

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35

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

Paula M. Niedenthal^{1¶}, Magdalena Rychlowska^{2*¶}, Adrienne Wood¹, Fangyun Zhao¹

¹ Department of Psychology, University of Wisconsin-Madison, Madison, WI

² School of Psychology, Queen's University Belfast, Belfast, Ireland

* Corresponding author
E-mail: magdalena.rychlowska@gmail.com

¶ These authors contributed equally to this work

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.

55

56

57

58

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.

204

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, $r(164) = .25, p = .001, 95\% \text{ CI } [.10, .39]$.

284

285

286

287

288

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

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

290
 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	.46***								
3. Enjoyment	.33*	.69***							
4. Happiness	.43***	.70***	.75***						
5. Anger	-.23	-.59***	-.70***	-.71***					
6. Sadness	-.29*	-.57***	-.66***	-.67***	.63***				
7. Stress	.09	-.19	-.13	-.07	.23	.33			
8. Worry	-.01	-.35**	-.41***	-.36**	.49**	.65***	.70***		
9. Income per capita	.47***	.32*	.16	.09	-.01	-.17	.17	.23	
10. Source countries in 2016	.01	-.10	-.35***	-.44**	.37**	.46***	.09	.19	.16

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

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, β
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.

542 **Acknowledgements**

543 P.M.N. was supported by a 2017-2018 Cattell Sabbatical Award (MSN206694) from the
544 James McKeen Cattell Fund. A.W. was support by an Emotion Research Training Grant
545 (T32MH018931-24) from the National Institute of Mental Health. We thank Markus Brauer for
546 discussions of and advice on correct data-analytic strategies and Elizabeth Edwards and Dafydd
547 Roberts for their help with retrieving census data and the Nuffield Foundation for funding their
548 work.

549 **References**

- 550 1. Oishi S. Socioecological Psychology. *Annu Rev Psychol.* 2014 Jan 3;65(1):581–609.
- 551 2. Sng O, Neuberg SL, Varnum MEW, Kenrick DT. The Behavioral Ecology of Cultural
552 Psychological Variation. *Psychol Rev.* 2018;
- 553 3. Gelfand MJ, Raver JL, Nishii L, Leslie LM, Lun J, Lim BC, et al. Differences Between
554 Tight and Loose Cultures: A 33-Nation Study. *Science.* 2011 May 26;332:1100–4.
- 555 4. Murray DR, Schaller M. Historical Prevalence of Infectious Diseases Within 230
556 Geopolitical Regions: A Tool for Investigating Origins of Culture. *J Cross-Cult Psychol.*
557 2010 Jan;41(1):99–108.
- 558 5. Murray DR, Schaller M, Suedfeld P. Pathogens and Politics: Further Evidence That Parasite
559 Prevalence Predicts Authoritarianism. *PLOS ONE.* 2013 May 1;8(5):e62275.

- 560 6. Schaller M, Park JH. The Behavioral Immune System (and Why It Matters). *Curr Dir*
561 *Psychol Sci.* 2011 Apr;20(2):99–103.
- 562 7. Niedenthal PM, Rychlowska M, Wood A. Feelings and contexts: socioecological influences
563 on the nonverbal expression of emotion. *Curr Opin Psychol.* 2017 Oct 1;17:170–5.
- 564 8. Rychlowska M, Miyamoto Y, Matsumoto D, Hess U, Gilboa-Schechtman E, Kamble S, et
565 al. Heterogeneity of long-history migration explains cultural differences in reports of
566 emotional expressivity and the functions of smiles. *Proc Natl Acad Sci.*
567 2015;112(19):E2429–36.
- 568 9. Wood A, Rychlowska M, Niedenthal PM. Heterogeneity of long-history migration predicts
569 emotion recognition accuracy. *Emotion.* 2016;16:413–20.
- 570 10. Shrira I, Wisman A, Noguchi K. Diversity of historical ancestry and personality traits
571 across 56 cultures. *Personal Individ Differ.* 2018 Jul;128:44–8.
- 572 11. Girard JM, McDuff D. Historical Heterogeneity Predicts Smiling: Evidence from Large-
573 Scale Observational Analyses. In *IEEE*; 2017 [cited 2018 Apr 15]. p. 719–26. Available
574 from: <http://ieeexplore.ieee.org/document/7961812/>
- 575 12. Diamond J. *Guns, germs, and steel: the fates of human societies.* NY: WW Norton &
576 Company 14; 1997.
- 577 13. Elfenbein HA, Ambady N. On the universality and cultural specificity of emotion
578 recognition: A meta-analysis. *Psychol Bull.* 2002;128:203–35.
- 579 14. Schug J, Matsumoto D, Horita Y, Yamagishi T, Bonnet K. Emotional expressivity as a
580 signal of cooperation. *Evol Hum Behav.* 2010 Mar;31(2):87–94.
- 581 15. Matsumoto D, Yoo SH, Chung J. The Expression of Anger Across Cultures. In: Potegal M,
582 Stemmler G, Spielberger C, editors. *International Handbook of Anger* [Internet]. New
583 York, NY: Springer New York; 2010 [cited 2018 Apr 20]. p. 125–37. Available from:
584 http://link.springer.com/10.1007/978-0-387-89676-2_8
- 585 16. Matsumoto D, Yoo SH, Fontaine J. Mapping Expressive Differences Around the World:
586 The Relationship Between Emotional Display Rules and Individualism Versus
587 Collectivism. *J Cross-Cult Psychol.* 2008 Jan;39(1):55–74.
- 588 17. Manzini P, Sadrieh A, Vriend NJ. On Smiles, Winks and Handshakes as Coordination
589 Devices. *Econ J.* 2009;119(537):826–54.
- 590 18. Mehu M, Little AC, Dunbar RIM. Duchenne smiles and the perception of generosity and
591 sociability in faces. *J Evol Psychol.* 2007 Mar;5(1):183–96.
- 592 19. Todorov A, Pakrashi M, Oosterhof NN. Evaluating Faces on Trustworthiness After
593 Minimal Time Exposure. *Soc Cogn.* 2009 Dec;27(6):813–33.

- 594 20. Martin J, Rychlowska M, Wood A, Niedenthal P. Smiles as Multipurpose Social Signals.
595 Trends Cogn Sci. 2017 Nov;21(11):864–77.
- 596 21. Wood A, Martin J, Niedenthal P. Towards a social functional account of laughter: Acoustic
597 features convey reward, affiliation, and dominance. PLOS ONE. 2017 Aug
598 29;12(8):e0183811.
- 599 22. Kuppens, P, Realo A, Diener, E .The role of positive and negative emotions in life-
600 satisfaction judgment across nations. J Pers Soc Psychol. 2008;66–75.
- 601 23. Easterlin RA, McVey LA, Switek M, Sawangfa O, Zweig JS. The happiness–income
602 paradox revisited. Proc Natl Acad Sci. 2010 Dec 28;107(52):22463–8.
- 603 24. Putterman L, Weil DN. Post-1500 population flows and the long-run determinants of
604 economic growth and inequality. Q J Econ. 2010;125(4):1627–82.
- 605 25. Gallup Analytics. (2018). Available from: [http://www.gallup.com/analytics/213617/gallup-](http://www.gallup.com/analytics/213617/gallup-analytics.aspx)
606 [analytics.aspx](http://www.gallup.com/analytics/213617/gallup-analytics.aspx).
607
- 608 26. Gallup. (2018). *Gallup 2017 Global Emotions*. Retrieved
609 from:<http://news.gallup.com/reports/212648/gallup-global-emotions-report-2017.aspx>
610
- 611 27. Inglehart, R., C. Haerpfer, A. Moreno, C. Welzel, K. Kizilova, J. Diez-Medrano, M. Lagos,
612 P. Norris, E. Ponarin & B. Puranen et al. (eds.). 2014. World Values Survey: Round Six -
613 Country-Pooled Datafile
614 Version: www.worldvaluessurvey.org/WVSDocumentationWV6.jsp. Madrid: JD Systems
615 Institute.
616
- 617 28. Kuppens P, Ceulemans E, Timmerman ME, Diener E, Kim-Prieto C. Universal intracultural
618 and intercultural dimensions of the recalled frequency of emotional experience. J Cross-
619 Cult Psychol. 2006 Sep;37(5):491–515.
- 620 29. The World Factbook — Central Intelligence Agency [Internet]. [cited 2018 May 3].
621 Available from: [https://www.cia.gov/library/publications/the-world-](https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html)
622 [factbook/rankorder/2004rank.html](https://www.cia.gov/library/publications/the-world-factbook/rankorder/2004rank.html)
- 623 30. Alesina A, Devleeschauwer A, Easterly W, Kurlat S, Wacziarg R. Fractionalization. J Econ
624 Growth. 8(2):40.
- 625 31. United Nations Population Division | Department of Economic and Social Affairs Available
626 from:[http://www.un.org/en/development/desa/population/migration/data/estimates2/estimat-](http://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.shtml)
627 [es15.shtml](http://www.un.org/en/development/desa/population/migration/data/estimates2/estimates15.shtml)
- 628 32. U.S. Bureau of the Census. (1999). *Nativity of the population, for regions, divisions, and*
629 *states: 1850 to 1990*. Retrieved from:
630 <https://www.census.gov/population/www/documentation/twps0029/tab13.html>
631

- 632 33. United States Census Bureau. (2003). *The foreign-born population: 2000. Census 2000*
633 *Brief*. Retrieved from: <https://www.census.gov/prod/2003pubs/c2kbr-34.pdf>
- 634 34. United States Census Bureau. (2006-2010). *Percent of People who are foreign born, 2006-*
635 *2010 American Community Survey 5-year estimates*. Retrieved from:
636 https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10
637 [_5YR_GCT0501.ST04&prodType=table](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10)
- 638
- 639 35. Migration Policy Institute. (2018). *State Immigration Data Profiles*. Originally published on
640 the Migration Policy Institute's Migration Data Hub.
641 (www.migrationpolicy.org/programs/migration-data-hub)
642
- 643 36. Price TF, Peterson CK, Harmon-Jones E. The emotive neuroscience of embodiment. *Motiv*
644 *Emot.* 2012 Mar;36(1):27–37.
- 645 37. Wood A, Rychlowska M, Korb S, Niedenthal P. Fashioning the Face: Sensorimotor
646 Simulation Contributes to Facial Expression Recognition. *Trends Cogn Sci.* 2016
647 Mar;20(3):227–40.
- 648 38. Kraft TL, Pressman SD. Grin and Bear It: The Influence of Manipulated Facial Expression
649 on the Stress Response. *Psychol Sci.* 2012 Nov;23(11):1372–8.

650

651

652



