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Heterogeneity of Long-History Migration Predicts Smiling, Laughter and Positive Emotion  
Across the Globe and Within the United States

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## 36 **Abstract**

37 Recent findings demonstrate that heterogeneity of long-history migration predicts present-day  
38 emotion behaviors and norms. Residents of countries characterized by high ancestral diversity  
39 display emotion expressions that are easier to decode by observers, endorse norms of higher  
40 emotion expressivity, and smile more in response to certain stimuli than residents of countries  
41 that lack ancestral diversity. We build on the extant findings and investigate historical  
42 heterogeneity as a predictor of daily smiling, laughter, and positive emotion across the world's  
43 countries and the states of the United States. Study 1 finds that historical heterogeneity is  
44 positively associated with self-reports of smiling, laughter, and positive emotions in the Gallup  
45 World Poll when controlling for GDP and current present-day population diversity. Study 2  
46 extends the findings to effects of long-history migration within the United States. We estimated  
47 the average percentage of foreign-born citizens in each state between 1850 and 2010 based on  
48 US Census information as an indicator of historical heterogeneity. Consistent with the world  
49 findings of Study 1, historical heterogeneity predicted smiling, laughter, and positive, but not  
50 negative, emotion. The relationships remained significant when controlling for per capita income  
51 and present-day diversity of population of each state. Together, the findings further demonstrate  
52 the important role of long-history migration in shaping emotion cultures of countries and states,  
53 which persist beyond the original socio-ecological conditions, and open promising avenues for  
54 cross-cultural research.

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## 59 **Introduction**

60 A trip to Indonesia or Nicaragua, an evening watching the Olympics on television, or a  
61 stroll through an American urban center each provides substantial evidence of great diversity in  
62 cultural practices across human societies. But just what are the origins of the cultural  
63 differences?

64 Recent accounts of culture, inspired by theories of biological evolution, propose one  
65 answer: Part of the global variations in human behavior and traits can be understood as selective  
66 adaptations to pressures posed by local social and ecological conditions (1,2). For example,  
67 evidence suggests that adjustment to the prevalence of pathogens in the immediate environment  
68 includes a reliance on authoritarian governing structures, the establishment of tight social norms  
69 especially about social interaction and sexuality, and individual-level traits of low extraversion  
70 and low openness to experience (3–5). These adaptations are part of the behavioral immune  
71 system (6) and become embodied as cultural practices and institutions serving to minimize  
72 exposure to diseases that are transmitted through inter-group contact.

73 The long-term demographic history of a population represents another socioecological  
74 condition to which systematic adaptations can be expected (7). Previous research links  
75 heterogeneity of long-term migration – a context associated with historical pressures to  
76 communicate in the absence of common language and social norms – with present-day emotion  
77 expressivity (8,9), the personality trait of openness to experience (10), and with the frequency of  
78 smiling in response to amusing or interesting stimuli (11). In the present work we build on these  
79 previous findings and use data from several global and national (within-U.S.) polling studies on  
80 emotional expressions and experiences to investigate how long-history migration patterns  
81 determine global and regional emotion cultures.

## 82 **Heterogeneity of Long History Migration**

83           Beginning with migration out of Africa and bolstered by innovations that supported the  
84 rise of colonialization roughly 500 years ago, humans have dispersed across the globe in waves  
85 of often massive proportions (12). Some regions (e.g., present-day Argentina and New Zealand)  
86 received migrants from many, and others (e.g., Finland and South Korea) from far fewer,  
87 different cultural groups that were largely unknown to each other. Arguably, the pressures posed  
88 by the socio-ecological environment of cultural heterogeneity differ from those confronted in  
89 more homogeneous environments. In particular, survival in heterogenous societies relied on the  
90 exchange of unfamiliar concepts and practices, the formation and re-formation of social groups  
91 and hierarchies, and the creation of new institutions. According to a recent theory (7), the  
92 absence of norms for and shared language about abstract concepts such as emotion and  
93 motivation would have favored the reliance on nonverbal behavior in the service of social  
94 coordination.

95           Recent research provides evidence supporting the idea that heterogeneity of long history  
96 migration explains cross-cultural variations in emotion expression and experience. Wood and  
97 colleagues, for instance, investigated the relationship between historical heterogeneity and the  
98 transparency of people's emotional expressions (9). The researchers re-analyzed existing  
99 findings from published studies that measured the accuracy of recognition of facial and vocal  
100 expressions of emotion across cultures (13). In each of the studies, spanning 92 articles  
101 involving participants from 79 cultures and expressions of representatives of 32 cultures,  
102 individuals from one culture were exposed to expressions of emotion of individuals from another  
103 culture. They then classified the expressions using a limited set of labels such as "joy" and  
104 "anger."

105 Results revealed that the heterogeneity of the country of the expresser (but not the  
106 perceiver) was related to emotion recognition accuracy, such that expressers from historically  
107 heterogeneous cultures made displays that were easier to recognize across cultures. This finding  
108 supports the idea that a boost in the signal value of emotion in the face and the voice may  
109 constitute an adaptation to the pressure of interacting with individuals with whom one shares few  
110 expectations and no nuanced emotion language. In other words, living with people from diverse  
111 cultural backgrounds over time appears to be associated with the use of facial and vocal  
112 expressions that are relatively unambiguous and easily decoded by unfamiliar others.

113 Rychlowska and colleagues investigated the related prediction that, in contrast to  
114 members of homogeneous cultures, those in heterogeneous cultures would benefit from the  
115 cultural evolution of display rules that favor the spontaneous expression (versus dissimulation) of  
116 emotion (8). This reasoning follows from consideration of the social advantages of expressing  
117 one's emotions (14), such as the establishment of trust through a transparency of communication  
118 and a facilitated understanding about the creation and achievement of goals. However,  
119 expressiveness is also costly and even risky, as it may disrupt social norms and existing  
120 hierarchies. Thus, display rules that favor emotional expressiveness make most sense in social  
121 contexts in which normative behavioral and emotional responses are not shared compared to the  
122 contexts in which expectations and cultural rules for emotion are widely shared (15).

123 To test this prediction, the authors reanalyzed an existing set of cross-cultural data about  
124 expressive display rules display rules governing the expression of anger, contempt, disgust, fear,  
125 happiness, sadness, and surprise across 32 countries (Matsumoto, Yoo, & Fontaine, 2008).  
126 Robust to the inclusion of other features of culture such as individualism and residential mobility  
127 in the statistical models, the findings revealed that display rules in heterogeneous cultures favor

128 higher emotion expressivity than in homogeneous cultures (8).

129         Historical heterogeneity may also predict the expression of specific emotions. In  
130 particular, the smile should be more frequent in societies that have experienced heterogeneity of  
131 long-history migration, in order to signal lack of threat and establish trust in the service of  
132 successful cooperation (17–19). Initial evidence supporting this reasoning comes from a recent  
133 study in which 866,726 participants from 31 countries were filmed when watching video  
134 advertisements (11). The analysis of the recordings revealed that the proportion of video frames  
135 during which participants smiled was best predicted by historical heterogeneity. In other words,  
136 individuals from heterogeneous cultures spent significantly more time smiling than did those  
137 from homogeneous cultures. The effect was robust to the inclusion of other aspects of culture,  
138 such as urbanization, gross-domestic products, individualism (Hofstede, 2001), and ethnic  
139 fractionalization (Alesina et al., 2003).

## 140 **Overview of the Present Research**

141         While the results of Girard and McDuff (2017) are consistent with the hypothesis that, in  
142 heterogeneous societies, certain types of smiles have been useful over cultural evolution in  
143 solving the social task of reinforcing behavior and inviting social interaction (8), they are not  
144 without limitations. Specifically, the study only examined smiles occurring in reaction to one  
145 type of stimuli (video advertisements) in a relatively restricted context of market research  
146 facilities. Thus, the findings may be due to the possibility that participants from homogeneous  
147 countries found the stimuli less entertaining or humorous than participants from heterogeneous  
148 countries. One purpose of the present research was to examine frequency of smiling in general.  
149 The Gallup World Poll and Gallup US Daily Tracking, which sampled individuals from a total of  
150 150 nations and from 51 United States (including the District of Columbia), contained the

151 question “Did you smile or laugh a lot yesterday?” While the item is memory-based, it allows for  
152 the possibility that smiling and laughter were elicited by any stimulus rather than only  
153 advertisements, especially that these behaviors are most common in social rather than solitary  
154 settings. We therefore analyzed this measure of smiling and laughter as a function of historical  
155 heterogeneity.

156 A second aim of the present research was to explore the implications of more frequent  
157 smiling and laughter, certain types of which are associated with positive emotions (20,21). Thus,  
158 frequent smiles and laughter could be an indication that members of heterogeneous cultures also  
159 experience more positive emotions than members of homogeneous cultures. To address this  
160 question, we examined the relationships between historical heterogeneity and measures of  
161 positive and negative emotions from several large-scale global and national surveys. Positive and  
162 negative emotional experiences are not strictly negatively correlated and have distinct  
163 relationships to features of culture and well-being (22). We examined negative emotions in order  
164 to be able to provide limiting conditions for the predictive value of historical heterogeneity.

165 Finally, the boundaries of existing nations do not inherently constitute the level at which  
166 the heterogeneity of cultures is defined. Regions within nations can vary in the extent to which  
167 they experienced extensive long history migration, a nuance that is lost in between-country  
168 analyses. Countries that are composed of provinces (Canada, Chile) or states (the United States)  
169 present opportunities to look at within-nation effects of heterogeneity on regional culture, since  
170 these nations maintain census data at the province/state level. In the present research we related  
171 the heterogeneity of the states of the United States to reports of smiles/laughter and positive  
172 experiences. Evidence that relationships hold at the level of the state would provide additional

173 support for the significance of long term diversity of ancestry in establishing cultures of emotion  
174 (Nettle, 2009).

## 175 **Study 1**

176 In Study 1, we built on the findings of Girard and McDuff (2017) and tested the  
177 hypothesis that country-level historical heterogeneity predicts smiling and laughter as well as  
178 positive and negative emotions. We used the number of source countries that contributed to the  
179 current population of a given country between 1500 and 2000 (Putterman & Weil, 2010) as an  
180 index of historical heterogeneity. The variable was then used as a predictor of smiling and  
181 laughter, four different measures of positive emotions, and five measures of negative emotions.  
182 We also included two control variables: gross domestic product (GDP) per capita and present-  
183 day migration diversity indexed by the number of countries contributing to the population of a  
184 given country in the year 2015. In the studies examining historical heterogeneity cited above  
185 (Rychlowska et al., 2015; Girard & McDuff, 2017; Shrira et al., 2018), this variable has been  
186 found to be a robust predictor of display rules for emotional expression, smiling, and also trait  
187 openness to experience when controlling for other aspects of culture (e.g., individualism) and  
188 economic conditions (e.g., GDP). In the present research we chose to control for GDP because of  
189 the complex relationship between economic viability and positive emotions (23). Measures of  
190 present-day diversity were included as controls in order to support conclusions about long-term  
191 versus more immediate effects of socioecological context on human behavior.

## 192 **Measures**

193 **Historical heterogeneity.** Long-history heterogeneity vs. homogeneity of migration  
194 was operationalized by the number of countries in which the ancestors of a given country's



195 modern inhabitants lived in A.D. 1500. The index is derived from the World Migration Matrix  
196 (24), whose entries represent the fraction of a country's ancestry in 1500 attributable to different  
197 source countries. The World Migration Matrix has been used in previous studies (9–11). The  
198 scores vary between 1 and 83 and are available for 172 countries. This variable will be called  
199 Heterogeneity and it is illustrated in Fig 1.

200

201 **Fig 1. The number of source countries to the countries of the world since A.D. 1500.** Darker  
202 colors indicate greater number of source countries. From Putterman and Weil (2010) World  
203 Migration Matrix.

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205

206 **Smiling and laughter.** Measures of smiling and laughter were derived from the  
207 World Poll – a large international survey conducted by the Gallup Organization since 2005 in  
208 more than 160 countries, which samples over approximately 99% of the world's adult  
209 population. Typically, at least 1000 respondents are polled in each country. The survey includes  
210 more than 100 global questions as well as region-specific items. Participants are interviewed by  
211 telephone or during face-to-face meetings. We used the latest available measures of smiling and  
212 laughter, from the 2017 Gallup World Poll (25) based on nearly 149,000 interviews with adults  
213 in 142 countries in 2016. The country-level scores reflect the percentage of respondents who  
214 answered “yes” to the question: “Did you smile or laugh a lot yesterday”. The measure was  
215 available for 142 countries, with scores ranging from 42 to 89%.

216 **Measures of positive emotion.** An Enjoyment measure was part of the 2017 Gallup  
217 World Poll. Similar to the index of smiling and laughter, the country-level scores reflect the  
218 percentage of respondents who answered “yes” to the question asking whether they experienced  
219 enjoyment during a lot of the day yesterday. Ratings were available for 142 countries and

220 ranging from 33 to 91%.

221 A composite Positive Experience Index was computed for the purposes of the 2017  
222 Global Emotions Report (26) using participants' responses to five questions: "Did you feel well-  
223 rested yesterday?", "Were you treated with respect all day yesterday?", "Did you smile or laugh  
224 a lot yesterday?", "Did you learn or do something interesting yesterday?" "Did you experience  
225 the following feelings during a lot of the day yesterday? How about enjoyment?". The Positive  
226 Experience Index score is the mean of all valid affirmative responses to these items multiplied by  
227 100. Scores were available for 142 countries and ranged from 0 to 100, with higher scores  
228 meaning that positive experiences are more pervasive in a country.

229 A measure of feelings of Happiness was derived from the World Values Survey (wave 6,  
230 2010-2014; (27), a global research project covering 60 countries, with a minimum of 1000  
231 respondents per country. The question "Taking all things together, would you say you are: 1)  
232 Very happy, 2) Rather happy, 3) Not very happy, 4) Not at all happy" was part of a large  
233 standardized questionnaire administered in face-to-face interviews and phone interviews for  
234 remote areas. Participants' valid responses were averaged to obtain country-level measures.  
235 Scores were available for 60 countries and ranged between 1 and 4, with higher scores indicating  
236 lower levels of happiness.

237 Our measure of Positive Emotion, derived from the International College Survey 2001  
238 (28) administered to 9857 college students in 48 countries, reflects the average frequency of  
239 positive emotions. In the survey, participants were asked to rate how often they had felt six  
240 positive emotions (pleasant, happy, cheerful, pride, gratitude, and love) using 9-point scales  
241 ranging from 1 (*not at all*) to 9 (*all the time*). Scores were averaged in a global measure of  
242 positive emotion, available for 46 countries, with higher values representing higher frequency of

243 positive emotions.

244 **Measures of negative emotion.** We used measures of Anger, Sadness, Stress, and  
245 Worry, which were part of the 2017 Gallup World Poll. Country-level scores reflected the  
246 percentage of respondents who answered “yes” to the question asking whether they experienced  
247 anger, sadness, stress, and worry during a lot of the day yesterday. Ratings were available for  
248 142 countries and ranged from 6 to 50% (anger), 7 to 61% (sadness), 12 to 66% (stress), and 15  
249 to 74% (worry).

250 Similar to the Positive Experience Index described above, the Negative Experience Index  
251 was a composite measure of respondents’ well-being computed from five items asking whether  
252 participants experienced physical pain, worry, sadness, stress, and anger during a lot of the day  
253 yesterday. The Negative Experience Index score is the mean of all valid affirmative responses to  
254 these items multiplied by 100. The scores were available for 142 countries and ranged from 0 to  
255 100, with higher scores indicating higher pervasiveness of negative experiences in a given  
256 country.

257 Similar to the Positive Emotion measure described above, the index of Negative Emotion  
258 was derived from the International College Survey 2001 (28) and averaged participants’  
259 responses to the items assessing the frequency of eight negative emotions (sad, anger,  
260 unpleasant, guilt, shame, worry, stress, and jealousy). Scores were available for 46 countries,  
261 with higher values reflecting higher frequency of negative emotions.

262 **GDP per capita.** We used each country’s gross domestic product divided by its total  
263 population. Values for 2017 were retrieved from the World Factbook (29) and were available for  
264 166 countries, ranging from \$700 to \$124,900.

265 **Present-day migration diversity.** The diversity of the present (vs. long-history)

266 migration was indexed by the construct of ethnic fractionalization (30), reflecting the probability  
267 that two randomly selected individuals from a given country belong to different ethnic groups.  
268 Population data used to compute the variable were provided by the sources published between  
269 1997 and 2001 or directly obtained from national censuses. Scores of ethnic fractionalization  
270 were available for 166 countries and varied between 0 and 1.

## 271 **Results**

272 **Correlations.** We first calculated the relationships between historical heterogeneity,  
273 smiling and laughter, and measures of positive and negative emotion by computing pairwise  
274 correlations for all variables described earlier. An inspection of the correlation matrix (see Table  
275 1) reveals significant positive associations between Heterogeneity and Smiling and Laughter,  
276  $r(140) = .31, p < .001, 95\% \text{ CI } [.15, .45]$ , Enjoyment,  $r(140) = .36, p < .001, 95\% \text{ CI } [.21, .50]$ ,  
277 Positive Experience Index,  $r(140) = .39, p < .001, 95\% \text{ CI } [.25, .52]$ , and Positive Emotion,  $r(44)$   
278  $= .38, p < .01, 95\% \text{ CI } [.10, .60]$ . The correlation with the negatively coded measure of happiness  
279 was only marginally significant,  $r(58) = -.25, p = .05, 95\% \text{ CI } [-.47, .00]$ . Heterogeneity was  
280 significantly and negatively associated with the experience of Anger,  $r(140) = -.22, p < .01, 95\%$   
281  $\text{CI } [-.37, -.06]$ , but was not significantly related to other negative emotions,  $r_s < .16, p_s > .05$ .  
282 Additionally, there was a significant positive correlation between Heterogeneity and GDP per  
283 capita,  $r(164) = .25, p = .001, 95\% \text{ CI } [.10, .39]$ .

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289 **Table 1. Correlations between variables in Study 1.**

	1	2	3	4	5	6	7	8	9
1. Heterogeneity									
2. Smiling and Laughter	<b>.31***</b>								
3. Enjoyment	<b>.36***</b>	<b>.68***</b>							
4. Positive Experience Index	<b>.39***</b>	<b>.89***</b>	<b>.79***</b>						
5. Happiness	-.25	<b>-.56***</b>	<b>-.54***</b>	<b>-.60***</b>					
6. Positive Emotion	<b>.38***</b>	<b>-.54***</b>	.28	<b>.60***</b>	<b>-.52**</b>				
7. Anger	<b>-.22**</b>	<b>-.32***</b>	<b>-.53***</b>	<b>-.48***</b>	<b>.32*</b>	-.03			
8. Sadness	-.04	-.13	<b>-.41***</b>	<b>-.28**</b>	.18	.20	<b>.71***</b>		
9. Stress	.15	.15	-.06	.07	.07	.03	<b>.35***</b>	<b>.40***</b>	
10. Worry	.06	-.11	<b>-.39***</b>	<b>-.21*</b>	.23	.23	<b>.58***</b>	<b>.75***</b>	<b>.47**</b>
11. Negative Experience Index	-.02	-.09	<b>-.43***</b>	<b>-.26**</b>	<b>.26*</b>	.16	<b>.80***</b>	<b>.89***</b>	<b>.65***</b>
12. Negative Emotion	-.19	-.15	-.18	-.13	-.34	.01	<b>.39**</b>	.24	.27
13. GDP per Capita	<b>.25**</b>	<b>.21*</b>	<b>.40***</b>	<b>.39***</b>	-.18	-.11	<b>-.44***</b>	<b>-.52***</b>	<b>-.003</b>
14. Ethnic Fractionalization	.02	.01	<b>-.20*</b>	-.10	<b>-.34**</b>	<b>.42**</b>	<b>.40***</b>	<b>.50***</b>	.02

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291 Note. Correlations in bold are significant, with \* denoting  $p < .05$ , \*\* denoting  $p < .01$ , and \*\*\*  
 292 denoting  $p < .001$ .

293

294 Overall, beyond predicting smiling and laughter, historical heterogeneity was also  
 295 consistently correlated with measures of positive emotion. Correlations with negative emotions  
 296 were less consistent, with only anger being significantly and negatively associated with  
 297 Heterogeneity. To extend the correlation analyses, we conducted a series of multiple regressions  
 298 examining the usefulness of Heterogeneity as a predictor of Smiling and Laughter, Enjoyment,  
 299 and Positive Experience Index. The analyses focused on the measures derived from Gallup  
 300 World Poll to maximize statistical power, as they included more data points than the World  
 301 Values Survey and the International College Survey 2001. Each analysis included GDP per  
 302 capita and Ethnic Fractionalization as control variables.

303 **Predicting Smiling and Laughter.** We first regressed the measure of Smiling and  
 304 Laughter on GDP per capita and Ethnic Fractionalization, saving the standardized residuals.  
 305 These residuals were then analyzed as a function of historical heterogeneity. In this analysis,  
 306 Heterogeneity was a significant positive predictor of Smiling and Laughter,  $\beta = .28$ ,  $F(1,139) =$

307 11.43,  $p = .001$ ,  $R^2_{adj} = .07$ . The effect of Heterogeneity was also significant in a similar  
308 regression model, in which Ethnic Fractionalization was replaced by another index of present-  
309 day population diversity, namely the number of source countries contributing to the population  
310 of a given country in 2015 (31) (UN, 2018),  $\beta = .25$ ,  $F(1,137) = 9.54$ ,  $p = .002$ ,  $R^2_{adj} = .06$ .

311 In a supplemental analysis, we simultaneously regressed the measure of Smiling and  
312 Laughter on Heterogeneity, GDP per capita, and Ethnic Fractionalization,  $F(3, 137) = 6.54$ ,  $p <$   
313  $.001$ ,  $R^2_{adj} = .11$ . Heterogeneity was a significant predictor of Smiling and Laughter,  $\beta = .28$ ,  
314  $F(1,137) = 11.77$ ,  $p = .001$ . The same was true for GDP per capita:  $\beta = .19$ ,  $F(1,137) = 4.31$ ,  $p =$   
315  $.04$ . The effect of Ethnic Fractionalization was not significant,  $\beta = .10$ ,  $F(1,137) = 1.17$ ,  $p = .28$ .

316 **Predicting Enjoyment.** We first regressed the measure of Enjoyment on GDP per capita  
317 and Ethnic Fractionalization, saving the standardized residuals. A subsequent analysis with  
318 residuals as a dependent variable and Heterogeneity as a predictor revealed a significant effect of  
319 Heterogeneity on the residuals,  $\beta = .32$ ,  $F(1,139) = 15.98$ ,  $p < .001$ ,  $R^2_{adj} = .10$ . The effect of  
320 Heterogeneity was also significant in the regression model in which Ethnic Fractionalization was  
321 replaced the number of source countries in 2015 (31),  $\beta = .30$ ,  $F(1,137) = 13.22$ ,  $p < .001$ ,  $R^2_{adj} =$   
322  $.08$ .

323 A supplemental regression model including Enjoyment as a dependent variable and  
324 Heterogeneity, GDP per capita, and Ethnic Fractionalization as predictors,  $F(3, 137) = 15.20$ ,  $p <$   
325  $.001$ ,  $R^2_{adj} = .23$ , revealed a significant effect of Heterogeneity,  $\beta = .31$ ,  $F(1,137) = 16.48$ ,  $p <$   
326  $.001$ . The effect of GDP was also significant,  $\beta = .31$ ,  $F(1,137) = 14.13$ ,  $p < .001$ . Ethnic  
327 Fractionalization was not a significant predictor of Enjoyment,  $\beta = -.06$ ,  $F(1,137) = 0.49$ ,  
328  $p = .48$ .

329 **Predicting the Positive Experience Index.** As in the previous analyses, Positive

330 Experience Index was first regressed on GDP and Ethnic Fractionalization. A subsequent  
331 regression analysis revealed that the standardized residuals were significantly accounted for by  
332 Heterogeneity,  $F(1, 139) = 16.69, p < .001, R^2_{adj} = .12$ . The effect of Heterogeneity was also  
333 significant in the regression model in which Ethnic Fractionalization was replaced the number of  
334 source countries in 2015 (31),  $\beta = .30, F(1,137) = 13.22, p < .001, R^2_{adj} = .08$ .

335 A regression model including the Positive Experience Index as a dependent variable and  
336 Heterogeneity, GDP per capita, and Ethnic Fractionalization as predictors,  $F(3, 137) = 16.53, p <$   
337  $.001, R^2_{adj} = .25$ , revealed a significant effect of Heterogeneity,  $\beta = .34, F(1,137) = 20.31, p <$   
338  $.001$ . The effect of GDP per capita was also significant,  $\beta = .35, F(1,137) = 18.12, p < .001$ .  
339 Ethnic Fractionalization was not a significant predictor,  $\beta = .06, F(1,137) = 0.62, p = .43$ .  
340 Additional regression analyses, in which Heterogeneity and GDP per capita were log-  
341 transformed (using base 10) because of high kurtosis values yielded an identical pattern of  
342 results.

## 343 **Study 2**

344 While Study 1 replicated and extended the findings of Girard and McDuff (2017) in  
345 showing that country-level historical heterogeneity is a positive predictor not only of smiling and  
346 laughter in a more general context, but also various indices of positive emotion, Study 2 focused  
347 on long-history migration within the United States. Historical heterogeneity of each of the U.S.  
348 states was estimated by averaging each decennial census's percentage of foreign-born  
349 contributing to its population between 1850 and 2010. As in Study 1, we examined the  
350 significance of heterogeneity in predicting smiling and laughter, as well as six different measures  
351 of positive and negative emotions derived from the Gallup U.S. Daily Tracking Poll. We also  
352 included per capita income for each state and a measure of source countries contributing to each

353 state's population in 2016 as a measure of present-day diversity.

## 354 **Measures**

355 **Historical heterogeneity.** Long-history heterogeneity of migration was  
356 operationalized as the percent of foreign-born citizens contributing to the population of each U.S.  
357 state between 1850 and 2010 provided by the US. Bureau of the Census. Scores were computed  
358 as an average of all census estimates available for a given state. Percentages of foreign-born  
359 individuals from 1850 to 2000 were retrieved from the decennial censuses (32,33) and from 2010  
360 were part of the 2006-2010 American Community Survey (34), a questionnaire conducted by the  
361 U.S. Census Bureau that replaced the decennial censuses. Scores varied between 0.79 and  
362 22.65% and were available for the 48 continental U.S. states as well as for Washington, D.C.  
363 Proportions of foreign-born citizens were available from 1860 for Kansas, North Dakota,  
364 Nebraska, Nevada, South Dakota, and Washington; from 1870 for Arizona, Colorado, Idaho,  
365 Montana, and Wyoming; and from 1890 for Oklahoma. We excluded Alaska and Hawaii from  
366 the analyses, as censuses from these states were only available starting in 1960, which would not  
367 provide the same long-history estimate as the other states. The variable will be called  
368 Heterogeneity and it is illustrated in Fig 2.

369

370 **Fig 2. Average percent foreign born populations of the states of the continental United**  
371 **States.** Based on censuses from 1850 (or between 1860 and 1890 for later-entry states) until  
372 2010. Darker colors indicate higher percent foreign born populations.

373

374

375 **Smiling and laughter.** The measure of smiling and laughter was derived from the  
376 Gallup U.S. Daily Tracking survey, in which phone interviews are administered every day to  
377 approximately 500 randomly selected American respondents. The project yields large sample



378 sizes, with as many as 175,000 participants surveyed each year. We used the latest available  
379 measures of smiling and laughter, from the 2016 U.S. Daily Tracking. The state-level scores  
380 reflected the percentage of respondents who answered “yes” to the question: “Did you smile or  
381 laugh a lot yesterday” and varied from 76 to 86%.

382 **Measures of positive emotion.** Similar to the index of smiling and laughter,  
383 measures of Enjoyment were also derived from the 2016 U.S. Daily Tracking Survey. The state-  
384 level scores indicated the percentage of respondents who answered “yes” to the question asking  
385 whether they experienced enjoyment during a lot of the day yesterday. Indications of enjoyment  
386 ranged from 82 to 91%.

387 The state-level Happiness scores indicated the percentage of respondents who answered  
388 “yes” to the question asking whether they experienced happiness during a lot of the day  
389 yesterday. Happiness scores ranged from 86 to 93%.

390 **Measures of negative emotion.** We analyzed reports of the emotions of anger,  
391 sadness, stress, and worry. The latest available measure of anger was collected as part of the  
392 2013 U.S. Daily Tracking Survey and the three other measures were from 2016. State-level  
393 scores reflected the percentage of respondents who answered “yes” to the question asking  
394 whether they experienced anger, sadness, stress, and worry during a lot of the day yesterday.  
395 Endorsements ranged from 9 to 18% (anger), 11 to 20% (sadness), 36 to 46% (stress), and 23 to  
396 36% (worry).

397 **Income.** We used state-level measures of income per capita. Values for 2016 were  
398 retrieved from the American Community Survey and ranged from \$22,694 to \$50,567.

399 **Present-day migration diversity.** The diversity of the present (vs. long-history)  
400 migration was indexed by the number of source countries whose citizens contributed to the

401 population of a given state in the year 2016. Scores were retrieved from the report State  
 402 Immigration Data Profiles (35) and ranged from 34 to 46.

## 403 Results

404 **Correlations.** We first calculated the relationships between historical heterogeneity,  
 405 smiling and laughter, and measures of positive and negative emotion by computing pairwise  
 406 correlations between all variables. An inspection of the correlation matrix (see Table 2) reveals  
 407 significant positive associations between Heterogeneity and Smiling and Laughter,  $r(47) = .46, p$   
 408  $< .01, 95\% \text{ CI } [.20, .65]$  as well as Enjoyment,  $r(47) = .33, p = .02, 95\% \text{ CI } [-.06, .56]$ , and  
 409 Happiness,  $r(47) = .43, p < .01, 95\% \text{ CI } [.16, .63]$ . Heterogeneity was also negatively correlated  
 410 with the measure of Sadness,  $r(47) = -.29, p = .04, 95\% \text{ CI } [-.53, -.01]$ . Additionally, there was a  
 411 significant positive correlation between heterogeneity and income,  $r(47) = .47, p = .001, 95\% \text{ CI}$   
 412  $[.22, .66]$ . None of the correlations between Heterogeneity and other negative emotions was  
 413 significant,  $r_s < .25, p_s > .10$ .

414 **Table 2. Correlations between variables in Study 2.**

	1	2	3	4	5	6	7	8	9
1. Heterogeneity									
2. Smiling and Laughter	<b>.46***</b>								
3. Enjoyment	<b>.33*</b>	<b>.69***</b>							
4. Happiness	<b>.43***</b>	<b>.70***</b>	<b>.75***</b>						
5. Anger	-.23	<b>-.59***</b>	<b>-.70***</b>	<b>-.71***</b>					
6. Sadness	<b>-.29*</b>	<b>-.57***</b>	<b>-.66***</b>	<b>-.67***</b>	<b>.63***</b>				
7. Stress	.09	-.19	-.13	-.07	.23	.33			
8. Worry	-.01	<b>-.35**</b>	<b>-.41***</b>	<b>-.36**</b>	<b>.49**</b>	<b>.65***</b>	<b>.70***</b>		
9. Income per capita	<b>.47***</b>	<b>.32*</b>	.16	.09	-.01	-.17	.17	.23	
10. Source countries in 2016	.01	-.10	<b>-.35***</b>	<b>-.44**</b>	<b>.37**</b>	<b>.46***</b>	.09	.19	.16

415 Note. Correlations in bold are significant, with \* denoting  $p < .05$ , \*\* denoting  $p < .01$ , and \*\*\*  
 416 denoting  $p < .001$ .  
 417  
 418

419 We then conducted three multiple regressions examining the role of Heterogeneity as a

420 predictor of Smiling and Laughter, Happiness, and Enjoyment. Each analysis included state-level  
421 income and the number of source countries in 2016 as control variable.

422 **Predicting Smiling and Laughter.** We first regressed the measure of Smiling and  
423 Laughter on Income and the number of source countries in 2016, saving the standardized  
424 residuals. These residuals were then analyzed as a function of historical heterogeneity. In this  
425 analysis, Heterogeneity was a significant predictor of smiling and laughter,  $\beta = .32$ ,  $F(1,47) =$   
426  $5.45$ ,  $p = .02$ ,  $R^2_{adj} = .08$ . The effect of Heterogeneity was also significant in a similar regression  
427 model, in which Source countries in 2016 were replaced by another index of demographic  
428 diversity, namely the proportion of foreign-born citizens contributing to the population of a given  
429 state in 2015 (U.S. Census Bureau, 2011-2015),  $\beta = .30$ ,  $F(1,47) = 4.81$ ,  $p = .03$ ,  $R^2_{adj} = .07$ .

430 A linear regression model including the measure of Smiling and Laughter as the  
431 dependent variable and Heterogeneity, Income, and the number of source countries in 2016 as  
432 predictors,  $F(3, 45) = 4.77$ ,  $p = .01$ ,  $R^2_{adj} = .19$ , revealed a significant effect of Heterogeneity,  $\beta =$   
433  $.39$ ,  $F(1,45) = 6.97$ ,  $p = .01$ . The effects of Income and Source countries in 2016 were not  
434 significant,  $\beta = .15$ ,  $F(1,45) = 1.08$ ,  $p = .30$  and  $\beta = -.13$ ,  $F(1,45) = 0.98$ ,  $p = .33$ , respectively.

435 **Predicting Enjoyment.** Again, we regressed the measure of Enjoyment on Income  
436 and the Source countries in 2016, saving the standardized residuals. These residuals were then  
437 regressed on historical heterogeneity. Heterogeneity was a marginally significant predictor of  
438 Enjoyment,  $\beta = .26$ ,  $F(1,47) = 3.34$ ,  $p = .07$ ,  $R^2_{adj} = .05$ . The effect of Heterogeneity was also  
439 significant in the regression model, in which Source countries in 2016 were replaced by the  
440 proportion of foreign-born citizens in 2015,  $\beta = .36$ ,  $F(1,47) = 6.89$ ,  $p = .01$ ,  $R^2_{adj} = .11$ .

441 A linear regression model including the measure of Enjoyment as the dependent variable  
442 and Heterogeneity, Income, and the number of source countries in 2016 as predictors,  $F(3, 45) =$

443 4.74,  $p = .01$ ,  $R^2_{adj} = .19$ , revealed a significant effect of Heterogeneity,  $\beta = .30$ ,  $F(1,45) = 4.21$ ,  $p$   
444  $= .05$ . The number of source countries in 2016 was negatively associated with Enjoyment,  $\beta = -$   
445  $.36$ ,  $F(1,45) = 7.58$ ,  $p = .01$ , The effect of Income was not significant,  $\beta = .08$ ,  $F(1,45) = 0.29$ ,  $p$   
446  $= .60$ .

447 **Predicting Happiness.** Again, we regressed the measure of Happiness on Income and  
448 the Source countries in 2016, saving the standardized residuals. These residuals were then  
449 regressed on historical heterogeneity. Heterogeneity was a significant predictor of Happiness,  $\beta$   
450  $= .40$ ,  $F(1,47) = 9.04$ ,  $p < .01$ ,  $R^2_{adj} = .14$ . The effect of Heterogeneity was also significant in the  
451 regression model, in which Source countries in 2016 were replaced by the proportion of foreign-  
452 born citizens in 2015 (U.S. Census Bureau, 2011-2015),  $\beta = .44$ ,  $F(1,47) = 11.51$ ,  $p = .001$ ,  $R^2_{adj}$   
453  $= .18$ .

454 A linear regression model including the measure of Happiness as the dependent variable  
455 and Heterogeneity, Income, and the number of source countries in 2016 as predictors,  $F(3, 45) =$   
456  $9.24$ ,  $p < .001$ ,  $R^2_{adj} = .34$ , revealed a significant effect of Heterogeneity,  $\beta = .46$ ,  $F(1,45) =$   
457  $11.82$ ,  $p = .001$ . The number of source countries in 2016 was negatively associated with  
458 Happiness,  $\beta = -.44$ ,  $F(1,45) = 13.40$ ,  $p = .001$ , The effect of Income was not significant,  $\beta = -$   
459  $.05$ ,  $F(1,45) = 0.15$ ,  $p = .70$ .

## 460 **General Discussion**

461 In two studies, we tested predictions derived from the idea that long-history migratory  
462 patterns resulting in high ancestral heterogeneity constitute a force that determines long-lasting  
463 aspects of emotion culture. The need to coordinate and build societal institutions in the absence  
464 of shared initial language and emotion norms creates a context with strong pressures for efficient  
465 non-verbal communication. Recent studies have examined behaviors such as smiling while

466 viewing advertisements (11) and facial expression recognition accuracy (9) and have found  
467 support for the significance of this socioecological factor: Individuals from historically  
468 heterogeneous cultures smile more and display facial expressions that are more readily decoded  
469 across cultures. The analysis of the large-sample datasets reported in the present work is  
470 compelling because the approach allows us to consider most of the world's countries rather than  
471 a subset and to explore additional emotion experiences. We also extended previous findings by  
472 examining indicators of smiling and positive emotions not bound to specific contexts or stimuli.

473         Using responses to the Gallup World Poll query about smiling and laughing on the  
474 previous day, we replicated the finding that historical heterogeneity is related to the frequency of  
475 smiling (11). Robust to the inclusion of GDP and present-day population diversity, historical  
476 heterogeneity was positively associated with reports of smiling and laughter on the previous day.  
477 An extant cross-cultural study found that signaling non-treat and openness to affiliation was a  
478 more important determinant of smiling for members of heterogeneous cultures than for members  
479 of homogeneous cultures (Rychlowska et al., 2015). It is thus possible that the more frequent  
480 smiling in historically heterogeneous countries observed in the present study reflects an  
481 adaptation to societal pressures to use nonverbal behavior – such as smiling – to invite and  
482 reinforce social interaction and cooperation.

483         Historical heterogeneity also predicted enjoyment and positive experiences more  
484 generally: Members of heterogeneous countries reported that they had felt enjoyment and had  
485 positive experiences on the previous day with greater frequency than members of homogeneous  
486 countries. These findings, consistent with those for smiles and laughter, were found over and  
487 above any effects of GDP and present-day population diversity. While present-day diversity was  
488 a significant predictor in some analyses, its effects were not as consistent as the effects of

489 historical heterogeneity. Specifically, the effects of Ethnic Fractionalization in the analyses of the  
490 world data were not significant. However, the number of source countries in 2016, used as a  
491 control variable in the within-US analyses, was a significant predictor of enjoyment and  
492 happiness. Importantly, while historical heterogeneity was positively associated with the  
493 measures of positive emotions, present-day population diversity was negatively associated with  
494 these measures suggesting that the two socioecological variables have different effects. While  
495 long-history migration may encourage specific emotion behaviors and reactions and shape an  
496 emotion culture over centuries (Cohen, 2001), present-day population movements may represent  
497 initial conditions, which exert their immediate social and economic effects, but are not yet  
498 incorporated in societal institutions and norms.

499         Because of the correlational nature of the present findings, we cannot draw strong  
500 conclusions about how or why historical heterogeneity is related to the experience of positive  
501 emotion and experience. As suggested, these outcomes could be related to the frequent use of  
502 smiles. A reliance on smiling to invite and maintain channels for new relationships can have  
503 salutary effects on emotions. This is because facial expressions can feed back to modulate  
504 emotional experiences (36,37). As an example, when participants in one study were covertly  
505 induced to smile while undergoing a painful cold-pressor task, they showed lower physiological  
506 arousal and self-reported negative affect than control participants who completed the task with a  
507 neutral expression (38). In addition to these beneficial intrapersonal effects of smiles, observers  
508 make positive attributions about smiling people and trust them more than people who do not  
509 express smiles (19). Smiles thus provide one basis for successful cooperation (17). As a  
510 consequence, positive experiences may result from a cultural adaptation that involves greater use  
511 of the smile.

512           There is no formal reason to estimate historical heterogeneity only at the level of the  
513 country. Putterman and Weil's World Migration Matrix (2010) provides such information, and  
514 the indicators of the number of source countries to present-day populations derived from the  
515 matrix has now been used in numerous studies. However, heterogeneity can also be analyzed  
516 within smaller territories of the same country. In the present research, we estimated the historical  
517 heterogeneity of the states of the United States because the states constitute territories that differ  
518 in their long-history migration. Our indicator of historical heterogeneity was an average of the  
519 percentage of foreign born population from the US Census from 1850 (or beginning when the  
520 state entered the Union) until 2010. This 160-year period is not as extended as the 500-year one  
521 that can be estimated for the world's countries but does reflect an important portion of the  
522 migratory history of the United States during which numerous large-scale waves of immigration  
523 from diverse countries contributed to the overall populations of many states. The natural  
524 waterways and the agricultural opportunities offered by the geographic conditions resulted in  
525 high variability in these percentages.

526           Using the Gallup US Daily Tracking surveys, we were able to perform analyses similar to  
527 those that we conducted for the world as a whole. Our results were overall consistent with the  
528 findings from the analyses of the countries of the world. Historical heterogeneity of the states of  
529 the United States was predictive of smiling and laughter such that, again, residents of more  
530 historically heterogeneous states reported more smiles and laughter. In addition, the positive  
531 relationship extended to reports of enjoyment and happiness. Overall, historical heterogeneity  
532 was related to higher levels of positive emotion. In the US sample, present-day diversity was  
533 also significantly and negatively related to positive experiences of happiness and enjoyment.

534           Future work should investigate potential causes of the relationship between historical

535 heterogeneity and the experience of positive emotions. Ongoing experimental work in our lab is  
536 examining how specific socio-ecological factors associated with heterogeneity – for instance a  
537 lack of shared verbal language boosting people’s reliance on nonverbal communication – lead to  
538 shifts in expressive behavior. Such is the strength of a socioecological perspective on cross-  
539 cultural differences: if specific features of the social environment exert the hypothesized  
540 influence on behavior, it should be observable in the laboratory and in prospective studies of  
541 cultural change.

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