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Enforcing pragmatic future-mindedness cures the Innovator's Bias

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Abstract

The innovator's bias is defined as the tendency for innovators to focus mainly on the positive potential impact of their inventions and to neglect, ignore, or downplay any potential negative impact. Such bias may help sustain the motivation needed for business success but may create problems by failing to acknowledge and prepare for problematic outcomes. We report three studies (total n = 1608) designed to demonstrate this bias — and to show how to overcome it (while ideally preserving the innovators' enthusiastic affection for their product). Three studies used hypothetical innovations, all with potential downsides. Feelings of ownership were manipulated by having some participants role-play being marketing manager, including naming the product, devising advertising slogans, and identifying target demographics for potential purchasers. Owners then rated their product, while non-owner controls rated a different product. Study 1 (n = 495) demonstrated the innovator's bias by showing that owners rated the likely consequences of their product more favorably than non-owners did. Owners also displayed more enthusiastic zeal for their product. Study 2 (n = 553) tested interventions aimed at reducing the bias while preserving the zeal. Of six interventions, the most successful was having owners imagine the worst-case scenario involving the most negative outcome that the invention could cause. Study 3 (n = 560) was a preregistered replication of the main findings from Study 2 (osf.io/ew9cq).

Keywords: Innovation, biases, prospection, pragmatic prospection, optimism, worst-case scenario, invention

Cultural progress in general, and business success in particular, thrive based on innovation. Workers develop new products and services that consumers are willing to pay for. In the best cases, inventions such as the automobile and smartphone improve the lives of millions of individuals. But bad outcomes are also possible. In many cases it seems easy in hindsight to see how such bad outcomes could possibly come to be, but in some cases one may be left scratching one's head and wondering how the inventor did not foresee it before it happened. Take "Tay," Microsoft's artificial-intelligence Twitter chatbot gone wrong, for example. Unfortunately for Microsoft, upon launch in 2016, Tay lasted less than 24 hours before being taken down due to generating numerous racist, sexist, and anti-Semitic tweets after learning from a coordinated effort of malicious online trolls (Worland, 2016). This sort of outcome had been foreseen for many years both in computer ethics literature and science fiction (Wolf et al., 2016), yet Microsoft did not heed such warnings and went ahead with the product. Apparently, the inventors who developed Tay did not adequately heed its potential for negative consequences.

More broadly, business innovators may be broadly disposed toward optimism, to the extent of unrealistic biases. Cooper et al. (1988) surveyed nearly three thousand entrepreneurs about how they perceived their chances for success. These are hardly idle speculations: Most of their research sample had invested substantial amounts from their personal savings in their venture, and the median workweek was 60 hours. Evidence reviewed by Cooper et al. at that time indicated that less than half of new businesses survive for five years. Yet the entrepreneurs' optimism was implausibly high. They perceived their odds of success as vastly better than average, and indeed a third (!) of them thought they were 100% certain to succeed. Crucially, their perceived odds of success were unrelated to factors that do objectively predict business success, such as having more partners, more business experience, higher education, and more

initial capital. Their optimism was also specific to themselves: They were confident that they would succeed whereas they thought other, similar businesses would not do so well.

The present investigation sought to understand what we call the innovator's bias, that is, a tendency for innovators to focus mainly on the positive potential impact (the upside) of their inventions and to neglect, ignore, or downplay any potential negative impact (the downside). We assume that the process of inventing requires intense concentration in the present and an optimistic assumption of the future benefits. To counteract this, we developed multiple interventions aimed at removing these blinders by focusing participants on a product's effects on other people, into the somewhat distant future, and on any potential for negative consequences.

Although it may be possible to motivate innovators to set aside their optimistic hopes, this could in fact be counterproductive. The process of finishing an invention, possibly obtaining a patent, and bringing it to market can be long and arduous. Individuals and groups may sustain this process better if they retain a healthy enthusiasm for their product, that is, a positive attitude that we have dubbed "zeal." In particular, persuading innovators that their cherished inventions might bring about disaster could dampen this zeal. Therefore, we sought interventions that would reduce the innovator's bias but sustain zeal.

Innovator's Bias

The first goal of the present investigation was to demonstrate an innovator's bias. That is, we sought to show that innovators would tend to show bias in favor of their inventions. We reasoned that innovators would overestimate the potential positive consequences of their inventions and downplay any negative ones. They would also show elevated zeal, as reflected in heightened interest and excitement about the invention, as well as feeling a sense of ownership and willingness to take some credit for its success.

Given the difficulty of actually inventing something, our procedures settled for creating the sense of ownership in a secondary fashion. We created a list of hypothetical inventions that seem plausible but do not (yet) actually exist. Participants in the "owner" conditions were assigned one particular invention and instructed to function as marketing manager, which included inventing a name for the product, proposing two slogans for a marketing campaign, and describing the target consumer demographics. They then rated their zeal and outcome positivity for this invention. In the control group, participants performed these tasks for one product but then rated their zeal and outcome positivity for a different one. This enabled comparison of zeal and positivity ratings for the same product between participants who had versus had not worked on it. The prediction was that owners (i.e., participants who had named and marketed the product) would predict more positive outcomes and display more zeal than non-owner controls. Study 1 focused specifically on testing this prediction, and Studies 2 and 3 provided conceptual replications.

Although we do not know of research dealing specifically with perceived ownership of innovation, there is some evidence to suggest that our manipulation of ownership would enhance positivity and zeal. As noted above, Cooper et al. (1988) found actual entrepreneurs to report implausibly high optimism about their chances for success — and they were less optimistically biased when estimating the prospects of other, similar ventures, in which they themselves were not involved. In other work, participants who have been randomly assigned to own some product rate it more highly than others (Kahneman et al., 1990; Beggan, 1992). In the self-reference effect, items thought of in connection with the self are remembered better than other items (Rogers et al., 1977). Recent work has extended that link by showing that memory is enhanced

by one's own mental activity: Items chosen for the self by the self are remembered better than items chosen for the self by others (Baldwin et al., 2021).

The existence of innovator's bias is also supported by evidence that people tend to be unrealistically optimistic with regard to their personal lives and prospects. Weinstein (1980) showed that people predict better outcomes for themselves than for the average member of their group (see also Taylor & Brown, 1988; Shepherd, et al., 2013). This widespread evidence of optimism was however qualified by findings that people shift toward caution when false predictions carry some cost (Monroe et al., 2017). Those findings led to the formulation of pragmatic prospection theory, which proposes that people think about the future in at least two heuristic steps (Baumeister et al., 2016; Oettingen, 2014). The first involves thinking of a desirable, positive goal, and so it is marked by optimistic bias. The second involves recognizing obstacles, pitfalls, and other problems that could prevent that goal, so it is characterized by realism and perhaps sometimes pessimism. Experimental studies have confirmed that responses are optimistically distorted when participants are instructed to respond rapidly — but become realistic when there is a brief delay before responding (Sjåstad & Baumeister, 2021).

Framed in terms of pragmatic prospection, the innovator's bias may result from becoming stuck in the first, optimistic, stage of thinking about the future. To overcome this bias, it may be necessary to push people into the second, more realistic, stage. Again, though, the optimum would be to accomplish realistic appraisal while not losing zealous enthusiasm for the product.

Debiasing Interventions

The second goal of the present investigation was to test several possible interventions designed to counteract the outcome favorability bias — preferably without destroying the zeal.

Study 2 tested three pairs of such interventions, and Study 3 was a preregistered replication of the key findings from Study 2.

Contemplating the future. The first intervention involved prompting participants to think about the future. While working on a creative task, people may well be focused on the immediate present. Experience sampling research has found that positive feelings are maximized by focusing on the present, especially when people are engrossed in current task performance (Baumeister et al., 2020). In contrast, overall positive feelings were diminished when thinking about the future. Hence it seemed plausible that having participants think about the future would diminish the positive bias.

How far into the future would work best? Our procedures tested two versions, a relatively short-term future (one year ahead) and a longer one (ten years). To be sure, many people might think of short-term as a matter of the next week or so rather than a year, but in business this is not realistic. To introduce a new product to the market, have consumers purchase it, and let the effects unfold is a time-consuming process. It may often take more than a year for all this to happen, so a year ahead seemed fairly short. In contrast, ten years should be sufficient and therefore qualifies as a long-term future.

Considering impact on other people. An innovator may operate from an egocentric perspective. When doing creative work, it may be helpful to focus narrowly on the positive aspect of what oneself is doing. Stepping outside one's own perspective to consider how various other people might be affected could conceivably prompt the person to consider both good and bad effects. This might overcome some of the favorable biases associated with self, such as the self-reference and ownership biases (Beggan, 1992; Rogers et al., 1977), the planning fallacy

(Buehler et al., 2010), and irrational perseverance based on prior investments (the sunk cost effect; e.g., Arkes & Hutzel, 2000).

We were not sure whether it would be best to consider people in general or a particular person. The so-called 'identifiable victim effect' has found that people are much more generous when donating money to a specific person than to a statistical category of anonymous victims (Jenni & Loewenstein, 1997; for meta-analysis, see Lee & Feeley, 2016). Therefore, again, we made two different versions of this intervention. One instructed participants to think about how the invention might affect people in general. The other had participants read a vignette about a specific person and write about the potential impact that the invention would have on that person's life, from that person's perspective.

Considering the downside. Pragmatic prospection theory holds that people are initially optimistic when thinking about the future based on considering what they most want to happen — but then become more realistic after considering the downsides, including problems and obstacles. Our goal was to nudge people into the second phase, thereby reducing or eliminating the optimistic biases. The most direct way to do this would be to instruct people to think about how their product could produce negative outcomes.

Indeed, an effective though little-discussed debiasing method was dubbed "considering the opposite" (Lord, Lepper, & Preston, 1984). A bias among innovators is likely to be evident in foreseeing positive benefits from the invention while neglecting or downplaying any potential costs or harm that could result. After all, the purpose of developing and marketing an invention is to produce positive effects. To counteract this by considering the opposite, we instructed participants to write about potential negative outcomes they could imagine from their invention. Again, we had two versions of this. One involved writing about what would likely be the most

frequent and common negative outcomes. The other was to write about the most severe and extreme negative outcomes they could imagine, thus a worst-case scenario.

Given that our research was intended to establish a fairly new phenomenon, rather than to test strong predictions derived from theory, our approach was deliberately exploratory. The hypotheses were that the various interventions would reduce or eliminate the innovator's bias. They might all also reduce or eliminate zeal, but as noted above, the optimal goal would be to maintain zeal while reducing bias. That would seemingly be best for facilitating productive work and progress while reducing the chances of unforeseen negative consequences.

Study 1

Study 1 was designed to demonstrate the innovator's bias. That is, the hypothesis was that when individuals are experimentally induced to feel as if they were part of a team of innovators who brought some invention to the world, they become positively biased toward their invention. A second hypothesis was that ownership would increase zeal. We operationalized zeal as a composite of several measures: feeling excitement for the invention, being interested in it, feeling a sense of ownership of the invention, and feeling entitled to some credit for the eventual success of the invention.

Method

Pilot Study. One-hundred ninety-five participants were given descriptions of 17 hypothetical inventions and asked to rate their anticipated consequences on a scale from -100 (mostly negative consequences) to +100 (mostly positive consequences). From these, we selected three inventions that received mean ratings closest to zero (drone lumberjack, loved ones hologram, and IQ booster*; M*s[95% CIs]: -0.40 [-16.4, 15.6], -2.19 [-15.1, 10.7], and -3.67 [-17.0, 9.70], respectively) and two that had the most negative ratings (artificial intelligence machine gun and

pet cloning; *M*s[95% CIs]: -32 [-47.0, -16.9], -34.6 [-49.2, -16.9], and -34.6 [-49.2, -16.9], respectively), as shown in Figure 1. These were used in the procedure for Study 1. Here are the labels we use throughout the present article (e.g., in-text, plots) and the exact descriptions for the five products selected for use in the main study:

1. "AI machine gun" – An inventor has created an AI-driven machine gun. It is primarily designed to remove human actors from the battlefield, but the inventors note that they could see it being used for other purposes as well. One aspect they spent a lot of time developing was the software that can recognize which enemies to target. However, as with any new invention, there may be many outcomes that they couldn't anticipate.
2. "At-home pet clone" – An inventor has created an at-home kit for pet cloning. It is primarily designed to help pet-owners cope with aging/dying pets, but the inventors note that they could see it being used for other purposes as well. One aspect they spent a lot of time developing was the ease of understanding the instructions and cloning the pet. However, as with any new invention, there may be many outcomes that they couldn't anticipate.
3. "Drone lumberjack" – An inventor has created an autonomous smart vehicle with chainsaws to chop trees down faster. It is primarily designed to harvest timber efficiently, but the inventors note that they could see it being used for other purposes as well. One aspect they spent a lot of time developing was ensuring the speed and maneuverability of the vehicle. However, as with any new invention, there may be many outcomes that they couldn't anticipate.
4. "IQ booster" – An inventor has created a psychoactive intelligence boosting drug. It is primarily designed to boost an individual's intelligence, but the inventors note that they

could see it being used for other purposes as well. One aspect they spent a lot of time developing was the accuracy of targeting intelligence regions of the brain and leaving other parts of the brain unaffected. However, as with any new invention, there may be many outcomes that they couldn't anticipate.

5. "Loved one hologram" – An inventor has created a hologram app that recreates people who have died. It is primarily designed to relive the past with a loved one, but the inventors note that they could see it being used for other purposes as well. One aspect they spent a lot of time developing was getting the voice to closely resemble the deceased loved one. However, as with any new invention, there may be many outcomes that they couldn't anticipate.

{{Figure 1 about here}}

After completing the pilot study, we recruited 495 participants (60% female, 66% white) using the Prolific crowd-sourcing platform (www.prolific.co). Eligibility was restricted to US residents, at least 18 years old and with at least 95% Prolific approval rate. Study 1 took on average 23 minutes and paid an average rate of $10/hour.

Procedure. Participants were led to believe they would take part in two ostensibly unrelated exercises, one on innovation marketing, the other on innovation evaluation. The marketing exercise was intended to foster a sense of ownership toward a particular innovation.

Innovation marketing. Participants were told we were interested in how people think about innovation and so they were supposed to imagine that they were joining an "innovation team." Their specific role would be to help the inventor market the invention. To increase motivation, participants were told that the 10% best responses would receive a 50-cent bonus. (All participants were eventually paid the bonus, regardless of the quality of their responses.)

They were then given one randomly selected invention from the five listed above. They were instructed to think of a good name for the invention and to devise two possible marketing slogans "that would capture the spirit of the invention and get customers excited." Next, participants were instructed to describe the target market in terms of age groups, professions, geographic regions, personal interests, and other factors. Last, participants were told to imagine they had been appointed the Chief Marketing Officer for the invention and to write how they would tell the story of the invention to future customers (250 character minimum). Participants were then thanked for completing this first activity and told to go to the next page, where they would get instructions for the next task.

Innovation evaluation. Next, participants were told we were interested in how they evaluate the future of innovations and that they would be randomly assigned a product to evaluate. All participants read the product description, then gave their evaluations for their assigned product. The main measures of interest were measures of innovator's bias and zeal. Innovator's bias was captured as a single item asking participants to rate the extent to which they anticipated the consequences of the invention would be good or bad, on a scale from -100 (Mostly negative consequences) to +100 (Mostly positive consequences). Zeal was measured with four 7-point Likert-type scales, on which participants rated the extent to which they (1) felt excitement about the invention, (2) had interest in the invention, (3) felt a sense of ownership toward the invention, and (4) felt a sense of credit for the success of the invention. These measures displayed strong internal reliability (⟨ = .93), so the mean across all four was used as the index of how much zeal the participant felt toward the invention.

Ownership manipulation. At the outset of the study, participants were randomly assigned to be either owners or non-owner controls. The manipulation comprised two key

distinctions. The first was the language used. Non-owners read the product description as presented above. For owners, the description of the product was modified to emphasize their ownership. For example (emphasis added):

Your team leader writes:

> *Our team* has created a psychoactive intelligence boosting drug. *We* primarily designed it to boost an individual's intelligence, but *we* note that we could see it being used for other purposes as well. One aspect *we* spent a lot of time developing was the accuracy of targeting intelligence regions of the brain and leaving other parts of the brain unaffected. However, as with any new invention, there may be some outcomes that *we* couldn't anticipate.

The language manipulation was continued in the measures, which referred to "*your* invention" for owners but "*the* invention" for non-owners. Note however, that the words such as own, owning, owner, and ownership were not used.

The second key aspect of the ownership manipulation involved the selection of the invention to be evaluated. Owners were always assigned to evaluate the same product they had marketed, whereas control participants rated a different random product (see Figure 2). Thus, while all participants were induced to have an innovator's mindset, comparisons between owners and non-owner controls are comparisons between innovators rating their own products and innovators rating someone else's products.

{{Figure 2 about here}}

Results

As shown in Figure 3, the mean consequence rating was higher (i.e., more positive) for owners than controls for all five inventions, and for three of the five there was no overlap in 95%

confidence intervals.[i] The mean zeal rating was likewise higher for owners than controls for all five inventions, and on zeal four of the five products showed no overlap in 95% confidence intervals. When we collapsed across all five products to evaluate the mean differences of anticipated consequences and zeal, owners (compared to non-owners) predicted more positive consequences and displayed more zeal than non-owners, with no overlap in 95% confidence intervals.

{{Figure 3 about here}}

We note some unexpected patterns in the results. First, for the AI machine gun, owners failed to express more positive anticipated consequences or more zeal than controls, as indicated by overlapping 95% confidence intervals. Second, although the other control ratings were broadly similar to the pilot data, the loved one's hologram received much more positive consequence ratings, indeed above the neutral midpoint of the scale and fairly similar to the owners' ratings. And finally, the at-home pet clone invention had been chosen on the basis of a negative consequence rating in the pilot study, whereas in the main study its 95% confidence interval included zero.

Discussion

Study 1 established the innovator's bias. Participants furnished ratings of the anticipated consequences of various possible inventions. Some of them ("owners") had imagined helping innovate the product and had been subtly encouraged to think of it as their own product via a marketing exercise and inclusive language. These people consistently rated the anticipated consequences of the invention more positively than non-owner control participants, who had evaluated a different product from the one they had marketed (and for whom no such inclusive language had been used). The positive bias was clear for three of the five products (and received

directional support with the other two), and an omnibus analysis collapsing across inventions confirmed a positive bias across all five products. Moreover, by comparing means with the scale midpoint (zero), it was possible to show that the owners were positively disposed toward four of the five inventions — even one that had been chosen based on its negative consequences, as rated in the pilot study (i.e., at-home pet clones). For the other invention rated as having mainly negative consequences in the pilot (i.e., the AI machine gun), the innovator's bias moved the owners to rate it as having about equal positive and negative consequences.

Owners also exhibited higher zeal than controls. Thus, the ownership manipulation was successful at inducing a mixture of feeling of ownership, excitement, and interest in the product, as well as taking credit for its potential success. The difference between owners and non-owners was distinct for four of the five products (all but the AI machine gun) and also in the combined omnibus analysis.

Study 2

Having established the innovator's bias in Study 1, we turned to exploring how to reduce the bias, preferably while retaining zeal. In this study, we tested two versions for each of three possible interventions. We selected the IQ booster invention as the one all participants would rate. In Study 1, the IQ booster had shown a strong ownership effect, such that non-owner ratings included the scale midpoint for both bias and zeal, while owners had been well above the midpoint on both.

Method

Participants. Study 2 recruited 553 participants (57% male, 74% White) in late September 2021 from the same platform and with the same criteria as in Study 1, with the added

caveat of excluding anyone who had participated in Study 1. Study 2 took on average 28 minutes and paid an average rate of $10/hour.

Procedure. The procedure was identical with Study 1 except as follows. First, participants were randomly assigned among six interventions (plus a no-intervention control condition), which took place between the innovation marketing exercise (which was again used as the owner manipulation) and the innovation evaluation exercise (see Figure 4). Second, in view of the design extension to create seven intervention conditions, we reduced the number of inventions. All participants evaluated the IQ booster. Owners also marketed that invention, while non-owner control participants marketed the drone lumberjack.

{{Figure 4 about here}}

The interventions were as follows. The time horizon interventions prompted participants to think and write about the impact the invention (i.e., the one they had just marketed) would have in the future. Half the participants were instructed to think in terms of one year ahead, and the rest were instructed to think ten years ahead.

The impact-on-others interventions instructed participants to think and write about how the invention might have an impact on other people's lives. Half were told only to consider "other people," with no further instructions. The other half read a vignette about a specific person and then were told to imagine that they were that person and to write about what that person might say about the potential consequences of the invention.

Last, the downsides interventions instructed participants to think and write about possible negative effects of the intervention. Half were told to describe the most frequently occurring negative outcome they could imagine. The rest wrote about the most extreme and severe

negative outcome they could realistically imagine. Thus, the former was focused on what might be problems with a high base rate, while the latter focused on the worst-case scenario.

There was also a no-intervention control condition. These participants (both owners and non-owners) proceeded straight from the marketing exercise to the evaluation exercise exactly as was done in Study 1.

The measures were almost identical to Study 1. The only change was that the four items that constituted the zeal measure were switched from 7-point scales to a 100-point feeling thermometer. Internal consistency was again high (⟨ = .87).

Results

A successful intervention was operationally defined as reducing the favorability bias to where the 95% confidence interval included zero. As shown in Figure 5, only one of the six interventions succeeded. Specifically, the "worst-case scenario" downside intervention was able to reduce owner's anticipated consequences ratings down to a mean of 7.06 with a 95%CI [-7.29, 21.42]. All the other owner conditions showed a bias toward more positive consequences, including the no-intervention owner condition. Meanwhile, five of the seven non-owner conditions had 95% confidence intervals containing zero, thus indicating no favorability bias. The two that did have 95% confidence intervals fully in the positive bias range (thus excluding zero) were the short-term future and the impact on specific other interventions. These two positive-bias findings were not predicted and we hesitate to draw conclusions. To illustrate, participants in the latter condition marketed the drone lumberjack, then read the description of the IQ booster, followed by a vignette about a specific person named "Casey," then wrote about how, if they were Casey, their life might be affected or changed by using the IQ booster. After doing so, they rated the IQ booster as likely to have more positive than negative consequences.

{{Figure 5 about here}}

Some unexpected patterns in the data deserve brief comment. The innovator zeal ratings in the no-intervention condition showed slight overlap of their 95% confidence intervals, whereas we had predicted a full separation between owners and non-owners. Given the small overlap, however, we find it no cause for serious concern. In terms of innovator's bias on anticipated consequence ratings, the non-owner participants in both the long-term and short-term time horizon interventions showed a slight positive bias, given that the 95% confidence interval did not include the neutral midpoint of the scale. (Owners in the long-term condition were still well above the non-owners, but not in the short-term.) Last, in the condition that focused on impact on specific others, owners and non-owners both showed a positive bias and were indistinguishable from each other.

Discussion

The innovator's bias was replicated in Study 2. Owners anticipated more positive consequences of their invention and displayed more zeal about it than non-owner controls (though, as noted, the 95% confidence intervals for zeal overlapped slightly).

More importantly, we tested multiple interventions aimed at eliminating the favorability bias while ideally sustaining the zeal. Only one of the six interventions succeeded at this. Specifically, having owners contemplate the worst-case scenario, that is, the most plausible negative consequences of their product, eliminated their positive bias — but they still reported positive zeal for it (i.e., interest, enthusiasm, ownership, and taking credit).

Study 3

Study 3 was conducted in late November 2021 as a preregistered replication of the main findings from Study 2. (Pre-registration plus relevant data and scripts can be found at

osf.io/ew9cq/). To conserve resources, we simplified the design such that there was only one intervention from each pair. In the first, participants were simply instructed to think about "the future" with no specific time frame. For the second, we deleted the "specific other" condition and simply instructed participants to think about the consequences for "others." For the third, we omitted the condition focusing on the supposedly most frequent problems and just included the worst-case scenario condition.

The prediction was that the findings from Study 2 would replicate, that is, only the worst-case scenario condition would succeed at eliminating the favorability bias, while enabling owners to retain some positive zeal. The preregistration states that our analysis plan was to compare means and 95% confidence intervals of the eight conditions in our 2 (owner, non-owner control) x 4 (interventions: time horizon, impact on others, downsides, no-intervention) design. We specified further that a successful replication would include (1) the 95% confidence interval of the mean of anticipated consequences for owners in the downsides intervention condition would include the scale midpoint (i.e., zero), whereas the owners in the other three conditions would have 95% confidence intervals whose lower bounds were above the midpoint (indicating positive bias); (2) all four groups of non-owner controls would have a favorability bias mean that would also capture zero or even be negative, and (3) the owners in the downsides condition would not have lower zeal than other owner groups (95% confidence intervals would overlap).

Method

Participants. Study 3 used the same recruitment platform and criteria as the previous studies (again excluding anyone who had participated in either Study 1 or 2). Consistent with pre-registration, we tested 560 participants (52% male, 79% White). The study took an average of 23 minutes. Study 3 took on average 21 minutes and paid an average rate of $10/hour.

Procedure. The procedure was the same as Study 2, except with only three interventions: (1) think and write about the impact of the invention on "the future" (with no specific time horizon), (2) think and write about the impact of the invention on "others" (with no specific person mentioned), and (3) think and write about the worst-case scenario ("downsides"), that is, the most severe negative consequence(s). In all the intervention writing conditions, a minimum of 250 characters was required. Once again, there was also a no-intervention control condition that proceeded straight from the marketing exercise to the evaluation exercise as in Studies 1 and 2. The measures were identical to those from Study 2. The four items whose composite formed the measure of zeal once again showed satisfactory reliability (⟨ = .87).

Results and Discussion

As shown in Figure 6, we once again replicated the innovator's bias. Owners generally displayed more positive bias in anticipated consequences and more zeal than non-owners.

{{Figure 6 about here}}

Also indicating effective replication, the non-owner means all had 95% confidence intervals that included the neutral midpoint or were below it – indeed, for both favorability bias and zeal. The favorability was thus not inherent in the product. Rather, the favorability bias was solely associated with the role of owner.

More importantly, Study 3 replicated the effectiveness of the worst-case scenario downside intervention. It was the only intervention that succeeded in eliminating the favorability bias among owners. After contemplating the worst-case scenario, owners had a mean favorability rating slightly below and not reliably different from the neutral midpoint between mostly positive and mostly negative consequences. The other owner conditions all were well above the scale midpoint. Moreover, the difference between owners and non-owners was eliminated by

contemplating the worst-case scenario, unlike the other interventions. Considering the worst possible outcome of one's intervention appears to be a uniquely effective way of eliminating the innovator's bias.

The one difference between Studies 2 and 3 is that the downside (worst-case scenario) intervention left zeal high in Study 2 but reduced it somewhat in Study 3. By comparison, although the mean of zeal in the worst-case scenario condition was the lowest of the seven conditions in Study 2, its 95% confidence interval was nevertheless located entirely above the scale midpoint. In Study 3, however, its 95% confidence interval included the midpoint and indeed its mean was slightly below it. The worst-case scenario intervention appeared to have lowered zeal in comparison to the other two interventions — but not in comparison with the no-intervention control group. Owners in the worst-case scenario condition and the no-intervention control condition had overlapping 95% confidence intervals. In that sense, at least, the worst-case scenario intervention enabled zeal to remain as high as no-intervention controls among owners, and substantially higher than among non-owners who had the same intervention.

Though these results for zeal in Study 3 were not clearly what we expected, we further explored the available data by combining the methodologically identical "worst-case scenario" participants (n = 87) and "no intervention" participants (n = 220) across Studies 2 and 3 for a holistic look (see Figure 7). In this comparison, the worst-case scenario participants were practically indistinguishable from the no-intervention group. This evidence suggests that thinking about the worst-case scenario can indeed overall reduce the innovator's bias without driving down zeal.

General Discussion

The goal of the present investigation was to establish a relatively new phenomenon, namely the innovator's bias, and to develop interventions aimed at reducing its potential downside while preserving its usefulness. We proposed that innovators have two types of feelings toward their invention. One is a positively biased assessment of how favorable its consequences will be. The other is a zealous positive excitement about it. The zeal may be useful in sustaining the hard work needed to bring a product to market, but the favorability bias presents dangers that potential downsides could be overlooked, leading to unforeseen but preventable disasters. Hence, we sought interventions to reduce the favorability bias while sustaining the zeal.

We established the innovator's bias consistently across three experiments. Participants were led to imagine themselves as part of an innovative team developing a new invention, and they performed exercises to help market the invention. Those exertions succeeded in generating feelings of ownership, as compared to participants in the non-owner control condition. Owners showed elevated levels of both the favorability bias and zeal.

We tested a variety of interventions, hoping to find one that would reduce the bias but maintain the zeal. The framework invoked pragmatic prospection theory and its tenet that thinking about the future often occurs in two sequential steps, an optimistic first step focused on the best desired outcome, and a realistic second step focused on potential roadblocks (Baumeister et al., 2016). The innovator's bias may involve getting stuck in the first step. To overcome that, we tried focusing people on the future, including the long-term future; focusing them on how other people might be affected; and focusing on negative consequences, either the likely most frequent problem, or the worst-case scenario. The worst-case scenario was the sole effective one. It successfully eliminated the favorability bias in two studies, including a pre-registered one. It

left zeal high in Study 2, whereas in Study 3 its effects on zeal were mixed: its 95% confidence interval overlapped both with the neutral scale midpoint and with the no-intervention control condition.

Nevertheless, overall, we believe these data have useful and important implications. Perhaps there is a line between "worst-case scenario thinking" and "nightmarish apocalyptic catastrophe thinking," and participants in Study 2 leaned towards one side while those in Study 3 leaned towards the other; this is one potential explanation as to why our zeal results did not manifest as clearly and consistently as we had hoped, though this is simply speculation after the fact. Exploring additional contexts and boundary conditions are ventures for future research.

Implications for Applied Practice

Our work was based on the assumption that innovation success will be maximized insofar as people can rein in positive distorting mental biases but sustain zealous enthusiasm for a product. Having people briefly consider the worst possible outcome of their invention may be a useful strategy to invoke at some point in product development. Ideally, this would make people take off their rose-colored glasses and grapple with what could really go wrong with their product, even preventing the occasional disaster – yet allow them to continue to be motivated to work on developing a product that actually will be a benefit to society (and to the company that markets it).

In contrast, while "think about the impact your product will have on others" or, "think about the future/long-term prospects of your product" may intuitively seem like good and useful recommendations for mitigating potentially negative future outcomes, our data suggest these will be unsuccessful at reducing bias. However, given that innovators presumably *are* (at least implicitly) generally thinking about others and the future as they innovate a product, in hindsight,

it is not entirely surprising that innovators are still overly optimistic and positively biased when they explicitly stop to think about others or the future of their product.

Implications for Psychological Theory

Motivated biases are a pervasive feature of human mental and social life. In the present investigation, they proved more difficult to overcome than we anticipated. Lord, Lepper, and Preston (1984) proposed a debiasing technique they dubbed "considering the opposite." Their work resonates with our finding that only the strongest among our six interventions — explicitly considering the worst possible outcome of one's invention — was able to overcome the general bias toward overestimating favorable outcomes.

The present findings also fit with pragmatic prospection theory but suggest a possible refinement. That theory proposed that initial thoughts about the future tend to be optimistic, whereas subsequent thoughts become more realistic. That seems to suggest that the mere passage of time and/or additional thinking would be enough to overcome the optimistic bias, as suggested by by Sjåstad and Baumeister (2021). In the present studies, however, merely thinking more or for longer was not enough to eliminate the positive bias. The implication is that people may sometimes be motivated to remain in the optimistically biased state (the first stage), and thinking more can simply sustain or reinforce that initial optimism. It took the strongest intervention to overcome that motivation and push people into a more balanced, realistic assessment.

The present findings complement some previous work that has shown people's biases in favor of their own undertakings[ii]. As already noted, Cooper et al. (1988) found that entrepreneurs were broadly and unrealistically optimistic about their chances for success. Subsequent work by Arkes and Hutzel (2000), using an imaginary vignette procedure with undergraduate samples, found that having made prior investments (sunk costs) led people to inflate their estimates of the

probability of success. In particular, participants imagined being head of an airline company that was heavily invested in a new product but just learned that a competitor had released a similar, possibly better version. The more their company had invested, the more confident they were of eventual success. Arkes and Hutzel were also able to show that the inflated estimates of chances of success were rationalizations for investing more in the project, after the decision had been made, rather than causally preceding the decision to continue investing. It is noteworthy that optimistic bias occurs in multiple settings. However, our findings do not reflect a difference in sunk costs, and they certainly do not indicate a post hoc rationalization for having made further investments after initial failure. Our findings also add the distinction between optimism and zealous enthusiasm — along with an intervention that succeeded at debiasing the probability of success while preserving the zeal.

Subjective estimates of probability can also be inflated by generating explanations in one's mind, as shown by Ross et al. (1977). After reading a case study, their participants thought up explanations for possible events later in that patient's life, and then estimated the probability of these events. Having thought of explanations for a particular event increased the participant's estimate of the probability that that event would actually happen. While these findings provide valuable insight into how the mind's judgments can be swayed by its own explanatory thoughts, they do not seem all that relevant to our work. Participants in the present studies did not generate explanations for possible future events and indeed mostly did not even consider specific outcomes. Rather, they rated whether the aggregated consequences of the innovation would likely be good or bad (and to what degree).

Optimistically biased predictions are also involved in the so-called planning fallacy (Buehler et al., 2010). However, the very definition of the planning fallacy makes a stark contrast

with our work on innovator bias. The definition of the planning fallacy invokes underestimating the time required to complete a task — particularly when the person has considerable experience of, or knowledge of, past failures of similar projects to be completed on time. Buehler et al. (2010) emphasize that merely making an optimistic estimate of how long it will take is not enough to qualify as planning fallacy. In their words, "The signature of the planning fallacy…is not that planners are optimistic but that they *maintain* their optimism about the current project in the face of historical evidence to the contrary" (p. 3; emphasis in original). In the present studies, participants had no such historical or experiential information available to them. Moreover, the optimism in the present studies was in the aggregate positivity of foreseeable consequences, not in the time required to complete the task. Another important difference in the present work was the intervention that reduced the prediction bias (but allowed zealous enthusiasm to remain). Buehler et al. (2010) cover several efforts at reducing the optimistic bias in the planning fallacy. The most prominent of these involved inducing people to base their predictions on prior experience and historical evidence (which is obviously irrelevant to the present work, since participants did not have prior experience of this sort). Another successful debiasing technique required participants to think about obstacles that could impede progress. Yet another was to consider all the different steps (subtasks) needing to be completed. As the authors note, this is similar to contemplating potential obstacles, because it reminds people of sources of delay that their top-of-the-head predicting might have overlooked.

Contemplating possible obstacles is the intervention most relevant to the present studies. Again, however, we note that several of our interventions prompted participants to consider future problems, but only one succeeded at debiasing. Moreover, that involved focusing on a single, particular problem, rather than obstacles in general. Thus, although debiasing the

planning fallacy (for estimating time) and debiasing the innovator bias (for estimating positive vs. negative consequences) are clearly separate processes that differ in multiple ways, they do at least converge on the helpfulness of explicitly contemplating the potential for negative developments.

The present findings also resonate with the self-serving attributional bias (e.g., Jones et al., 1972; Zuckerman, 1979). The bias refers to a pattern in which people take credit for success but deny blame for failure, or, put another way, make internal self-attributions for success but make external attributions when they fail. The present findings involved feelings and expectations, rather than attributions for outcomes, but there is an underlying similarity in the general positivity of the self and the associated drive to attain successes and avoid failures (for recent review, see Baumeister, 2022). Nevertheless, ignoring potential downsides of one's innovations can be damaging to the self's reputation and social status in the long run. Therefore, the innovator's bias is a less promising means of enhancing the self (and of protecting it from loss of esteem) than is the self-serving bias.

Limitations and Directions for Future Research

We hasten to point out several limitations in our research. Two that immediately stand out are linked to the artificial environment of the laboratory. First, although participants did engage in mental work to develop marketing plans and the like, there may be multiple differences between doing a real job and participating in a laboratory simulation in which the job is imagined and the products are not real. Second, given the difficulty of actually inventing something, our studies settled for creating a sense of ownership by having people engage in secondary creative behavior with an assigned (and imaginary) new invention. Our manipulation check data suggest that we succeeded in fostering a sense of ownership, but we have to assume

that this sense is weaker than what may often occur with an inventor who has spent months or years inventing and perfecting a new product. Indeed, the feelings of an innovator toward his or her invention may be more complex than the sense of ownership that we manipulated, though undoubtedly there is substantial overlap. Future research should explore the experiences of actual inventors. To be sure, the benefits of debiasing suggest that organizations may prefer to have innovators engage in the worst-case scenario thinking, rather than doing a proper randomized clinical trial, in which some inventions and innovators are not subjected to any debiasing procedures. An ideal setting may be one in which workers must frequently devise innovative solutions to ad hoc problems, especially in which the same tried-and-true methods cannot simply be applied to new products or circumstances.

We note also that the marketing task, which we used to increase feelings of ownership, may have contributed in general to a positive, optimistic assessment of the product's consequences. Marketing is a kind of influence, seeking to persuade potential customers to purchase a product or service. Inevitably, therefore, it focuses on the positive applications and features of the product, not the negative ones. To be sure, we think inventors likewise emphasize the positive applications and features of what they create — indeed for inventors, like for marketers, those positive features are the central purpose of the product. Nevertheless, it may be easier for a marketer than for an inventor to ignore negative features.

Concluding Remarks

Innovation is an important driver of cultural progress. It is in society's best interest to encourage these. The experience of bringing an innovation into society (to the marketplace, or elsewhere), or the outcome of it, must be sufficiently positive that individuals can be motivated

to do it. Yet there can be too much innovation, and innovation can go awry, as did the example of the offensive Twitter-trained AI-bot, Tay, with which we began this manuscript/article. The best for society, in terms of bringing the most benefits and resources to the greatest number of members, would be to promote innovation while trying to minimize its occasional excesses and damaging episodes. Understanding how to achieve that balance would benefit society as a whole. An enlightened society would probably use incentives to help achieve this, such as bestowing rewards on people who produce the most beneficial innovations. Therefore, effective innovation is also of great pragmatic benefit to the businesses and even individuals who get it right.

That innovators may be biased about the benefits of their inventions may be unsurprising. Our investigation has however turned up two bits of good news. First, it is possible to counteract the bias, thereby enabling a balanced assessment of the good and bad consequences of the invention. And, second, it may be possible to eliminate this bias while sustaining the innovator's zealous enthusiasm for the invention.

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[i] Because (1) the exact values are less important than the presence or absence of overlapping confidence intervals and (2) the overwhelming volume of cells when considering study · invention · condition or study · intervention · condition, we do not report exact means or 95% confidence intervals in-text and instead display the data only as figures. We remind readers who are interested in exact values that the data and scripts are available at osf.io/ew9cq.

[ii] We thank an anonymous reviewer for suggesting these connections.