Homophily and acrophily as drivers of political segregation

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Political segregation is an important social problem, increasing polarization and impeding effective governance. Previous work has viewed the central driver of segregation to be political homophily, the tendency to associate with others who have similar views. Here we propose that, in addition to homophily, people's social tie decisions are driven by political acrophily, the tendency to associate with others who have more extreme political views (rather than more moderate). We examined this using a paradigm in which participants share emotions and attitudes on political policies, observe others' responses and choose which others to affiliate with. In four studies (N = 1,235), both liberal and conservative participants' social tie decisions reflected the presence of acrophily. We found that participants who viewed peers who expressed more extreme views as more prototypical of their political group also tended to engage in greater acrophily. These studies identify a previously overlooked tendency in tie formation.

The extreme levels of political segregation evident in the United States today presents a major social challenge[1]. Political segregation reduces interactions between group members, which contributes to polarization and inter-group hostility, and undermines political civility and effective governance[2–4].

Previous work has focused mainly on one key driver of segregation, namely political homophily, defined as the tendency to affiliate with others with similar political views[5–9]. Political homophily is a pervasive and enduring propensity[10] that results in the formation of echo chambers of like-minded people who rarely interact across political lines[11,12]. But does homophily alone drive individuals' decisions about who to affiliate with in political contexts?

In this Article, we propose that, in addition to political homophily, people's tie selection decisions are also driven by political acrophily, which we define as the tendency to prefer to affiliate with others who represent more extreme (as opposed to more moderate) political views in the direction of one's political leaning. Take for example a case in which a conservative selects between two conservative peers

of the exact same distance from their view, one who is more extreme and the other who is more moderate. The prediction of who is chosen based on homophily would suggest an equal probability to both ties, whereas a prediction based on acrophily would suggest a preference for the more extreme peer. Determining whether political acrophily is evident in addition to homophily is important because it could be a critical catalyst of political segregation in social networks and, by extension, a driver of attitudinal and affective polarization.

Homophily and acrophily are not mutually exclusive, and given the documented strength of political homophily, they are likely to co-occur. To illustrate how the two may integrate, consider a liberal who responds with outrage to an incident of police brutality and then encounters others' responses to the same incident. We illustrate three combinations of the two propensities (Fig. 1): Under homophily, the chooser would affiliate with others whose outrage responses are closest to their own (Fig. 1a), regardless of whether these responses show more or less outrage. Under homophily + acrophily (Fig. 1b), the chooser would be asymmetrically biased towards the one side of the scale that

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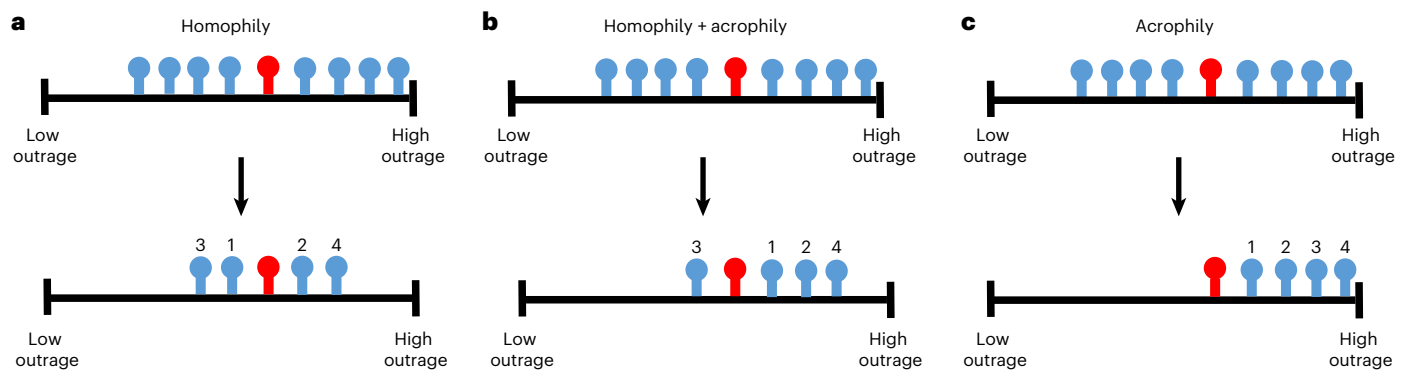
Fig. 1 | Three hypothetical tie selection strategies. The red ticker represents a chooser's moral outrage to a certain case of police brutality. The blue tickers represent potential ties' moral outrage, and the numbers represent the order of choosing. **a**, When applying homophily, the chooser elects to keep others whose responses are closest, regardless of whether they are more or less intense. **b**, When applying homophily + acrophily, the chooser has a preference for high outrage responses. **c**, When applying acrophily, the chooser keeps only others who are expressing higher outrage.

is considered a more extreme view related to one's political beliefs, in this context others who express more outrage than they do. However, the chooser would not completely exclude others who expressed less outrage if their responses were similar. Finally, under acrophily, the chooser would elect to affiliate only with others who express more extreme responses than their own, which in this case is people who express more outrage (Fig. 1c). These strategies operate on a continuum, and dividing them into these three categories is done for heuristic purposes. Nevertheless, considering the strength of homophily, our assumption is that participants' choices should be most similar to the homophily + acrophily strategy.

Indirect evidence for its occurrence can be found in existing work. One relevant finding is from research on group deviance, which suggests that people evaluate deviation from group norms towards the extreme more favourably than deviations towards more moderate views[13–16]. A second relevant finding is that people like others who present more coherent political views, a tendency that is often associated with more extreme views[17–19]. Third, acrophily can be extrapolated from the notion of 'directional voting'[20–22], which suggests that people have a clear preference for representatives of their side, even if the distance in attitudes to these representatives is bigger than to representatives on the other side. One corollary of this idea is that people are attracted, to a certain extent, to representatives who are more extreme than them. However, this idea has been the focus of a great debate without clear empirical evidence for its occurrence[23,24]. Furthermore, it is not clear that preference for representatives, on the one hand, and social ties, on the other hand, capture an identical phenomenon. Finally, a fourth indication of a tendency to prefer extreme views comes from the literature on attitude polarization[25–31]. One driver of polarization, among many, is people's tendency to express extreme views to be 'better' than others in their group[32–36]. Interestingly, while the mechanisms that drive such polarization point to an attraction towards extreme views (as in acrophily), the individual-level immediate outcomes are actually opposite in the two cases. When polarizing, people adopt more extreme views, and therefore become more extreme in relation to others. Selecting ties on the basis of acrophily, however, results in individuals becoming less extreme than others in their group because they have selectively affiliated with more extreme others. While acrophily may eventually lead to polarization, the process by which this occurs is completely different.

If acrophily were in fact robustly demonstrated, why might people prefer affiliating with more extreme group members? We suggest that one possibility is that more extreme views may be perceived as more prototypical of one's political group. People tend to believe their group holds more extreme views on average than they actually do[37–41]. If people estimate the views and emotional responses of their

political group to be more extreme than they actually are, they may be more attracted to extreme compared with moderate views because they think that these views are more prototypical representations of their political group.

We conducted four studies with the goal of examining the occurrence of acrophily. In studies 1–3 we examined participants' tie selection strategies as they choose other participants on the basis of others' responses of moral outrage to cases of police brutality. In study 3 we show that one mechanism for acrophily is the perception that the prototypical view of the group is more extreme. Study 4 was designed to examine the occurrence of acrophily in a different context from emotions to police brutality, providing evidence of its existence when selecting social ties on the basis of support for political policies.

Results

Analyses for all studies were conducted in R using mixed models for repeated measures. Assumptions of normality (Kolmogorov–Smirnov test) and equal variance (Levene test) were done for all main analyses (for full report, see sections on formal tests of assumptions in Supplementary Information). When these assumptions were violated, we conducted a robust estimation of mixed effects using the package robustlmm[42] finding similar results in all cases (Supplementary Information).

Acrophily based on moral outrage to police brutality

The goal of studies 1–3 was to examine participants' tie selection strategies when evaluating responses of moral outrage to pictures of police brutality against Black demonstrators. We chose to focus on expressions of outrage—defined as a negative emotional response, primarily consisting of anger, towards a transgressor in reaction to a wrongdoing[43]—because it has been shown to be especially important in social signalling[44,45] and in driving affiliation decisions[18,46]. We chose to specifically focus on responses to police brutality both because it is a highly salient issue and because responses to police brutality vary greatly by political affiliation in the United States[47]. In study 1 we examined liberals' tie selection decisions when choosing from a network of liberals and conservatives. In study 2 we transitioned to an online design that allowed us to increase the sample size to include both liberals and conservatives. In study 3 we replicated the findings of study 2 and examined a potential mechanism for the effects, namely the tendency to evaluate the prototypical belief of one's group as more extreme. We had a few pre-registrations of hypotheses (studies 1 and 2 were pre-registered; study 1: https://osf.io/n9uxy, study 2: https://osf.io/xdnj4; for review, see Supplementary Information), the most central one was that participants' tie selection decisions would involve some degree of acrophily, such that participants' tie selection choices would be asymmetrically biased towards preferring responses that
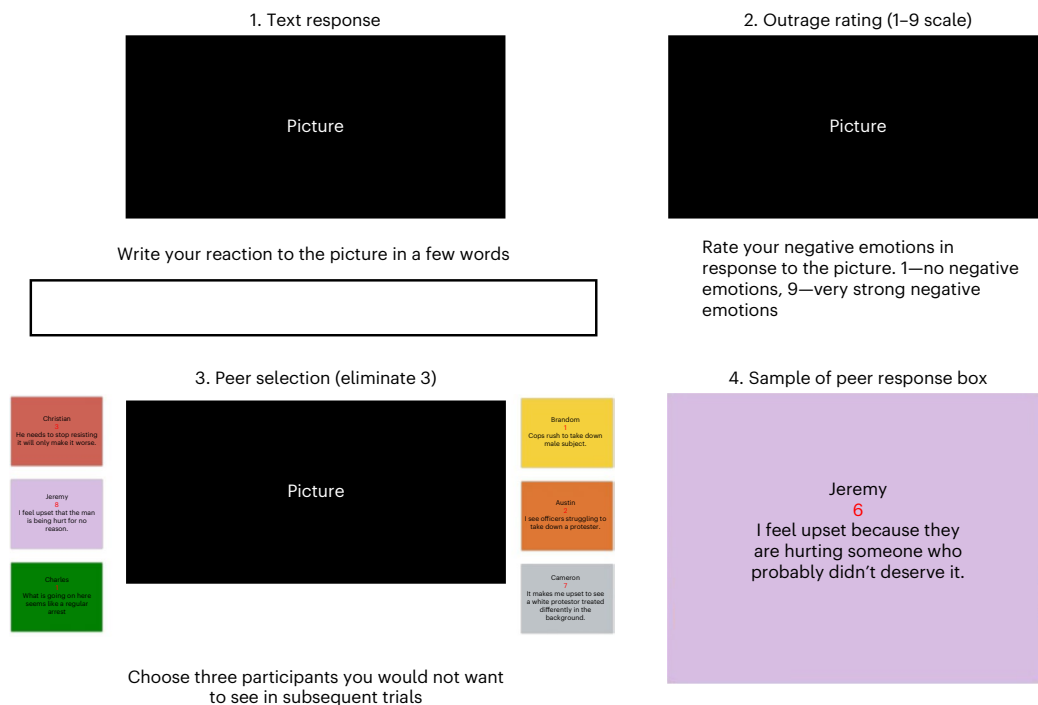
Fig. 2 | An outline of a trial in the choice condition. After being presented with a picture of police brutality against a Black demonstrator, participants were asked to: (1) provide a text response to the picture; (2) rate their negative emotions from 1 (no emotion) to 9 (a lot of emotion); and (3) view six peer responses to the same picture (each response includes a name, a rating and a text response) and choose three peers they do not wish to see in subsequent trials. The three peers whom participants chose to keep stay for the next trial and participants are able to see their responses to the following image. An enlarged version of a representative peer response is shown in panel 4.

represented a more extreme view based on their political view. In the case of outrage to police brutality, acrophily for liberals meant preferring peers who expressed stronger outrage and acrophily for conservatives meant preferring peers who expressed weaker outrage.

Task. The task was similar in studies 1–3, with small variations described in each study (Fig. 2). In each trial, participants saw pictures of police brutality against Black demonstrators intended to elicit negative emotions. For each picture, participants were first asked to provide their emotional response to the picture in a few words and then to rate their emotions in response to the picture on a scale of 1 (no negative emotion) to 9 (a lot of negative emotion). After rating and responding to the picture, participants then saw six boxes with unique colours, each containing a peer response to the same picture that they just rated. Each box included a name that was congruent with the participant's gender, a peer rating and their text response to the same picture. Peer ratings and responses were collected in a pre-test and included real ratings by real participants. After observing the responses for five seconds, participants' choices were different in the choice versus no choice conditions. In the choice condition, participants were asked to select three peers they would not want to see in a subsequent trial by clicking on the boxes they wished to eliminate. In the no choice condition, participants were asked to eliminate a random subset of three names coloured in red. In both conditions, participants were told that the eliminated peers would be eliminated completely from the entire task and their names and responses would not be seen again, while the kept participants would be seen in the subsequent trial. We created the two conditions to examine the occurrence of homophily (which was found) and to examine potential differences in ratings as a result of tie selection (which were not found). The lack of difference in ratings allowed us to omit the control condition from studies 3 and 4. For full analysis, see Supplementary Information. Participants completed the task for 20 trials (for full description, see Methods).

Studies 1 and 2. Participants in study 1 were self-identified liberals who completed the task in the lab. Participants in study 2 were both liberals and conservatives who completed the study online with an effort to increase the sample size and diversity in political affiliation (compared with what could be found around Stanford). In both studies, participants were randomly divided into the choice and no choice conditions. This was mainly designed to provide evidence for the occurrence of homophily that was found in both studies, and to look at changes in ratings as a function of condition, which were not found (analysis of participants' emotions in Supplementary Information). Our main analysis of acrophily focuses on results from the choice condition.

To examine the occurrence of acrophily, we conducted two tests, both focusing on the choice condition. Our first test of acrophily was done by creating an acrophily coefficient for each participant in each trial and testing whether these coefficients were similar or different from zero, and whether they changed over time. Our acrophily coefficient was designed to estimate the difference between participants' actual choices and what would have been a symmetrical homophily choice. Recall that, in each trial, participants were presented with ratings of six peers, and were asked to eliminate three peers (and keep three peers). Participants therefore had $\binom{6}{3} = 20$ possible choices of sets of peers to keep in each trial. Of these 20 average combinations, one combination (or more) reflected the most homophilous choice in each set. To create our coefficient, we calculated a difference score between the most homophilous combination of potentially chosen peers and the combination that participants actually chose. A positive number indicated that the combination of peers whom participants chose to keep expressed stronger emotions on average than the most homophilous combination of peers, and the opposite for a negative number. Zero reflected no acrophily in participants' choice (for mathematical representation, see acrophily coefficient section in Supplementary Information). We standardized the acrophily
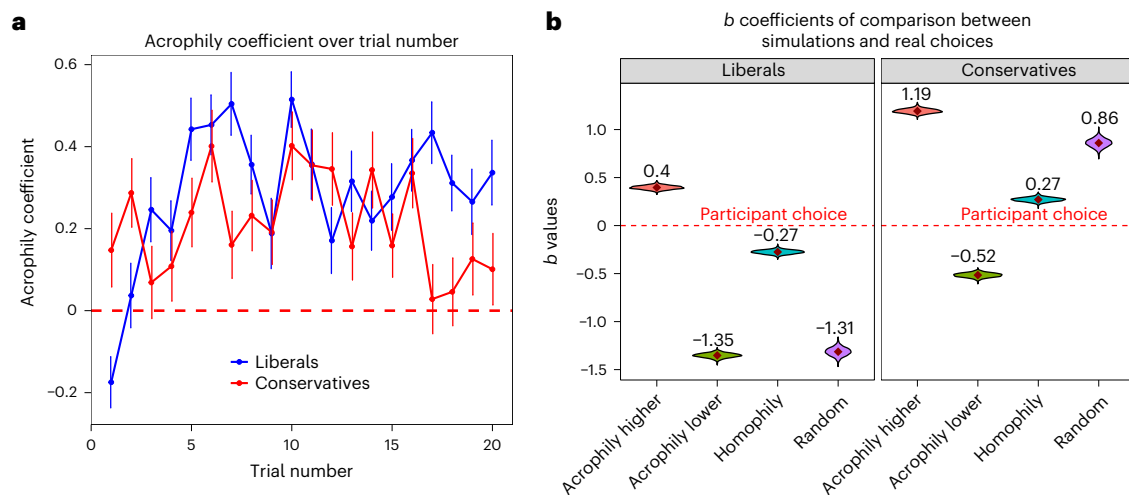
a
Acrophily coefficient over trial number

b
b coefficients of comparison between simulations and real choices

Fig. 3 | Results from study 2 (*n* = 213, experimental condition). a, The acrophily coefficient (reverse scaled for conservatives for ease of comparison) over trial number, where positive values represent a tendency for acrophily. Error bars represent 95% confidence intervals. b, Summary of comparisons between the average kept ratings and the four simulations (acrophily higher, acrophily lower, homophily and random). Each simulation was repeated 1,000 times and was compared with the actual average kept ratings. The zero line represents the average of participants' kept rating. Each red dot represents the average *b* coefficient for the simulation and its distribution. Participants' average kept ratings are located in between a pure homophily tie selection strategy and a pure acrophily strategy, higher for liberals and lower for conservatives.

coefficient by dividing it by the standard deviation (s.d.) of all possible choices of sets of peers.

In both studies 1 and 2, we calculated an acrophily coefficient for each participant in each trial in the choice condition and created a mixed-model analysis predicting the acrophily coefficient from trial number. We standardized trial number to be able to evaluate the average coefficient using the intercept of the model. In addition, and similar to the previous analysis, we used a random intercept of participants' ID. Furthermore, in study 2 we added an interaction term with political affiliation to evaluate differences in acrophily between the political groups. We report results by political affiliation although no significant differences were found between political groups (acrophily and political affiliation in Supplementary Information). Notice that coefficients for all of our analysis are in standardized values and can be compared across studies.

For our liberal participants, results suggested that the acrophily coefficient was significantly positive (study 1: $b = 0.33$, $t(30) = 2.51$, $P = 0.01$, $R^2 = 0.23$, 95% confidence interval [0.07, 0.60]; study 2: $b = 0.29$, $t(195) = 3.56$, $P < 0.001$, $R^2 = 0.32$, 95% confidence interval [0.11, 0.44]), pointing to an acrophily. Furthermore, results of study 2 (same direction to study 1 with less power) suggested that liberal tendency for acrophily increased over time (study 1: $b = 0.08$, $t(588) = 1.49$, $P = 0.13$, $R^2 = 0.23$, 95% confidence interval [−0.02, 0.19]; study 2: $b = 0.05$ [0.001, 0.11], $t(3,760) = 1.98$, $P = 0.04$, $R^2 = 0.32$, confidence interval [0.02, 0.05]; Fig. 2a).

We then examined the same effects with our conservative participants in study 2. Looking first at the intercept of the model, results suggested that the acrophily coefficient was negative and significantly different from zero ($b = −0.21$, $t(196) = −2.53$, $P = 0.01$, $R^2 = 0.32$, 95% confidence interval [−0.40, −0.06]), pointing to an acrophily tie selection strategy towards a less emotional response. Unlike study 1 (and study 3), we did not find a change in conservatives acrophily coefficient over time ($b = 0.02$, $t(3,760) = 0.73$, $P = 0.46$, $R^2 = 0.32$, 95% confidence interval [−0.03, 0.03]).

While our first test of acrophily was able to show a difference in tie selection relative to a homophilous, balanced choice, we could not compare the degree of acrophily seen by participants to other strategies. Our second test of acrophily was designed to address this limitation by comparing participants' actual tie selection choices in the choice condition with what they would have chosen if they used four different tie selection strategies: a no choice strategy, homophily (without any acrophily) and two complete acrophily strategies (one towards more emotional ratings, and one towards less emotional ratings). Simulating participants' tie selection choice in these strategies was done by using participants' actual ratings to the pictures they saw, but instead of making the actual tie selection choices that they made, our simulation executed one of the four tie selection strategies mentioned above. Notice that trials in our task are dependent, such that the peers whom participants saw in a given trial were dependent on their choices in previous trials. Therefore, our simulation was designed to replicate the task structure from the first trial and allow the simulation choices in each trial to affect the peers in the following trial.

In the random selection strategy, agents in our simulations chose peers randomly. In the homophily strategy, agents in our simulations chose in each trial the three peers closest to participants' ratings, regardless of whether they were more moderate or more extreme. In both of our acrophily simulations (more outrage and less outrage), agents in our simulations chose the peers closest to their own rating, but only on one side of the scale, either more outrage or less outrage. Only if there were no available peers in designated side (more or less depending on the simulation) did agents choose the closest peer from the other side.

We ran 1,000 iterations of each of the four simulations (random selection, homophily, acrophily higher and acrophily lower) such that each simulation generated an average of rating of the kept peer in each trial. We then ran 1,000 models in which we compared participants' actual average kept ratings (the peers whom participants decided to keep) to the average rating of the peers who were kept in each of the four simulations. Each analysis was done using a mixed-model analysis comparing between the actual average kept ratings by each participant, and the average kept ratings of each of our four simulations in the same model. We also included a by-participant random intercept in each model. We report here the *b* and *t* values for each comparison between the actual kept ratings and one of the simulations with a 95% confidence interval for *t* values and *P* values when it is necessary (Fig. 3b).

Looking first at the liberal participants, results suggested that the average rating of the actually kept peers was significantly higher than the homophily simulation (study 1: $b = −0.646$, $t = −3.58$, 95% confidence interval [−0.650, −0.643], $P < 0.001$; study 2: $b = −0.27$, $t = −2.60$, 95% confidence interval [−0.275, −0.273], $P = 0.010$ [0.010, 0.11]), and significantly lower from the more outrage acrophily strategy in study 2 but not in study 1 (Study 1: $b = 0.327$, $t = 1.82$, 95% confidence interval [0.323, 0.330], $P = 0.088$ [0.084, 0.92]; study 2: $b = 0.396$, $t = 3.75$, 95% confidence interval [0.395, 0.397], $P < 0.001$), indicating that participants' tie selection strategy was between homophily and acrophily in study 2 and marginally significantly different from acrophily in study 1. Coefficient sizes indicate that differences from acrophily high was ~50% smaller in study 1 and 44% bigger in study 2 than the distance to homophily. These findings suggest that, despite the fact that participants' choices in both studies fell between homophily and acrophily, there was quite a lot of variance in whether participants behaviour was closer to homophily or acrophily. Finally, as expected, the average kept ratings in participants' actual choice was also significantly higher than a random selection (study 1: $b = −1.111$, $t = −6.15$, 95% confidence interval [−1.117, −1.106], $P < 0.001$; study 2: $b = −1.313$, $t = −12.44$, 95% confidence interval [−1.316, −1.311], $P < 0.001$) and the acrophily lower strategy (Study 1: $b = −1.911$, $t = −10.58$, 95% confidence interval [−1.915, −1.907], $P < 0.001$; study 2: $b = −1.351$, $t = −12.80$, 95% confidence interval [−1.353, −1.350], $P < 0.001$). Results from our comparisons in the choice condition provided further evidence that participants' tie selection choice included a combination of homophily + acrophily towards more emotional responses.

Looking next at the conservative participants in study 2, as expected, results suggested the exact opposite: conservatives' peer choices were lower than what they would have chosen with just homophily ($b = 0.271$, $t = 2.02$, 95% confidence interval [0.269, 0.272], $P = 0.04$ [0.044, 0.45]) and higher than the acrophily lower simulation ($b = 0.515$, $t = −3.85$, 95% confidence interval [−0.517, −0.514], $P < 0.001$), suggesting that choices were between homophily and acrophily lower (but 88% closer to homophily in this case), which represented a more extreme conservative view. As expected, the average rating of the actually kept peers was significantly lower than a random selection ($b = 0.860$, $t = 6.43$, 95% confidence interval [0.857, 0.862], $P < 0.001$) and also significantly lower than the acrophily higher simulation ($b = 1.192$, $t = 8.91$, 95% confidence interval [1.190, 1.194], $P < 0.001$). Results from our comparisons in the choice condition provide further evidence that participants' tie selection choices involved a combination of homophily and acrophily, but in this case towards less intense ratings.

Study 3. The goal of study 3 was to replicate findings of study 2 and further test a potential mechanism driving acrophily. We hypothesized that participants were selecting ties who are more extreme because they evaluated these extreme responses as more prototypical of their groups' responses. To evaluate this hypothesis, participants first completed a task that was similar to that of studies 1 and 2 (with some minor differences; Methods). At a second stage, participants were then shown six of the trials they completed again (with the exact same peer responses) and were asked to rank the three responses that represented the most prototypical response of their own political group. We did not provide participants further details regarding the meaning of that term but assumed that participants understood it to be related to the political spectrum.

Similar to studies 1 and 2, we first found evidence for homophily (homophily analysis in Supplementary Information). We then tested whether participants' tie selections were also driven by acrophily. Looking first at the acrophily coefficients using the same analysis as in studies 1 and 2, results suggested that the coefficient for the liberal participants was positive, significantly different from zero and very similar to the one found in previous studies ($b = 0.32$, $t(374) = 6.54$, $P < 0.001$, $R^2 = 0.28$, 95% confidence interval [0.22, 0.42]). Similar to studies

1 and 2, the acrophily coefficient became stronger with trial number for liberal participants ($b = 0.04$, $t(7,161) = 2.46$, $P = 0.01$, $R^2 = 0.28$, 95% confidence interval [0.01, 0.08]). For the conservative participants, results suggested that the acrophily coefficient was negative, significantly different from zero, and slightly smaller than in study 2 ($b = −0.15$, $t(374) = −3.06$, $P = 0.001$, $R^2 = 0.28$, 95% confidence interval [−0.25, −0.05]), pointing to an acrophily tie selection strategy. Interestingly, results suggested that the acrophily shown in our conservative participants decreased with trial number ($b = 0.06$, $t(7,161) = 3.46$, $P < 0.001$, $R^2 = 0.28$, 95% confidence interval [0.03, 0.10]). It is unclear why acrophily decreased for conservatives and increased for liberals. This could be caused by the salience of strong emotional responses that reduce the strength of acrophily over time, or by some inherent differences in the way acrophily operates between liberals and conservatives.

We then turned to our second method of evaluating acrophily, by comparing it with simulated data of various strategies replicating the results of study 2. Looking first at liberals, results suggested that the average rating of the actually kept peers was significantly higher than just homophily ($b = −4.87$, $t = −5.06$, 95% confidence interval [−4.86, −4.89], $P < 0.001$), and significantly lower compared with the acrophily higher simulation ($b = 5.88$, $t = 6.11$, 95% confidence interval [5.87, 5.89], $P < 0.001$), revealing again a mix of homophily and acrophily, with distant from acrophily ~20% bigger. Finally, as expected, the average kept rating in participants' actual selection was significantly higher than a random selection ($b = −15.22$, $t = −15.81$, 95% confidence interval [−15.24, −15.20], $P < .001$), and also significantly higher than the acrophily lower simulation ($b = −19.26$, $t = −20.00$, 95% confidence interval [−19.27, −19.25], $P < 0.001$), suggesting that average kept ratings are between homophily and acrophily. Findings of the conservative participants were as expected, the exact opposite. The average rating of the conservative tie selection was lower than just homophily ($b = 2.28$, $t = 2.28$, 95% confidence interval [2.27, 2.29], $P < 0.001$), and higher than the acrophily lower simulation ($b = −7.24$, $t = −7.25$, 95% confidence interval [−7.25, 7.23], $P < 0.001$). In this case, however, conservative choices were much closer to homophily that previously seen (although still significant on average). Finally, as expected, the average kept rating in participants' actual choices was also significantly lower than a random selection ($b = 21.26$, $t = 21.29$, 95% confidence interval [21.24, 21.29], $P < 0.001$) and significantly lower than the acrophily higher simulation ($b = 18.47$, $t = 18.49$, 95% confidence interval [18.46, 18.48], $P < 0.001$).

After establishing the existence of acrophily, we then turned to examine one possible mechanism for acrophily. As a reminder, after completing the first phase of the task, participants were shown six previous trials that were identical to those they just saw and were asked to rank the most prototypical response of their group of the available six peers, from 1 to 3. To analyse this phase of the task, we created a difference score between participants' ratings and the peers participants marked as prototypical, such that a positive number indicated that the chosen prototypical person that was chosen by our participant rated the pictures more strongly than the participant and the opposite for a negative number. As participants chose prototypical peers in order (1–3), we did this for each of the three peers chosen by participants. We then conducted an interaction between the rank of prototypical peer (1–3) and participants' political affiliation in predicting the difference score between participants and the prototypical peer. The outcome could tell us whether the first selected prototypical peer was higher or lower than participant's rating (the intercept of the model), whether this difference was reduced for the second or third selected peer (slope) and whether this was different between liberals and conservatives (interaction).

To evaluate the difference from the most prototypical peer chosen by participants, we made sure that the intercept of the model was equal to the first peer. We first centred our model on the liberal participants. The intercept of the model was significantly positive, suggesting that the most prototypical peer designated by the liberal
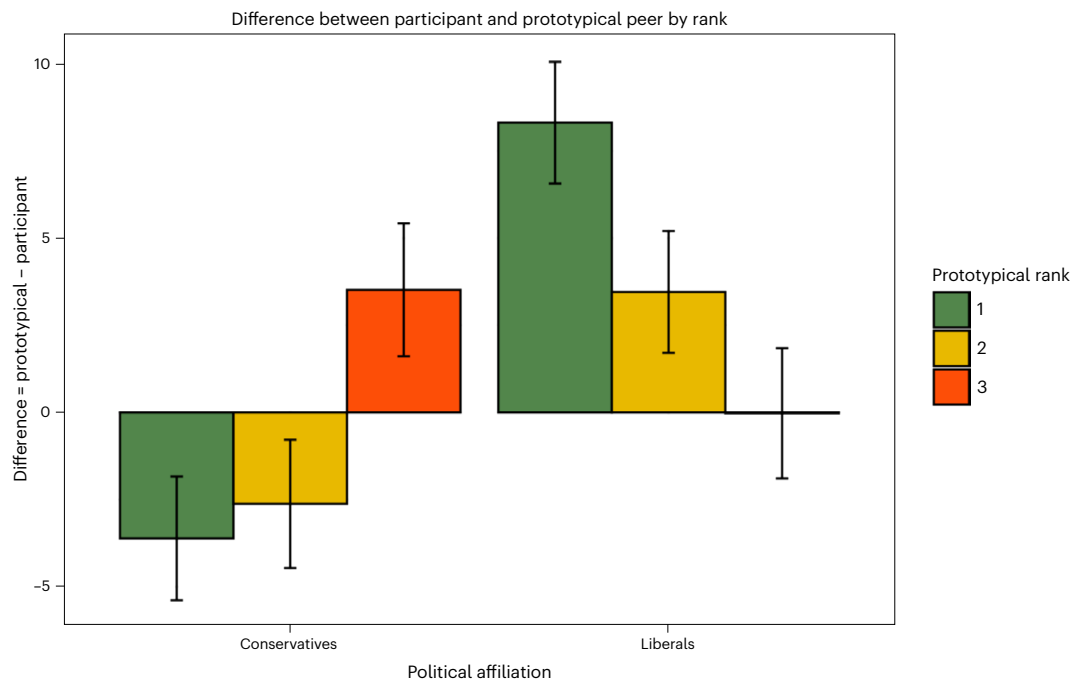
Fig. 4 | Results from study 3. The difference between participants' ratings and the peers they chose as most prototypical of their political camp in a rank order of 1 to 3 ($N = 387$). Liberals evaluated the first most prototypical peer as well as the second most prototypical peer to be expressing stronger emotions than their own emotions. The third peer seems to be equal to participants' emotions, but this is caused by the fact that there were not available peers who were expressing stronger emotions after the first two. Conservatives show the same patter but in the opposite direction. Conservatives evaluated the first most prototypical peer as well as the second most prototypical peer to be expressing less strong emotions compared with their own emotion. The third most prototypical peer seems to be expressing stronger emotions, but this is caused by the fact that there were not available peers who were expressing weaker emotions after the first two. Error bars represent 95% confidence intervals.

participants was estimated to express more negative emotions compared to participants' own ratings by 8.07 points on the 1–100 scale ($b = 8.07$, $t(545) = 6.02$, $P < 0.001$, $R^2 = 0.30$, 95% confidence interval [5.45, 10.70]). As expected, going down the prototypicality rank led to reduced difference between participants and the prototypical peer ($b = -4.15$, $t(545) = -7.50$, $P < 0.001$, $R^2 = 0.30$, 95% confidence interval [−5.25, −3.07]), as fewer peers who expressed stronger emotions were available (Fig. 4). We then centred the model on the conservative participants. The intercept of the model was significantly negative, suggesting that the most prototypical peer designated by the conservative participants was estimated to express less negative emotions compared with participants' own ratings by 4.47 points ($b = -4.47$, $t(545) = -3.23$, $P < 0.001$, $R^2 = 0.30$, 95% confidence interval [−7.17, −1.76]). As expected, going down the prototypicality rank led to reduced difference between participants and the prototypical peer ($b = 0.56$, $t(545) = 6.23$, $P < 0.001$, $R^2 = 0.30$, 95% confidence interval [2.44, 4.68]). Notice that conservatives' third choice was on average higher in rating than participants' own ratings. This is probably caused by the fact that on average there were not enough conservatives who were more extreme than participants by the third choice. Results also revealed a stronger difference for liberals, such that liberals assumed prototypical members to be more extreme compared with the assumption made by conservative (for further information, see prototypicality and political affiliation in Supplementary Information).

Finally, to further investigate participants' evaluation of prototypical peers as a potential mechanism for acrophily, we examined the association between two tendencies: participants' degree of acrophily and their tendency to mark more extreme participants as prototypicality. Given that the acrophily tendency and the ratings of prototypicality were done in different trials, we decided to average participants' acrophily coefficient as well as participants' average rating of the prototypical peer. Results suggested a significant association between participants' acrophily and participants' choice of the prototypical members of their political group ($b = 0.30$, $t(375) = 6.29$, $P < 0.001$, $R^2 = 0.09$, 95% confidence interval [0.34, 0.44]), supporting the idea that participants choice of prototypicality was associated with their degree of acrophily.

Study 4

The goal of study 4 was to address key limitations of studies 1–3. First, we wanted to examine whether acrophily can be seen in tie selection based on other types of responses than emotions, asking participants to rate and choose ties on the basis of support for four different political policies associated with four highly contentious topics: affirmative action, gun control, hunting and military budget. Second, we wanted to see whether acrophily is evident when participants choose to keep rather than eliminate peers. Third, we wanted to simplify the task to allow acrophily to be detected without using simulations. To be able to achieve these goals, study 4 has quite a different design from the previous studies. However, we believe that by addressing the limitations of studies 1–3, we were able expand the notion of acrophily in important ways. In the revised task, participants provided text responses and rating of support (1–7 scale) for four political policies. After rating each policy, participants saw seven peers who provided all potential responses to the policy on a 1–7 scale. Then, participants were asked to choose one peer whose response they would like to keep (Fig. 5).

To evaluate acrophily, we created an acrophily difference score such that higher scores always indicated choosing to keep a peer whose rating represented a more extreme view in relation to the specific policy and political affiliation of the chooser. This allowed us to compare acrophily among participants with different political affiliations. We then conducted an analysis with participants' political affiliation as the independent variable and the acrophily difference score as the dependent variable. The model also included two random intercepts, one of
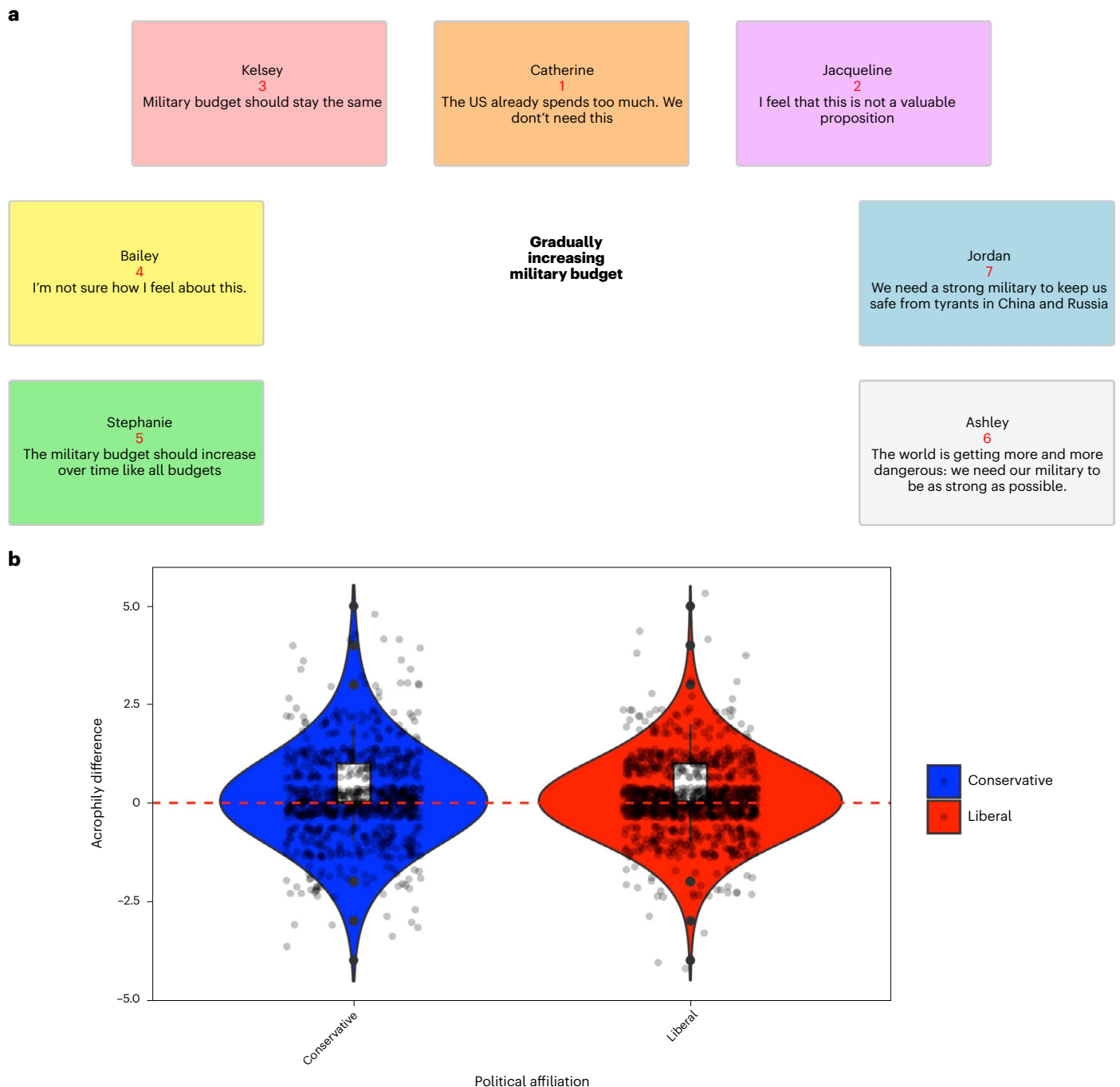
a

Kelsey 3 — Military budget should stay the same	**Catherine** 1 — The US already spends too much. We don't need this	**Jacqueline** 2 — I feel that this is not a valuable proposition
Bailey 4 — I'm not sure how I feel about this.	**Gradually increasing military budget**	**Jordan** 7 — We need a strong military to keep us safe from tyrants in China and Russia
Stephanie 5 — The military budget should increase over time like all budgets		**Ashley** 6 — The world is getting more and more dangerous: we need our military to be as strong as possible.

b

Fig. 5 | Task and results of study 4. a, Representative peer rating window from which participants were asked to choose one peer they would like to keep. **b**, Acrophily difference between participants and the peer they chose to keep in response to each concept (*N* = 386). Positive values represent acrophily, and results suggest acrophily in both the liberal and conservative users. The boxes represent the interquartile range (IQR). The lines represent the first quartile − 1.5 IQR and the third quartile + 1.5 IQR.

participants' ID and one of policy type. Looking first at the intercept of the model, which was our liberal participants, results suggested that our liberal participants chose to keep peers whose rating represented a more extreme view compared with their own ($b = 0.12$, $t(427) = 3.62$, $P < 0.001$, $R^2 = 0.02$, 95% confidence interval [0.05, 0.18]). There was no difference between liberals and conservatives in their degree of acrophily ($b = 0.01$, $t(415) = 0.19$, $P = 0.84$, $R^2 = 0.02$, 95% confidence interval [−0.08, 0.10]) as conservatives also showed a tendency for acrophily. Results provide important additional evidence regarding acrophily. First, it seems that acrophily can occur in context other than emotions. This is important because it suggests that acrophily is even more common than initially thought and can occur when choosing ties on the basis of a variety of response types. Second, it suggests that acrophily can occur when people choose new ties, rather than eliminate existing ones, again expanding the situations in which acrophily can occur. Third, the simplicity of the current task provides evidence that acrophily can occur in a much simpler contexts, in which participant do not need to make decisions on multiple ties at the same time. This is encouraging because it presents a road map for future research on this topic. Importantly, the effects that were found in this final study are relatively small. However, notice that this analysis includes participants who rated certain stimuli as 7 or 1 and therefore cannot reach

acrophily. Removing such ratings (which represent 31.3% of all ratings) doubles the effect (study 4 analysis in Supplementary Information). Albeit small, these results are especially striking given the structure of the task and the fact that participants just rated their response to the stimuli and then immediately chose users whose ratings are more extreme than their own.

General discussion

The goal of the current project was to introduce the concept of acrophily—the tendency to prefer to affiliate with others with more extreme (as opposed to more moderate) political views—and to assess whether acrophily is evident in tie selection decisions as an additional driving force of political segregation and polarization. In four studies, we showed that participants tended to keep ties whose ratings reflected a preference towards more extreme (versus more moderate) views. Importantly, we found strong evidence for homophily as well, and participants' tie selection strategy seemed to reflect a mix of homophily and acrophily.

Our findings have important implications for understanding political segregation. If people's tie selection is affected by acrophily in addition to homophily, we should assume that segregation occurs at a faster rate and leads to more extreme outcomes than would otherwise be expected. To evaluate this possibility, we created an agent-based model (section on agent-based model of network segregation in Supplementary Information) that randomly populated a network of both liberals and conservatives and examined the rate and degree of network segregation as a result of homophily alone, acrophily alone or a combination of homophily and acrophily similar to that found in our studies. As expected, our simulation suggested stronger segregation in either version featuring acrophily, relative to homophily alone.

Research on acrophily is especially important in the current digital era, in which people make many tie selection decisions every day. Social media algorithms are often designed to increase or decrease strength in ties on the basis of users' activity. Liking a certain post on social media is likely to lead to an increase in tie strength with the person who produced the post, and ignoring a post is likely to contribute to weakening of a social tie. Therefore, in the many hours that people spend on social media every day, they make many tie selection decisions. Further specifying tie selection strategies and the psychological processes that give rise to them is of utmost importance in light of their daily prevalence and their impact on social segregation.

In addition to providing evidence for the existence of acrophily, results of study 3 also provided an indication of why acrophily may be occurring, suggesting that one reason for the preference for more extreme views is that participants see the prototypical group member as more extreme than they actually are, and may want to have ties to these prototypical ingroup members. Further analysis supporting this idea revealed that individual-level tendencies to evaluate prototypical peers as extremes were associated with increased tendencies for acrophily. One limitation of the current measure is that participants were asked to indicated a prototypical member of their group, without specifically indicating a political group. Future work should re-examine this evaluation with a more specific indication of political group.

Despite this encouraging evidence, it is likely that other mechanisms also contribute to acrophily. One such mechanism is the relative salience of extreme views. Such salience may be caused by increased certainty[48,49], the use of more covert signals of one's own group membership[50] and the fact that increased certainty is probably associated with increased willingness to express political views. In the current set of studies, acrophily was found while keeping the frequency of occurrence constant. Yet, in real social interactions, extreme users may be even more salient, which should increase the effect of acrophily. Further studies should further examine these potential mechanisms looking at more natural interactions.

Our experiments leave open several questions regarding how acrophily is translated to emotions, attitudes and behaviour outside the lab. One limitation relates to the fact that in each study participants chose ties on the basis of peers' responses to a single issue, whereas in the real world multiple issues drive processes of tie selections. We chose to minimize the complexity of information about the peers whom participants saw in order to reveal the occurrence of acrophily. However, it is likely that tie selection decisions that are made on the basis of responses to a single issue are more susceptible to acrophily than more complex tie selection decisions, in which people need to balance multiple issues[51]. Future studies should examine the existence of acrophily in natural social settings, for example, on social media, or in closed organizations such as companies and schools. Future studies should also examine whether acrophily occurs in topics that are not political in nature.

A second limitation relates to the goals that participants had for keeping certain peers. In the current study, the goal was much simpler than in many interactions in real life: to keep seeing their response in a subsequent trial. In many situations outside the lab, people choose ties to achieve various affiliative and strategic needs. Future studies should modify the goals for participants' interactions and examine how they affect the occurrence of acrophily.

A third limitation of the current work is that we focused on providing evidence for acrophily rather than thinking about what could mitigate the effects of acrophily. Future work should examine the possibility of mitigating participants' tendency towards acrophily by either making them aware of such tendency, or by providing them information of the true prototypical ratings of their group members.

Finally, our findings raise interesting questions about the drivers of recent changes in political segregation. Given that we see much higher levels of segregation and polarization in the United States and in other societies around the globe now than ever before, one interesting question is what has changed. A related question is what the future holds given the tendency of acrophily. It is possible that acrophily tendencies would taper off when segregation reaches an extreme level, but whether and when this would happen is not clear. We believe that our demonstration of the presence of both homophily and acrophily in political tie selection decisions can inform investigation of segregation, and we see great potential in not only further investigating acrophily but also perhaps finding ways to reduce acrophily and segregation.

Methods

This research was approved by Stanford University (study 1: IRB7373) and Harvard University (studies 2 and 3: IRB19-1409; study 4: IRB21-0698). All participants provided informed consent and were compensated for their time.

Studies 1–3

Participants. In study 1, we used data from a task that resembled the task used in the present research to be able to estimate the required sample size. Our estimated sample size for study 1 was based on finding evidence for homophily. Results suggested that using 30 participants completing 20 trials in our experimental condition would be enough to obtain almost 100% power for the study (for power estimations based on each sample size, see Supplementary Information). As our study included both choice and no choice conditions, the final sample of study 1 included 70 participants (males: 26, females: 42, other: 2; age: mean 21.30 years, s.d. 9.20 years) randomly assigned either to a choice condition or to a no choice condition (described in detail below). All of the participants were American citizens who self-identified as liberals. Participants were recruited using the Stanford University paid participant pool, which includes a mix of Stanford students and community members. Participants received $10 for their participation in the study. Notice that this lab study was merely the first examination of the phenomenon and sample sizes were dramatically increased in studies

2 and 3 when transitioning the task to online studies. No participants who completed the study were removed from the analysis.

Study 2 was designed with the goal to recruit a larger and more diverse participant sample. For this reason, we converted our lab task into an online task and increased the target sample size to 400 participants (200 in the choice condition), with the hope of recruiting 200 liberals and 200 conservatives and increasing the power to almost 100% (power analysis in Supplementary Information). Participants were recruited using the online platform Prolific in exchange for $2.50 (~20 min). Out of the 400 participants who completed our task, we removed 8 participants for providing nonsensical text responses or not providing their demographics. Our final sample therefore included 392 participants (males: 228, females: 160, other: 4; age: mean 37.15 years, s.d. 13.49 years), who were randomly divided into no choice and choice conditions. All participants were American citizens. We were aiming to get an equal number of participants in each political side. Accordingly, in terms of their political affiliation, 184 participants identified as liberals, 180 identified as conservatives and 28 identified as located in the middle. We removed middle participants from the main analysis.

In study 3, as in study 2, we recruited 400 participants with the hope of recruiting 200 liberals and 200 conservatives. Participants were recruited using the online platform Prolific in exchange for $3.5 (~30 min). Out of the 400 participants who completed our task, we removed 13 participants for providing nonsensical text responses or not providing their demographics. Our final sample therefore included 387 participants (males: 236, females: 149, other: 2; age: mean 43.25 years, s.d. 13.14 years). All participants were American citizens. In terms of their political affiliation, 194 participants identified as liberals, 183 identified as conservatives and 10 identified as located in the middle. Similar to study 2, we removed middle participants from the main analysis.

Tie selection task. The structure of the tie selection task was the same in all studies with a few modifications that will be described below. Participants were told that they were taking part in a study with the goal of understanding how people respond emotionally to political situations, as well as how they make decisions about what responses they would like to see. The task included 3 practice (in which participants saw anger-inducing pictures relating to driving) and 20 actual trials. In the actual trials, participants saw pictures of police brutality against Black demonstrators. Pictures were pre-tested to elicit negative emotions, primarily anger (full description in the image pool below). For each picture, participants were first asked to provide their emotional response to the picture in a few words (Fig. 2). After providing their response, participants were asked to rate their emotions in response to the picture on a scale of 1 (no negative emotion) to 9 (a lot of negative emotion). We chose to use a neutral to negative emotion scale rather than a positive to negative scale for two reasons. First, measuring tie decisions on the basis of a neutral to negative scale allowed us to test in study 2 whether acrophily is caused by just attraction to more emotion, or rather to extreme views expressed by either no emotion or a lot of emotion, depending on one's political beliefs. Second, we specifically selected pictures that were evaluated as eliciting negative emotions by more than 90% of the participants including conservatives (see description below), which means that positive raters would be outliers and would change the focus of the task.

After rating and responding to the picture, participants then saw six boxes, each containing a peer response to the same picture that they just rated. Each box included a name that was congruent with the participant's gender. Names were chosen randomly from a list of popular names from 2017 (for full list, see Supplementary Information). Below the peer name, participants saw the peer rating and their text response to the same picture. Each box had a unique colour to help participants identify the peer in future trials. Peer ratings and responses were collected in a pre-test and reflected real ratings by real participants

(for further details, see image and peer pool). Participants were forced to look at the six responses for 5 s before making any decisions. After 5 s, participants' choices were different depending on whether they were assigned to the choice versus no choice conditions. In the choice condition, participants were asked to select three peers they would not want to see in a subsequent trial by clicking on the boxes they wished to eliminate. Clicking on each box eliminated it from the screen. We chose to instruct participants to eliminate those they did not want to see rather than selecting those they did want to see in order to emphasize the fact that eliminated participants are never shown again. In the no choice condition, a random subset of three names was coloured in red. Participants were asked to click on the boxes with the red names. In both conditions, participants were told that the eliminated peers would be eliminated completely from the entire task and their names and responses would not be seen again, while the kept participants would be seen in the subsequent trial.

After eliminating three peers in each trial, participants transitioned to the next trial, in which they were again asked to provide a text response and rate their emotional response to a new picture of police brutality. Participants were then shown six boxes with six responses to the new picture. In every trial except for the first, three of the six boxes were of peers who were kept from the previous trial. These boxes retained the same location, colour and name from the previous trial, and the peer ratings and responses were produced by the same original person who participants kept from the previous trial. The other three boxes were randomly generated from the peer pool and included new names, ratings and responses. After completing 20 trials in which they provided their responses to new pictures and chose to eliminate three new peers, participants completed a short survey described below.

Image and peer pool. We conducted a pilot study to create the image pool for the study, testing 40 candidate pictures of police brutality against Black citizens. One hundred and four participants were presented with each picture and were asked to first provide a text response to the picture. Participants were then asked to rate their emotional response to the picture using the same scale that was used in the task. Finally, participants were asked to select whether observing the picture elicited a negative emotion, positive emotion or no emotion at all. This question did not appear in the actual task and was used to select which pictures would be used. Two criteria were used to select the pictures. First, all of the selected pictures were rated by less than 10% of participants as positive. Second, we excluded pictures whose average rating was higher than 7 or lower than 3 (to allow variance in peer responses). As expected, our pictures were rated as eliciting significantly more negative emotion by liberals compared with conservatives (Supplementary Fig. 1).

Out of the 104 participants who completed the pilot study, we chose 63 participants to be part of our peer pool to allow for the elimination of three peers in each trial in addition to six peers in the first trial (19 × 3 + 6). Our first criterion in choosing peers was to make sure that our peer pool was heterogeneous in terms of political affiliation. We chose 30 conservative, 30 liberals and 3 participants who self-identified as middle. Our second criterion for choosing our peers was participants' text. We chose participants who mostly provided more than one-word responses to all of the pictures, and ones whose text responses were more or less similar to their ratings in terms of emotional intensity. After choosing our peer pool, we provided final editing of participants' responses to make sure that the peer text was coherent and that it matched their ratings of the pictures. In study 2 we slightly modified our peer pool by removing some liberal peers who provided less elaborate text, and substituting them with data from participants from study 1. Similar to study 1, our final peer sample included 30 conservatives, 30 liberals and 3 peers who identified as being in the middle of the political spectrum.

Study 3 was based on study 2's procedure with four meaningful changes. First, participants were only assigned to the select condition, as the goal was to get a better sense of the mechanism for acrophily. Second, we recreated our peer pool from that of study 2, by employing a new set of peers who provided new responses to the pictures of police brutality in the task. The reason for this change is that the social movement related to the death of George Floyd occurred between studies 2 and 3 and we suspected that such a large-scale movement may have changed people's attitudes towards police brutality. We therefore ran an additional pilot in which we created a new peer pool to the same pictures of studies 1 and 2 (Supplementary Information). Third, we changed the scale participants used to rate their emotions from 1–9 to 0–100, 0 indicating no outrage and 100 very strong outrage. This was done to increase the variance in participants' responses. The fourth and most important change to the task was our measurements of the prototypicality of response. After completing the task in a similar way to studies 1 and 2, participants then completed six additional trials in which they saw a copy of a previous trial (trials 3, 6, 9, 12, 15 and 18) and were asked to rank the responses that represented the top three most prototypical responses of their political group using this question: 'Choose the three peers that represent the most prototypical response of your political group.' After completing these six trials, participants were forwarded to a survey that included a few final questions described below.

Measures. While completing the task, we collected participants' ratings and text in response to each picture. We also recorded which peers they chose to keep versus eliminate. In study 1, after completing the task, participants completed a survey that included two questions relating to their motivation to keep certain peers based on similarity and difference. In the similarity question, participants were asked: 'To what extent did you choose people who felt similar emotions to you in response to the pictures?' In the difference question, participants were asked the same question, but using the words 'different emotions' instead. Participants rated their response using a scale from 1 (not at all) to 6 (very much so). Participants also completed a few scales including a group identification scale[52], a heterogeneity test in which participants were asked to estimate what portion of their social environment has different race, socio-economic status, a political affiliation measure, a need-to-belong scale[53] and a personality scale[54]. These scales were measured with the intention of testing them as potential mechanisms for acrophily (for full description and analysis of the connection between these scales and acrophily, see Supplementary Tables 1, 5, 6, 10 and 11). In study 2 we removed the need to belong scales from our survey and added a few new scales in which we examined potential motivations for acrophily (choosing people because they are more creative, provided new interpretations, made the participants feel good, and so on), feeling thermometers for various groups[55], and participants' political identification (for further analysis, see Supplementary Information). In study 3, after participants completed the task, we measured participants' ranking of peers' prototypicality using the task described above. Finally, participants answered a few survey questions that were similar to study 2 (Supplementary Information).

Study 4

We recruited 400 participants after processing results from study 3 to ensure that a sample of this size would produce power of >0.9, even when we reduced the stimuli from 20 to 4. Participants were recruited using the online platform mTurk in exchange for $3.5 (~30 min). Out of the 400 participants who completed our task, we removed 14 participants for providing nonsensical text responses or not providing their demographics. Our final sample therefore included 386 participants (males: 199, females: 183, other: 4; age: mean 39.88 years, s.d. 12.04 years). All participants were American citizens. In terms of their political affiliation, 217 participants identified as liberals and 169 identified as conservatives. We had no participants identified as middle in this study as participants had to make a binary choice at the beginning of the task.

Tie selection task. The structure of the task was based on the task used in studies 1–3 with a few important modifications. The task included one practice trial and four actual trials. Participants saw texts describing a political policy (see description below). For each policy, participants were first asked to provide their text response to the policy in a few words. After providing their response, participants were asked to rate their support for the policy on a scale of 1 (completely against) to 7 (completely support).

After rating and responding to the policies, participants then saw seven boxes, each containing a peer response to the same policy that they just rated. While the type of content in the boxes was similar to studies 1–3 and included a name, a rating and a text, there were a few important differences in this stage compared with the task used in studies 1–3. First, we made sure that all seven optional responses were present at each trial, covering the whole scale from 1 to 7. This was designed to allow participants in each trial to choose the exact rating that they wanted and not be limited by what was available from the random draw. We decided to use this structure to simplify the detection of acrophily. The order of ratings was randomized to make sure that participants looked at the whole screen. Here again, participants had to watch all the boxes for 5 s before making their pick. Second, instead of choosing to eliminate peers, participants chose the peer they wanted to keep. This was to make sure that acrophily can be detected both in decisions to keep and to eliminate. Third, participants were asked to choose just one peer of the seven on the screen. This was modified because there was always one peer per rating. Fourth, peers who were kept in a certain trial were not necessarily carried forward to the next trial owing to the structure of the task. Unlike previous tasks, participants were not told explicitly that choosing to keep certain people would mean that participants would see them in subsequent trials.

Policy and peer pool. We conducted a pilot study to create the policy pool for the study, testing multiple six candidate policies. One hundred and six participants were presented with each policy and were asked to first provide a text response to the picture. Participants were then asked to rate their support for the policy using the same 1–7 scale that was used in the task. We selected the four policies that produced the least polarized ratings (to allow for the possibility of acrophily), with the intention of selecting two eliciting more support among conservatives and two among liberals: ('Gradually increasing military budget', 'Reducing the power of the federal government over states', 'Increasing affirmative action to minorities' and 'Increasing restrictions on hunting'). As expected, our policies were rated differently by conservatives and liberals (Supplementary Fig. 3).

For each policy and for each rating (from 1 to 7), we chose four responses based on coherence and fit between the text and the ratings (Supplementary Table 15). In the cases in which it was possible, we tried to get two responses by a liberal and two responses by a conservative for each rating. In the few cases in which such responses were not available, we used responses from the other political group. This meant that participants in our task saw responses that were mostly produced by people who identified with their own political group, despite the fact that these included all ratings from 1 to 7 in response to each policy.

Measures. While completing the task, we collected participants' ratings and text in response to each picture. We also recorded which peers they chose to keep versus eliminate. After completing the task, participants completed a survey that included a few questions, similar to study 2, in which we examined potential motivations for acrophily (choosing people because they are more creative, provided new interpretations, made the participants feel good, and so on), a personality

scale and participants' political identification (for further analysis, see Supplementary Tables 16 and 17).

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

Data for study 1 are available here: https://osf.io/nz4dk/. Data for studies 2–4 are available here: https://osf.io/649fq/. Data for the agent-based model are available here: https://osf.io/ad7vh/.

Code availability

Code for study 1 is available here: https://osf.io/nz4dk/. Code for studies 2–4 is available here: https://osf.io/649fq/. Code for the agent-based model is available here: https://osf.io/ad7vh/.

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Author contributions

A.G., J.J.G., E.H., R.W. and J.M.A. conceived and designed the experiments. A.G., Z.H., J.S. and D.B. ran the experiments. A.G. and J.M.A. analysed studies 1–4. A.G. wrote the paper, and E.H., R.W., J.M.A. and J.J.G. were involved in reviewing and editing the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Data collection was done using a task that was built in jspsych.
Data analysis	Data analysis was done with R and Python

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Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	Studies are mostly repeated-measure within participant tasks evaluated quantitatively.
Research sample	All participants were recruited from prolific/mturk. Data is not representative in terms of population. Specific details: Study 1: N=70; men: 26, women: 42; age: M= 21.30, SD = 9.20, Study 2: N= 392 men: 228, women: 160, Other: 4; age: M= 37.15, SD = 13.49 Study 3: N= 387; men: 236, women:149, other: 2, Age: M = 43.25, SD = 13.14 Study 4: N = 386; men: 199, women:183, other: 4, Age: M = 39.88, SD = 12.04
Sampling strategy	Sampling for Study 1 was done through the Stanford participant pool. Sampling for Study 2 was done through prolific and for Studies 3 and 4 through mturk (using the platform mturk prime). Sample sized were determined by power analyses that were conducted either as a result of previous findings (Study 1), or based on results from the previous studies in the study sequences.
Data collection	All of our data were collected online with a jspsych task that was designed by the research team. Participants were sent to the task and followed the instructions. Once they completed the task, they were sent to a Qualtrics survey and answered a few questions. In cases in which some variables were manipulated, for example when manipulating whether participants were assigned to the choice or no choice conditions, participants were not informed of such manipulations due to the fear that it would affect their performance in the task.
Timing	Start - Feb 2018 End - May 2022.
Data exclusions	Our exclusion criteria for studies 1-4 was for participants who provided nonsensical text responses to the pictures (that were not related at all to the stimuli at hand). Study 1: N=70; excluded - 0 Study 2: N= 392; excluded - 8 Study 3: N= 384; excluded - 13 Study 4: N = 386; excluded - 14
Non-participation	*State how many participants dropped out/declined participation and the reason(s) given OR provide response rate OR state that no participants dropped out/declined participation.*
Randomization	In studies in which was done (Studies 1, 2) this was done randomly.

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☐	☒ Human research participants
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Methods

n/a	Involved in the study
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Policy information about studies involving human research participants

Population characteristics	See above
Recruitment	Participants were recruited through the Stanford participant pool, prolific and mturk.
Ethics oversight	Stanford University (Study 1) Harvard University (Studies 2-4)

Note that full information on the approval of the study protocol must also be provided in the manuscript.