The One that Got Away:
Overestimation of Foregone Alternatives as a Hidden Source of Regret

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Abstract

Past research has established that observing the outcomes of foregone alternatives is an important driver of regret. In this article, we predict and empirically corroborate a seemingly opposite result: Participants in our experiments are more likely to experience regret when they do not observe a foregone outcome than when it is revealed. Our prediction draws on two theoretical observations. First, feelings of regret frequently stem from comparing a chosen option to one’s belief about what the foregone alternative would have been. Second, when there are many alternatives to choose from under uncertainty, the perceived attractiveness of the almost-chosen alternative tends to exceed its reality. In four pre-registered studies (Ns = 800, 599, 150, and 197), we find that participants predictably overestimate the foregone path, and this overestimation causes undue regret. We discuss the psychological implications of this hidden source of regret, and reconcile the ostensible contradiction with past research.

Keywords: Decision-making, Uncertainty, Regret, Counterfactual thinking, Heuristics and Biases
Do you ever wonder what it would have been like if you had gone to the other university for your degree? What if you had chosen the other career path? What if you had married your high school sweetheart? (Or what if you hadn’t?) People naturally reflect on their bygone decisions and, when their past choices look like mistakes, they feel regret.

Psychological research has produced a rich literature on regret in decision making (e.g., Connolly & Butler, 2006; Kahneman & Miller, 1986; Roese et al., 2009; Zeelenberg & Pieters, 2007). A fundamental insight from that literature is that we feel regret when a choice results in an outcome that compares unfavorably to one that could have otherwise been obtained (Connolly & Zeelenberg, 2002; Zeelenberg, 1999). Indeed, decision-makers both anticipate and experience greater regret when they can observe the consequences of unchosen options (e.g., Boles & Messick, 1995; Coricelli et al., 2005; Inman, Dyer, & Jia, 1997; Larrick & Boles, 1995; Ritov, 1996; Zeelenberg, Beattie, van der Pligt, & de Vries, 1996). This robust finding suggests that the direct comparison between the outcomes of chosen and unchosen options is what generates feelings of regret, and that observing the foregone outcome is thus an important driver of regret (e.g., Gigerenzer & García-Retamero, 2017; Golman, Hagmann, & Loewenstein 2017; Janis & Mann, 1977; Zeelenberg, 1999).

In this article, we predict and empirically corroborate a seemingly opposite result: Participants in our experiments are more likely to experience regret when they do not observe the outcome of the foregone alternative than when it is revealed. Our point of departure is the observation that feelings of regret frequently stem from comparing a chosen option’s outcome to one’s belief about what the foregone alternative’s outcome would have been. This observation raises the question of what occurs when beliefs about an unchosen option are systematically biased, and when revealing its outcome can correct that misperception. We will theorize—and
show in four pre-registered experiments—that under predictable circumstances, people systematically overestimate the path not chosen, and that this overestimation leads to more feelings of regret.

A Counterfactual Emotion

Regret has been described as a counterfactual emotion that arises when a decision lacks ex post justification or results in an outcome that falls short of a standard of comparison (Connolly & Zeelenberg, 2002; Kahneman & Miller, 1986; Zeelenberg & Pieters, 2007). Typically, this standard of comparison is determined by the concrete outcomes of unchosen options. A calculus of anticipated regret, in which decision-makers consider the potential regret that they might experience if an unchosen option were to result in a better outcome, has been formalized in both economic (Loomes & Sudgen, 1982) and psychological regret theories (Gigerenzer & García-Retamero, 2017). Under the assumption that people are generally regret-averse, it can explain behavioral patterns in settings as diverse as gambling in Dutch national lotteries (Zeelenberg & Pieters, 2004) and in fMRI scanners (Coricelli et al., 2005), salary negotiations (Larrick & Boles, 1995), and auctions for spectrum licenses and electric power (Engelbrecht-Wiggans & Katok, 2007). Regret can even be regulated by avoiding outcome feedback and information regarding paths not chosen (Zeelenberg & Pieters, 2007; Gigerenzer & García-Retamero, 2017). Based on these findings, previous regret research has emphasized that a foregone alternative’s concrete, observable outcome represents a starker standard of comparison for the chosen alternative than unknown or uncertain counterfactuals.

We complement this work by showing how revealing a foregone alternative’s outcome has a second important consequence: It can correct misperceptions of the foregone alternative’s value or attractiveness. This effect is important because, as we will explicate below, the
perceived attractiveness of an almost-chosen alternative will frequently exceed its reality. Strikingly, when our beliefs about an uncertain counterfactual exhibit positive bias, we are likely to feel more regret when its true outcome remains unknown than when it is revealed.

Noisy Judgments, Biased Beliefs, and Regret

To see why beliefs about foregone alternatives may frequently be biased, consider a decision-maker with imperfect, noisy expectations about several options that he or she is choosing between. The decision-maker may symmetrically overestimate the attractiveness of some options, and underestimate the attractiveness of others. But importantly, overestimating an option’s attractiveness makes that option more likely to be selected—whereas underestimating an option decreases the chance of selection (Smith & Winkler, 2006). When the decision-maker chooses between many alternatives, this asymmetry has an interesting implication that people tend to be naive towards: Those options that look best at the time of choice are more-likely-than-not being overestimated (Tong, Feiler, & Ivantsova, 2018). As a result, the best-looking options often disappoint by being less attractive than we expect them to be.

Now consider a decision-maker who starts with a large consideration set, narrows it down to two final contenders, and finally chooses one of them. We use the term foregone alternative to refer to the second-most preferred option from the large consideration set, i.e., the final contender that was ultimately rejected. By the logic of the previous paragraph, both the chosen option and the foregone alternative—being the two best-looking options from the large set—were likely being overestimated. Moreover, an asymmetry emerges: While the decision-maker will observe, experience, and learn about the chosen option, the foregone alternative remains unknown. Although the “top two” in the consideration set were likely both overestimated,
experience thus only corrects this bias for the chosen path. In contrast, the biased belief about the foregone path persists.

We predict that even though people will be frequently disappointed with the chosen option, they will fail to appreciate that they had probably also overestimated the foregone alternative. An idealized view of the path not taken can then become an unfair standard of comparison for the chosen path. In particular, we hypothesize that a persistent bias by which people overestimate the attractiveness of the foregone alternative leads them to experience regret. We report four pre-registered studies that provide evidence in support of this hypothesis and psychological mechanism.

**Study 1**

According to our theory, decision-makers experience regret after the true outcome of their chosen option is revealed because they tend to overestimate the attractiveness of the foregone alternative. This theory predicts that observing not only the chosen option’s outcome but also that of the foregone alternative should correct this misperception and lead to less regret. Study 1 tests this prediction in a 2-cell, between-participant experiment.

**Methods**

*Participants.* For our pre-registered target of 800 participants, we recruited US residents on Amazon Mechanical Turk using TurkPrime (Litman, Robinson, & Abberbock, 2017). Our participants averaged 33.4 years of age; 394 (or 49.3%) were female; and 76 (9.5%) self-identified as Asian, 60 (7.5%) as African-American, 594 (74.3%) as Caucasian or White, 47 (5.9%) as Hispanic, 17 (2.1%) as multiracial, 4 as Native American, and 1 as Pacific Islander. One participant did not disclose their gender or race. No responses met our pre-registered exclusion criteria (e.g., duplicate IP addresses), so all analyses reported below are based on the
complete sample of 800 responses. Sample sizes for all of our studies reflect the number of conditions and estimates of effect sizes that usually drew on our previous studies and on pilots, and in some cases (Studies 1 and 2) formal power analyses.

Procedure. The experiment consisted of Qualtrics web forms. After a brief attention check, participants were informed that they would be “playing a virtual dating app simulation,” in which they would “see faces of people and consider which person you think is the most attractive.” Participants then indicated whether they wanted to see faces of men or faces of women. To familiarize participants with the photo stimuli—which we describe under Materials below—they were subsequently shown a representative set of five photos ranging from relatively unattractive to relatively attractive in previous ratings.

Figure 1. Screenshot from Experiment 1 showing the choice between two blurred photos that a participant had selected from the initial set of nine.
In the main part of the experiment, participants in both experimental conditions saw nine photos. These photos were also representatively sampled from across the attractiveness distribution (see *Materials* below). Unlike the five example photos, however, the nine photos in the main part were blurred, so that participants could not discern their exact features. Participants were instructed to choose their “top two” favorites from the nine blurred photos. These two photos were then presented once more to the participants, along with the instruction to select the one that they think will be the most attractive when unblurred (see Figure 1).

On the subsequent screen we revealed their chosen face: Each participant saw their chosen photo with the blur removed. The screen also showed participants the other photo from their top two. Participants randomly assigned to the *alternative blurred* condition saw only their chosen photo without the blur, and the other photo remained blurred. In contrast, participants randomly assigned to the *alternative revealed* condition saw both photos without the blur. In other words, we manipulated whether or not the foregone alternative was revealed along with the chosen option, which was always revealed.

In both conditions, we then asked participants: “After seeing the person that you chose, how much regret do you feel from passing on the other person in your Top Two?” They responded on a 7-point scale, ranging from ‘None at all’ to ‘A lot’. On the following screens, we asked participants “How attractive do you think your chosen person is?” and then either “How attractive do you think the other person from your Top Two is?” in the alternative revealed condition, or “If the picture was unblurred, how attractive do you think the other person from your Top Two would be?” in the alternative blurred condition. Participants responded to these questions on 7-point scales ranging from “Not attractive at all” to “Extremely attractive.” The study concluded with a short demographic questionnaire, asking participants to report age,
ethnicity, gender, and relationship status. It did not include any measures or conditions that are not reported here.

**Materials.** The photo stimuli that we used for the study were taken from the Chicago Face Database developed and maintained by Ma, Correll, and Wittenbrink (2015). The database provides high-resolution, standardized photographs of male and female faces of varying ethnicity between the ages of 17-65. Importantly, it comes with norming data featuring age and attractiveness ratings from more than 1000 independent judges. From the complete database, we extracted all photos of faces rated to be between 20 and 30 years of age. This resulted in a base set of 170 male faces and 213 female faces.

We then constructed, for each gender, a representative example set that we could show participants to familiarize them with the stimuli. For each gender, the example set included the five photos with ratings exactly at the 10th, 30th, 50th, 70th, and 90th percentile of the rated attractiveness distribution.

Next, we constructed the stimulus sets for the main part of the experiment. For each gender, we created 9 equal-sized bins, containing faces with attractiveness ratings near the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, or 90th percentiles (see Online Supplement for further details on this process). From each of these bins, we then randomly sampled one photo for each of the four ethnicities in the database (Asian, Black, Latinx, and White). We thus ultimately have a total of 72 photos in our experiment (9 attractiveness bins x 2 genders x 4 ethnicities). In the experiment, each participant chose which gender they would like to see and we showed them a representative consideration set by randomly selecting one face from each attractiveness bin.

**Pre-Registration.** We pre-registered our experimental design, data collection, and statistical methodology at https://aspredicted.org/blind.php?x=kw2jp6 (February 16, 2021).
Results

We first compared the proportion of participants in each condition that reported regretting their choice. As shown in Figure 2, participants were significantly more likely to report feeling regret when the photo they had shortlisted but not chosen was left blurred (285/402, or 70.9%) than when it was unblurred (245/398, or 61.6%), as predicted in our pre-registration, $\chi^2(1, N = 800) = 7.80, p < .01$, odds ratio ($OR$) = 1.52, 95% confidence interval ($CI$) for the $OR = [1.13, 2.04]$, $\phi = .099$. This effect also obtained—and with virtually the same effect size—in a logistic regression with fixed effects for the chosen photos, $b_{\text{Condition}} = 0.42$, $SE(b) = 0.16$, $z = 2.57$, $p = .01$, $OR = 1.53$, 95% $CI$ for the $OR = [1.11, 2.11]$. That is, even when holding the revealed, chosen photo constant across conditions, significantly more participants regretted their choice when the photo they had shortlisted but not chosen remained blurred. Table SOM-1 in the Online Supplement shows that the effect is further robust to controlling for the perceived attractiveness of the chosen photo, and for age, ethnicity, gender, and relationship status. Our hypothesis that participants would be more likely to regret their choice when the foregone alternative remained uncertain rather than being revealed thus found strong support in the data.

We then compared mean regret across conditions. On average, regret was slightly higher, when the photo that participants had shortlisted but not chosen was left blurred ($M = 1.97$, $SD = 1.84$) than when it was unblurred ($M = 1.89$, $SD = 1.93$), though not significantly so, $t(798) = .55$, $p = .58$. Table SOM-2 in the Online Supplement shows that mean regret remained slightly but non-significantly higher when the foregone alternative remained blurred in OLS regressions with fixed effects, or controls for the perceived attractiveness of the chosen photo, age, ethnicity, gender, and relationship status. Thus, in terms of regret intensity, our prediction found only directional support in Study 1.
Participants in Study 1 were more likely to regret choosing a photo when their second-most preferred photo remained blurred (dark gray) than when it was unblurred (light gray).

Next, we examined whether beliefs about the attractiveness of the foregone alternative—the shortlisted photo that was not chosen—differed across conditions. This post-hoc analysis tests our theoretical assumption that participants overestimated the attractiveness of the foregone alternative when they could not observe its outcome. Indeed, participants in the alternative blurred condition expected the foregone shortlisted photos to be significantly more attractive if the blur were to be removed ($M = 3.74$, $SD = 1.02$) than their counterparts in the alternative revealed condition perceived the actual, unblurred foregone shortlisted photos to be ($M = 3.45$, $SD = 1.46$), $t(798) = 3.20$, 95% CI for difference in means $= [0.11, 0.46]$, $p < .01$, $d = .23$. We include histograms of the perceived attractiveness of the foregone shortlisted photos for each condition in Figure SOM-1 in the Online Supplement. In contrast, and further in line with our theory, the chosen option—which was unblurred in both conditions—was perceived about equally attractive by participants whose foregone alternative remained blurred ($M = 4.00$, $SD = 1.31$).
1.43) and participants whose foregone alternative was unblurred (M = 3.94, SD = 1.29), t(798) = .60, p = .55.

Lastly, we examined the relation between regret and the photos’ perceived attractiveness to corroborate that the effects we observe are indeed driven by regret and do not reflect a more general positive response to the photo stimuli. A set of OLS regressions, described in detail in Table SOM-3 in the Online Supplement, shows that, consistent with our theory, participants who rated the foregone shortlisted photo as more attractive reported feeling more regret (p < .0001). This effect was significantly larger when the photo was unblurred (p < .01). Also in line with the observed effects being driven by regret, participants who rated their chosen photo as more attractive reported feeling less regret (ps < .0001), and this association was about equally strong in both conditions (p = .21).

On the whole, Study 1 provided initial support for our prediction that participants would overestimate the attractiveness of a foregone alternative when they could not observe its outcome, and that this overestimation can lead to feelings of regret.

**Study 2**

Our second study replicates the finding that observing the outcome of a foregone alternative can reduce regret in a different setting, with a completely different set of stimuli and with monetary incentives.

**Methods**

*Participants.* Our pre-registered target sample was 600 participants, who we recruited through Amazon Mechanical Turk. We opened the call to U.S. residents and collected data from 599 participants. The participants in our final sample averaged 38.5 years of age (1 did not disclose); 251 (or 41.9%) were female, 342 (57.1%) male, and 4 (0.7%) non-binary (2 did not
disclose); and 29 (4.8%) self-identified as Asian, 83 (13.9%) as African-American or Black, 412 (68.8%) as Caucasian or White, 25 (4.2%) as Hispanic, and 5 (0.8%) as Native American.

Procedure. We implemented a variation on the experimental task used by Tong, Feiler, and Ivantsova (2018). Participants assumed the role of chief recruiter at a consulting firm, were presented with a set of ten job candidates, and were tasked with hiring the candidate with the highest ‘ability’ for a job opening. These hiring choices were incentivized with a monetary bonus payment described below.

Participants were informed that the candidates’ abilities were normally distributed with an average ability of 200 and a standard deviation of 20. With a graphical summary in terms of a histogram, and with explanations in non-technical, everyday language, we aimed to make this information maximally accessible. Importantly, participants could not observe the ability of the candidates they could choose from. They instead observed two noisy signals of each candidate’s ability, the “interview score” and the “test score.” These signals provided participants with two independent measures of ability. Participants were informed that, on average, the two measures were equal to a candidate’s true ability and that they were equally accurate. But they were also informed that “each score will usually be somewhat higher or somewhat lower than the candidate’s true ability, because they are not perfect measures.” In particular, they were told that both scores tracked ability with measurement errors that were normally distributed with an average of 0 and a standard deviation of 45, again alongside a histogram and explanations in non-technical, everyday language.

From these distributions for ability and measurement errors, the experimental software then randomly generated ten candidates with their respective abilities, interview scores, and test scores. Based on the observable interview and test scores, participants were instructed to first
create a shortlist consisting of the two candidates that they thought had the highest ability. On the subsequent screen, which again featured the two shortlisted candidates’ interview and test scores, participants decided which of the two to hire.

After making their choice, participants were told that several months after the hiring decision, the HR office had learned the (previously unobservable) chosen candidate's true ability. At this point, participants were randomly assigned to either the alternative concealed or the alternative revealed condition. Participants in the alternative concealed condition were reminded of their other shortlisted candidate—the foregone alternative—and were shown that candidate’s interview and test scores alongside their chosen candidate’s true ability. Participants in the alternative revealed condition were shown both candidates’ true abilities instead. In both conditions, participants were then asked, “After finding out your chosen candidate's true ability, how much regret do you feel from passing on the other shortlisted candidate?” They responded on a 7-point scale, ranging from ‘None at all’ to ‘A lot’.

The study’s final screen informed participants of the monetary bonus payment they would receive. Participants received a 1 cent bonus for each unit that the chosen candidate’s ability exceeded 175. Finally, participants reported their age, ethnicity, gender, highest completed level of education, and current country of residence.

Pre-registration. We pre-registered our experimental design, data collection, exclusion criteria, and statistical methodology at https://aspredicted.org/blind.php?x=hk48rp (January 13, 2021).

Results

In line with our pre-registered prediction, average regret was significantly higher among participants who could not observe the true ability of the candidate they had shortlisted but
ultimately rejected ($M = 3.67, SD = 2.28$) than among participants who could observe both candidates’ true abilities ($M = 3.16, SD = 2.10$), $t(597) = 2.81$, $95\%$ CI for difference in means $= [0.15, 0.85]$, $p < .01$, $d = .23$. This difference in regret across conditions remained of similar magnitude, and statistically significant, when controlling for the revealed true ability of the chosen candidate in an OLS regression, $b_{\text{Condition}} = .43$, $t(596) = 2.62$, $95\%$ CI for $b_{\text{Condition}} = [0.11, 0.76]$, $p < .01$.

Figure 3. Participants in Study 2 were more likely to regret their choice of candidate when they could not observe their second-most preferred candidate’s true ability (dark gray) than when they could observe both candidates’ true abilities (light gray).

The same pattern of results obtained for the binarized measure of the likelihood of regret ($0 = \text{no regret}, 1 = \text{at least some regret}$) that we had also pre-registered. As shown in Figure 3, participants were significantly more likely to report regretting their choice of candidate when they could not observe the true ability of the candidate they had shortlisted but ultimately rejected (232/299, or 77.6%), than when they could observe both candidates’ true abilities.
(166/300, or 55.3%), as predicted in our pre-registration, $\chi^2 (1, N = 599) = 33.3, p < .0001, OR = 2.80, 95\% CI for the OR = [1.96, 3.98], \varphi = .24$. In the Online Supplement, Tables SOM-4 and SOM-5 show that these effects also hold when controlling for age, ethnicity, and gender, and without the pre-registered exclusion criteria.

Study 2 thus provides additional, robust support for our hypothesis that when beliefs about foregone alternatives are likely to be biased high, observing the outcome of a foregone alternative can reduce feelings of regret.

**Study 3**

In this study, we directly measure the proposed mechanism. As in the previous studies, we measure regret after the chosen alternative is revealed. In addition, we had participants explicitly estimate the attractiveness of the foregone alternative. This enabled us to test our hypothesis that beliefs about the foregone alternative are positively biased and that this bias is associated with greater regret.

**Methods**

*Participants.* Our pre-registered target sample was 150 participants, who we recruited through Amazon Mechanical Turk. We opened the call to U.S. residents between 18 and 65 years of age, and collected data from 157 participants. Per our pre-registered exclusion conditions, we winsorized the sample at 2.5 standard deviations for both the dependent variable (5 exclusions) and response time (2 exclusions). All results below and their statistical significance remain qualitatively unchanged when all data are included. The 150 participants in our final sample averaged 36.0 years of age; 57 (or 38.0%) were female; and 9 (6.0%) self-identified as Asian, 7 (4.7%) as African-American or Black, 121 (80.7%) as Caucasian or White, 7 (4.7%) as Hispanic, 5 (3.3%) as multiracial, and 1 (0.7%) as Native American.
Procedure. The procedure was almost identical to the alternative concealed condition in Study 2, but added a second dependent measure to that design. That is, all participants first shortlisted two candidates, then selected one of them, and were later asked whether they felt any regret from passing on the other shortlisted candidate once their chosen candidate’s—but not the other shortlisted candidate’s—true ability was revealed to them. Unlike in Study 2, participants were at this point also asked to estimate the ability of the foregone, shortlisted candidate (with a possible monetary accuracy bonus described below). The regret measure and the ability estimate were elicited on two separate screens that appeared in randomly counterbalanced order.

The study’s final screen revealed the foregone candidate’s true ability and informed participants of the monetary bonus payment they would receive. The bonus consisted of two parts. The first part corresponded to the initial hiring decision, and paid 1 cent for each unit that the chosen candidate’s ability exceeded 175. The second part corresponded to the estimate of the foregone candidate’s ability and paid 30 cents minus 1 cent per unit that the estimate deviated from the foregone candidate’s true ability. Finally, participants reported their gender, age, ethnicity, highest completed level of education, and current country of residence.

Pre-registration. We pre-registered our study design, data collection, exclusion criteria, and statistical methodology at https://aspredicted.org/blind.php?x=sw3t7a (October 16, 2018).

Results
Following our pre-registration, we first tested for positive bias in participants’ beliefs about the foregone alternative—i.e., the “foregone candidate” they had shortlisted but ultimately rejected. Second, we tested whether inflated beliefs about the foregone alternative were associated with greater regret after the chosen candidate’s true ability was revealed.
The pre-registered paired t-test revealed that on average, participants’ estimates of the foregone candidate’s ability were significantly higher than the candidate’s true ability ($M = 6.91$, $SD = 23.11$), $t(149) = 3.66$, 95% CI for difference in means $= [3.18, 10.64]$, $p < .001$, $d = .30$. At the individual level, 96 participants (64.0%) provided estimates higher than the candidate’s true ability, which is significantly higher than chance (binomial test, $p < .001$). In line with our theory, we thus found positive bias in beliefs about the foregone candidate.

We also found evidence for the predicted association between positive beliefs about the foregone candidate and feelings of regret. The pre-registered OLS regression revealed an association between higher estimates of the ability of the foregone candidate and greater regret, albeit just shy of statistical significance, $b_{\text{Ability}} = 0.014$, $t(148) = 1.79$, 95% CI for $b_{\text{Ability}} = [-0.001, 0.029]$, $p = .076$. But this effect was more pronounced, and statistically significant, when controlling for the revealed ability of the chosen candidate, $b_{\text{Ability}} = 0.026$, $t(148) = 3.39$, 95% CI for $b_{\text{Ability}} = [0.010, 0.041]$, $p < .001$. This coefficient estimate translates to sizeable differences in regret: For the range of estimates of the foregone candidate’s ability observed in the data and for the average revealed ability of the chosen candidate, the regression predicts values of regret that range from merely 1.7 for the minimal estimate of the foregone candidate’s ability to 4.1 for the maximal estimate. In the Online Supplement, Tables SOM-6 and SOM-7 show that this effect also holds for a binarized measure of regret, and when controlling for age, ethnicity, and gender, and with no exclusions (deviating from our pre-registration). A histogram of participants’ estimates of the foregone candidate’s true ability can be found in Figure SOM-2.

Consistent with our theory, beliefs about the foregone candidate were inflated because participants tended to shortlist those candidates whose interview and test scores exaggerated their true ability: On average, the two scores’ average was a positively biased signal relative to the
foregone candidates’ true ability ($M = 22.39, SD = 23.76$), paired $t(149) = 11.54$, 95% CI for difference in means $= [18.56, 26.23]$, $p < .0001$, $d = .82$. But their while estimates of the foregone candidate were biased high (see above), participants were not completely naive to this dynamic. In particular, they tended to adjust their estimates downward from the average of the interview and test score ($M = 15.48, SD = 27.97$), paired $t(149) = 6.78$, 95% CI for mean difference $= [10.97, 19.99]$, $p < .00001$, $d = .50$. Participants thus made significant adjustments, but their adjustments were insufficient to fully account for the positive bias in the observed signals.

Study 3 provides direct evidence for inflated beliefs about a foregone alternative. Moreover, these inflated beliefs were associated with greater regret.

**Study 4: Debiasing**

In this experiment we directly manipulated the hypothesized mechanism with a debiasing intervention that allows us to calibrate participants’ beliefs about the foregone alternative. Recalibrating participants’ expectations about the foregone candidate should lessen their regret, according to our theory. We also measured the effect of this debiasing intervention on the extent to which participants wish they had chosen the other shortlisted candidate.

**Methods**

*Participants.* Our pre-registered target sample was 200 participants. We recruited U.S. residents between 18 and 65 years of age through Amazon Mechanical Turk, and collected 203 responses. Per our pre-registered exclusion condition, we winsorized the sample at 2.5 standard deviations for response time (6 exclusions). All results below and their statistical significance remain qualitatively unchanged when all data are included. The 197 participants in our final sample averaged 35.4 years of age; 74 (or 37.6%) were female; and 8 (4.1%) self-identified as
Asian, 15 (7.6%) as African-American or Black, 162 (82.2%) as Caucasian or White, 6 (3.0%) as Hispanic, and 6 (3.0%) as multiracial.

**Procedures.** The procedures in this study were identical to those in Study 3, with the following exceptions. Importantly, the study randomly assigned participants to one of two conditions in a two-cell between-subjects design (“Debias” vs. “Control”). As in Study 3, participants in both conditions shortlisted two candidates from a randomly generated set of ten candidates, and finally hired one of the two shortlisted candidates. After they made their choices, however, and after the chosen candidate’s ability was revealed, participants in the *Debias* condition were shown the optimal, Bayesian estimate of the foregone candidate’s ability given the interview and test scores. In contrast, participants in the *Control* condition were simply shown the foregone candidate’s interview and test scores again. Other than that, the conditions were identical.

As in Study 3, participants answered how much regret they felt from passing on the foregone candidate (on a scale from 1 ‘None at all’ to 7 ‘A lot’) after learning their chosen candidate’s true ability. Additionally, in this experiment they also reported the extent to which they wished they had chosen the other candidate on their shortlist (on a scale from 1 ‘Not at all’ to 7 ‘Very much’). The only other difference from the previous experiment was that there was no estimate of the foregone candidate’s ability.

*Pre-registration.* We pre-registered our experimental design, data collection, exclusion criteria, and statistical methodology at [https://aspredicted.org/blind.php?x=vy5zj6](https://aspredicted.org/blind.php?x=vy5zj6) (September 24, 2018).
Results

Following our pre-registration, we first compared regret across the experimental conditions. As predicted, participants in the *Debias* condition felt significantly less regret ($M = 2.99, SD = 2.04$) than those in the *Control* condition ($M = 3.61, SD = 1.94$), $t(195) = 2.17, p = .031, d = .31$. This difference in regret across conditions remained virtually unchanged, and statistically significant, when controlling for the revealed true ability of the chosen candidate in an OLS regression, $b_{\text{Condition}} = .62, t(194) = 2.48, 95\% \text{ CI for } b_{\text{Condition}} = [0.13, 1.11], p = .014$. We also considered a binarized measure of regret akin to that from Experiment 1 ($0 = \text{no regret}, 1 = \text{at least some regret}$). In line with our predictions, 39 of 98 participants (39.8\%) in the *Debias* condition reported feeling no regret versus 22 of 99 in the *Control* condition (22.2\%), $\chi^2 (1, N = 197) = 7.11, p < .01, OR = 2.31, 95\% \text{ CI for the } OR = [1.24, 4.31], \phi = .19$ (see Figure 4).

In the Online Supplement, Tables SOM-8 and SOM-9 show that these effects also hold when controlling for age, ethnicity, and gender, and without the pre-registered exclusion criteria. Overall, we thus found strong support for our pre-registered prediction that debiasing beliefs about the foregone alternative can weaken feelings of regret.
Figure 4. Participants in Study 4 were less likely to regret choosing a candidate when provided with a Bayesian estimate of the foregone candidate’s true ability (light gray) than in the Control condition (dark gray).

Participants’ wishes to have chosen differently showed a similar, if somewhat weaker, pattern. While participants in the Control condition wished they had chosen the foregone alternative (rather than the chosen option) more than those in the Debias condition, the difference was small ($M_S = 3.67$ vs. 3.38) and not statistically significant, $t(195) = .97, p = .33$.

We once again tested the effect of debiasing on a binarized version of the variable (0 = not at all; 1 otherwise). In the Debias condition, 37 of 98 participants (37.8%) reported feeling no wish to have chosen the other candidate, compared to 18 of 99 in the Control condition (18.2%), $\chi^2 (1, N = 197) = 9.38, p < .01$, $OR = 2.73$, 95% CI for the $OR = [1.42, 5.25]$, $\varphi = .22$. Our pre-registered prediction that debiasing would decrease the wish to have chosen the foregone candidate thus found partial support overall.

In sum, participants were more likely to feel regret in the control condition than in the debias condition. Recalibrating their beliefs about the ability of the foregone alternative
decreased regret—as predicted by a theory in which biased beliefs about a foregone alternative are a key driver of regret.

**Discussion**

We hypothesized that people frequently experience regret because they overestimate the attractiveness of foregone alternatives. In line with this hypothesis, we find in Studies 1 and 2 that the absence of feedback about a foregone alternative can increase regret. In Study 3, we measure the mechanism, showing a positive bias in estimates of the foregone alternative and establishing an empirical association between these beliefs and felt regret. Finally, we directly manipulate the mechanism in Study 4: When we debias estimates by recalibrating participants’ beliefs about the foregone alternative, regret is significantly decreased.

Our findings are robust across two markedly different experimental paradigms. In Study 1’s dating app simulation, participants seek the most attractive face among blurred photos, not unlike the experience of looking for a match in the “noise” of social media. Participants in Studies 2–4, on the other hand, play chief recruiter at a consulting firm and aim to hire the best talent based on imperfect information about candidates’ ability. For the generalizability of our results, this robustness is reassuring. At the same time, both paradigms feature large choice sets, relatively high uncertainty about the attractiveness of alternatives, and foregone alternatives that act as a natural basis for comparison. This points to potential boundary conditions. Appraisals of sufficiently simple foregone alternatives (i.e., those with low uncertainty), for instance, may be quite accurate, leaving little room for overestimation to cause regret. And if other standards of comparison become more salient than a foregone alternative (Huang & Zeelenberg, 2012; Lin, Huang, and Zeelenberg, 2006), the effect we observe may also diminish.
In seeming contradiction with our findings, previous work has identified feedback about unchosen options as a key ingredient for regret (e.g., Coricelli et al., 2005; Larrick & Boles, 1995; Zeelenberg et al., 1996). This difference can be reconciled by understanding how the decision environment shapes the experience of regret. As foreshadowed above, there are two important environmental factors to consider: the size of the choice set and the uncertainty associated with the possible outcomes.

Much foundational work on regret features choices between two options. Moreover, these options usually have only one or two possible outcomes, which the classic paradigms typically describe in detail, along with the precise probabilities associated with them (e.g., Boles & Messick, 1995; Coricelli et al., 2005; Zeelenberg et al., 1996). Such choice environments are an ideal testbed for studying the risk and anticipation of regret, because they provide specificity regarding potential future regret. Feedback about unchosen options raises the possibility of acute regret in these environments if a foregone alternative turns out to be highly desirable (e.g., Larrick & Boles, 1995; Zeelenberg, et al., 1996).

In contrast, we have studied choice environments with larger choice sets and greater uncertainty (or even ambiguity) regarding the outcomes. In these more complex choice environments, foregone alternatives that turn out to be highly desirable may still generate the acute regret that extant research has focused on. In Study 1, for instance, the association between regret and the perceived attractiveness of the foregone shortlisted photo was stronger when the photo was unblurred. But in complex choice environments, beliefs will not always be unbiased—and the absence of feedback about unchosen options raises the possibility of regret when a foregone alternative is erroneously idealized. Our studies document how in larger choice sets with substantial uncertainty or ambiguity, foregone alternatives become unfair standards of
comparison for chosen options and predictably generate regret. But according to our theory, this will generally not occur in choices between few, precisely-described options, where beliefs about foregone alternatives are much more likely to be unbiased. The ostensible contradiction between our findings and classic regret research is thus resolved when the role of the environment is accounted for, adding to our rich understanding of the complex dynamics of regret (Zeelenberg & Pieters, 2007).

Our research may be seen as adopting an “information sampling” perspective on regret (Fiedler, 2000; Fiedler & Juslin, 2006; Kareev, Arnon, & Horwitz-Zeliger, 2002; Le Mens, Kareev, & Avrahami, 2016). In repeated decisions, overly negative initial impressions are likely to last, because they decrease the likelihood that decision-makers try an alternative again and correct the underestimation by acquiring additional experience (e.g., Denrell & Le Mens, 2007). But other decisions occur infrequently and provide little room for repetition or experiential learning. Only rarely do we choose a life partner or a career path, for example, and when we do, changing our minds to learn about foregone alternatives is difficult or costly. In these one-shot decisions, our results suggest that overly positive initial beliefs are likely to last—and to cause regret—because decision-makers cannot always try a foregone alternative and correct the overestimation by acquiring experience.

Finally, is overestimating the paths we do not take causing us too much regret? While regret can have benefits for experiential learning, it is an inherently negative emotion and has been found to be associated with depression and excessive anxiety (Kocovski, Endler, Rector, & Flett, 2005; Markman & Miller, 2006; Roese et al., 2009). Because the regret in our studies is driven by biased beliefs, it may be excessive—after all, better-calibrated beliefs about foregone alternatives would cause less regret. Whether calibrating beliefs about foregone alternatives
could also help in alleviating regret’s harmful psychological consequences is an important question for future research.
References


