersion and well-being in Study 3

	Life satisfaction				
Intercept	4.174***(.020)	4.161***(.027)	4.197***(.017)	4.227***(.024)	4.285***(.032)
Fixed effects					
stereotype dispersion	-.065**(.022)			-.051†(.030)	
perceived diversity		-.060 (.051)			-.201**(.062)
college			-.170***(.018)	-.147***(.030)	-.275***(.046)
stereotype dispersion : college				-.039 (.040)	
perceived diversity : college					.228*(.100)
Random effects					
state intercept	.003 (.052)	.002 (.049)	.002 (.049)	.003 (.052)	.002 (.048)
individual intercept	.159 (.399)	.159 (.399)	.171 (.413)	.168 (.410)	.168 (.410)
residual	.474 (.689)	.479 (.692)	.458 (.677)	.459 (.678)	.463 (.680)
Number of observations					
state-level	49	49	49	49	49
individual-level	3719	3770	3770	3719	3770
number of obs	5949	6068	6141	5949	6068

10. Stereotype dispersion and positivity

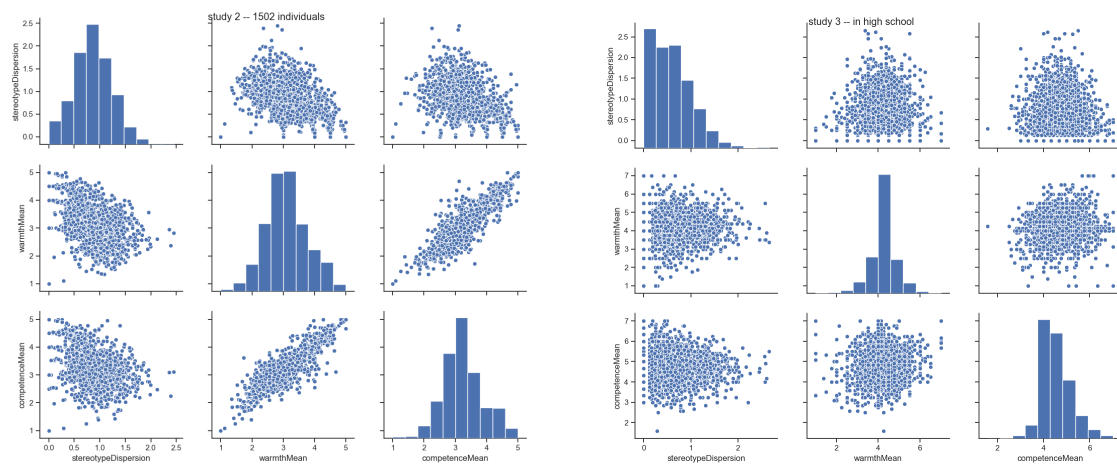
Here, we provide visual inspections on the positivity effect. In country level, state level, and individual data, we found that less dispersed stereotype content maps tend to co-exist with more positive evaluations than neutral or negative evaluations. However, we did not observe the same pattern in longitudinal dataset. Accompanying Fig S.2-3, Fig S.5-6, please see figures (Fig S.12) below on pairwise comparisons between stereotype dispersion and ratings on warmth and competence. See statistics in the main text.

Fig.S 12 – Scatterplot matrix on positivity and stereotype dispersion.



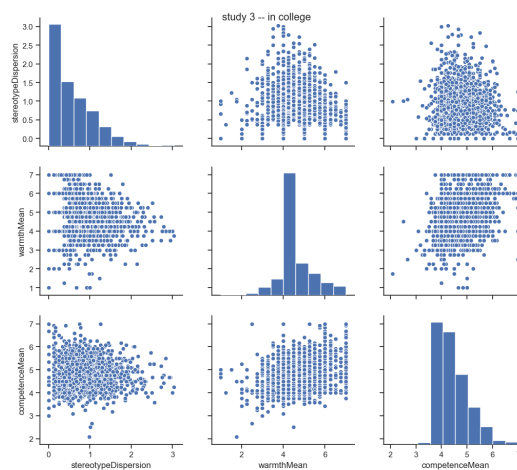
(a) positivity and dispersion in 46 nations

(b) positivity and dispersion in 50 states



(c) positivity and dispersion in 1502 online Americans

(d) positivity and dispersion in 3924 high school students



(e) positivity and dispersion in 3924 college students

11. Ingroup favoritism

We explore ingroup favoritism in this section. In studies 1 and 2, participants did not rate their ingroups over time, but in study 3, participants rated their ingroups at two time points. Therefore, we are able to explore whether greater diversity led to reduced ingroup favoritism. As diversity increase, do people become sober in their perceptions on ingroups?

Using data from Study 3, we analyzed whether [White/ Asian/Black/Hispanic] students favored their respective ingroup on either the warmth or competence dimension, if they perceive more ethnic diversity. Using multilevel modeling with error clustered at time period(pre/post), we found mixed effects, mostly statistically non-significant, except for Black students' ratings on ingroup's competence. Black students who perceive more campus diversity decreased ingroup favoritism (lower ratings) on the competence dimension.

- Whites: for each unit increase in perceived diversity, there is .181 unit decrease in perceived warmth ($b = -.181, 95\%CI[-.383, .022], P = .079$), and .027 unit increase in perceived competence ($b = .027, 95\%CI[-.183, .126], P = .734$) toward their ingroup.
- Asians: for each unit increase in perceived diversity, there is .124 increase in perceived warmth ($b = .124, 95\%CI[-.105, .348], P = .285$) and .138 unit increase in perceived competence ($b = .138, 95\%CI[-.073, .351], P = .200$) toward ingroup.
- Blacks: for each unit increase in perceived diversity, there is .134 increase in perceived warmth ($b = .134, 95\%CI[-.083, .364], P = .239$) and .227 unit decrease in perceived competence ($b = -.227, 95\%CI[-.420, -.038], P = .020$) toward ingroup.
- Hispanics: for each unit increase in perceived diversity, there is .060 increase in perceived warmth ($b = .060, 95\%CI[-.177, .295], P = .617$) and .044 unit increase in perceived competence ($b = .044, 95\%CI[-.145, .234], P = .651$) toward ingroup.

The above exploration makes us wonder, whether people are more likely to change perceptions about outgroups, but not ingroups. Ingroups already entail higher exposure, so the perceptions may be less malleable. In contrast, outgroup members receive higher exposure during diversity, therefore increasing the opportunity for perception changes. In a relative sense, increased outgroup perceptions indeed may decrease ingroup perceptions, as the reviewer suggests. Our data did not support this hypothesis, so it is an empirical question for future work.

12. Diversity perception accuracy

We explore perceived diversity in this section. In Study 2, we asked participants' perceived diversity. We also have an objective diversity, i.e., Herfindhal score in each state. We explored mismatches between the measures, and found some interesting patterns.

First of all, we found a moderate to small correlation between objective diversity and perceived diversity, $r(1497) = .373, p < .001$, indicating participants were moderately accurate in estimating diversity. Although we found participants to do a worse job in estimating perceived inequality, $r(1497) = .146, p < .001$.

Next, to create an accuracy measure, we first transformed the continuous state level Herfindhal index into 5-point likert scale, with the least diverse 10 states recoded into 1, to the most diverse 10 states recoded into 5. The two diversity measures are comparable, and the level of accuracy can be measured by the distance between perceived diversity and rescaled Herfindhal. On average, participants overestimate diversity ($M = .314, SD = 1.524$).

We wonder what shapes perceptions of diversity. Prior research suggests immediate environments, media coverage, or individual beliefs in authoritarianism (Van Assche, et al., 2019). Among our measures, we found subjective social ladder and immediate living contexts to be important.

- Participants higher on self-report social ladder tend to overestimate diversity (1 bottom to 9 top: $b = .068, 95\%CI[.0382, .0978], p < .001$).
- Participants who live in bigger cities tend to overestimate diversity (1 big city to 5 village: $b = -.171, 95\%CI[-.220, -.121], p < .001$).
- No relation with age, gender, immigrant group, years of living, education, or objective income.