Journal of Personality and Social Psychology

Revising Probability Estimates: Why Increasing Likelihood Means Increasing Impact

Sam J. Maglio and Evan Polman

Online First Publication, June 9, 2016. http://dx.doi.org/10.1037/pspa0000058

CITATION

Maglio, S. J., & Polman, E. (2016, June 9). Revising Probability Estimates: Why Increasing Likelihood Means Increasing Impact. *Journal of Personality and Social Psychology*. Advance online publication. http://dx.doi.org/10.1037/pspa0000058

Journal of Personality and Social Psychology

© 2016 American Psychological Association
0022-3514/16/$12.00 http://dx.doi.org/10.1037/pspa0000058

Revising Probability Estimates: Why Increasing Likelihood Means Increasing Impact

Sam J. Maglio
University of Toronto Scarborough

Evan Polman
University of Wisconsin-Madison

Forecasted probabilities rarely stay the same for long. Instead, they are subject to constant revision—moving upward or downward, uncertain events become more or less likely. Yet little is known about how people interpret probability estimates beyond static snapshots, like a 30% chance of rain. Here, we consider the cognitive, affective, and behavioral consequences of revisions to probability forecasts. Stemming from a lay belief that revisions signal the emergence of a trend, we find in 10 studies (comprising uncertain events such as weather, climate change, sex, sports, and wine) that upward changes to event-probability (e.g., increasing from 20% to 30%) cause events to feel less remote than downward changes (e.g., decreasing from 40% to 30%), and subsequently change people's behavior regarding those events despite the revised event-probabilities being the same. Our research sheds light on how revising the probabilities for future events changes how people manage those uncertain events.

Keywords: judgment and decision making, momentum, probability, psychological distance

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

The probability of rain can change hourly; the likelihood of someone winning an election can change daily; the odds of rescuing an earthquake survivor can change weekly; the chance of a stock appreciating can change almost instantaneously. In the interest of providing people with the most up-to-date information, probability estimates are subject to constant revision—moving upward or downward, uncertain events become more or less likely. Despite the diversity of contexts in which changes to probability forecasts occur, research to date has focused almost exclusively upon how people appraise static snapshots—in particular, the latest or most recent snapshots—of probability for an event rather than how people respond to changes to probability estimates. We propose that people respond differently to events when those events have undergone an increase in the probability of occurring (e.g., from a 20% to a 30% likelihood) than when those events accompany a decrease in the probability of occurring (e.g., from a 40% to a 30% likelihood), even though those uncertain events have identical ultimate likelihoods of occurring after the respective revisions.

How might probability revisions change decision making? In a classic exploration of how people respond to probabilities, the Asian Disease problem describes a disease that is expected to kill 600 people; in the problem, participants have to choose between a certain option and a risky option in either a gain or loss frame (Tversky & Kahneman, 1981). For example, participants in the gain frame must choose between a certain option in which 200 people will be saved, and a risky option in which there is a 33% chance that 600 people will be saved and a 67% chance that no people will be saved. Responses to the Asian Disease problem have offered robust support for a framing effect by which people prefer the certain option when the options are framed as gains and the risky option when the options are framed as losses. But what if, for the risky option, the probability had been revised from a prior estimate to the ultimate 33% chance?

We tested this question in an initial, exploratory treatment of our research question. Specifically, we examined how people respond to the probabilities in the classic Asian Disease problem when we introduce a revision to those probabilities. That is, in our test, the final probabilities were the same as those used in the original problem. However, we added that the probability of lives saved or lost was revised downward (e.g., from a 46% probability that 600 people will be saved to the original 33% probability that 600 people will be saved). As a procedural control, we also added revisions to the sure options as well (see Appendix for sample details and materials for the gain and loss scenarios). Comparing the proportions of participants who picked the sure option in the gain and loss scenarios, our results closely resembled Tversky and Kahneman's (1981) original findings, whereby 69.3% chose the sure option in the gain scenario and far fewer (35.1%) chose the

Sam J. Maglio, Department of Management, Department of Psychology, and Rotman School of Management, University of Toronto Scarborough; Evan Polman, Wisconsin School of Business, University of Wisconsin-Madison.

The authors contributed equally to this research and are listed in alphabetical order.

This research was supported by a Connaught New Researcher Award at the University of Toronto. The authors thank Cris Rabaglia for valuable discussions of this work and Darcy Balaban, Lynda Barry, Christopher Chan, Angela Davis, and Natasha Sarju for assistance with the execution of the studies. Additional thanks to Rosewood Estate Vineyards, Daniel Taylor of the Leslieville Farmers Market, and Nick Bertrand for helping to coordinate Study 10.

Correspondence concerning this article should be addressed to Sam J. Maglio, Department of Management, University of Toronto Scarborough, 1265 Military Trail, Toronto, Ontario M1C 1A4, Canada. E-mail: sam.maglio@utoronto.ca

sure option in the loss scenario, $\chi^2(1) = 68.76$, $p < .001$. In a departure from their findings, however, we found that in scenarios where the choices conveyed a downward revision (that subsequently matched the original numbers used by Tversky and Kahneman), participants' preferences for the sure option were significantly altered in both the gain and loss scenarios, to the extent that in both scenarios, the sure option was preferred even more, 78.9% (vs. 69.3%) in the gain scenario, $\chi^2(1) = 6.99$, $p = .008$; and 43.2% (vs. 35.1%) in the loss scenario, $\chi^2(1) = 4.03$, $p = .045$. These findings show that a hitherto unexplored yet nonetheless ubiquitous situational variable, a revision to a forecast, influenced choices by altering a well-documented cognitive bias that is fundamental among decision makers. In what follows, we explore this phenomenon more deeply, developing a hypothesis derived from theory and subsequently testing it more formally in a series of studies.

Thinking About Probability

People regularly confront all manner of numerical information. Very often, they struggle to make sense of this information, revealing reliably robust errors in mathematical cognition. The field of *numerosity* has documented inconsistencies resulting from how people interpret numbers (e.g., Bagchi & Li, 2011; Pelham, Sumarta, & Myaskovsky, 1994). Percentages, falling within the general domain of numerosity, constitute one subfield of this domain. Percentages are used to convey (and confuse) many different types of information, including (a) degree of change (e.g., a 20% increase in the population of a city), (b) fractions or rates (e.g., correctly answering 80% of the questions on an exam), and (c) the likelihood that an uncertain event will come to pass. It is this third take on information conveyed in percentage form that we examine in the present investigation.

Though forecasts may offer clear, direct, numerical probabilities of uncertain events (e.g., a 30% chance of rain), forecasts undergo psychological translation into a subjective sense or feeling and influence how people interpret and act upon those events (Gallistel, Krishan, Liu, Miller, & Latham, 2014; Loewenstein, Weber, Hsee, & Welch, 2001). Research from judgment and decision making has illuminated how information can get lost in this translation, warping the subjective interpretation of numerical probability information. For instance, in the well-documented *ratio bias*, gamblers sometimes choose the option with objectively worse odds of winning when they can envision more paths to victory (e.g., preferring an urn that promises a 7/100 chance of success compared with an urn that promises a 1/10 chance of success; Denes-Raj & Epstein, 1994; see also Denes-Raj, Epstein, & Cole, 1995). In other words, though one option *is* better, the other option (subjectively) *feels* better, and the latter often overrides the former. Thus, it remains important to understand determinants of subjective probability given its role in predicting behavior.

In much the same way that intuitions can warp objective probability information about an event, so too can incorporation of—and overreliance upon—event representativeness (Weber & Hilton, 1990). For example, a 5% chance of rain should feel the same regardless of the rain's geographical location. However, a 5% chance of rain forecasted for (typically rainy) London feels subjectively more likely to occur than the same 5% chance of rain forecasted for (typically arid) Madrid (Windschitl & Weber, 1999). These accounts attest to how probability forecasts are susceptible to context effects that change people's subjective feelings of probability for those events. Building from these accounts, the present investigation tests whether changes—or *revisions*—to probability forecasts influence individual-level thoughts and actions.

Probability as Psychological Distance

Despite a lack of research in the domain of changes in forecasted likelihood, we can conceptualize probability estimates within the larger construct of *psychological distance*, which affords several germane insights. By definition, a target of consideration becomes psychologically distant insofar as it is removed from one's egocentric and immediate experience (Liberman & Trope, 2008; Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2010). Accordingly, theorizing on psychological distance has identified four means by which targets can drift in distance: in time (from now to earlier or later; Kyung, Menon, & Trope, 2010; Trope & Liberman, 2000); in space (from here to another place; Fujita, Henderson, Eng, Trope, & Liberman, 2006; Henderson & Wakslak, 2010); in social contexts (from the self to others; Jones & Rachlin, 2006; Liviatan, Trope, & Liberman, 2008); and in probability (from more to less certain; Todorov, Goren, & Trope, 2007; Wakslak, Trope, Liberman, & Alony, 2006). This last dimension of distance encapsulates our construct of interest: A *remote* chance (e.g., 1%) of an event occurring is more distant than an event that might occur with *near* certainty (e.g., 99%).

Recent empirical investigations have found that subjective distance judgments (i.e., how close or far something feels) are not solely the result of static distance but also shaped by changes in distance. For instance, the future tends to feel closer than the past (Caruso, Van Boven, Chin, & Ward, 2013) and a location toward which someone is oriented in space (i.e., expects to physically move toward) tends to feel closer than a location in the opposite direction (Maglio & Polman, 2014)—despite the fact that, in both instances, the objective time and objective physical distance in the toward and away conditions, respectively, is held constant. Notwithstanding differences between the four types of psychological distance (e.g., Boroditsky, 2000; Caruso, Gilbert, & Wilson, 2008), theoretical work has argued that they have a shared meaning in that they are all avenues of removal from immediate experience (Maglio, Trope, & Liberman, 2013a). Research has established that the four dimensions of distance operate psychologically as correlated, interchangeable, and substitutable (Fiedler, Jung, Wänke, & Alexopoulos, 2012; Fiedler, Jung, Wänke, Alexopoulos, & de Molière, 2015; Maglio, Trope, & Liberman, 2013b; Van Boven, Kane, McGraw, & Dale, 2010), suggesting that what is true for one dimension of distance should hold true for each. Accordingly, because people are sensitive to changes within temporal and spatial distance, we expect that similar effects should obtain in the realm of probability. However, people know that the present always approaches and can ascertain with a fairly high degree of confidence which way they are headed in space; both judgments rely upon an unambiguous forward or toward orientation. In the case of revisions to probability estimates, we propose an alternative mechanism that relies upon incorporation of information from the past to make an estimate about the future.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Psychological Momentum

We propose that how people interpret revisions to probability estimates relates to the construct of *psychological momentum*. In physics, momentum describes the phenomenon by which objects in motion may not stop immediately upon application of a resisting force but instead continue their course, if only for a little while. In psychology, researchers (particularly sports psychologists) have drawn a cognitive parallel to physical momentum, describing, for example, how initial success in a competitive, athletic context breeds further success (e.g., a racquetball match between two players; Iso-Ahola & Mobily, 1980). When athletes perform well initially, they feel as though they are "on track," which boosts their confidence, self-efficacy, and, subsequently, their performance (Iso-Ahola & Dotson, 2014). Despite separate evidence suggesting that psychological momentum may not exert a tangible force in and of itself (e.g., Richardson, Adler, & Hankes, 1988), what matters most for the present investigation is that individuals regularly identify and act on perceptions of psychological momentum (e.g., cyclists; Perreault, Vallerand, Montgomery, & Provencher, 1998).

This particular "on track" feeling was codified by Markman and Guenther (2007) in their general theory of psychological momentum (Psychological Momentum Theory; PMT) which extends psychological momentum to all kinds of tasks, irrespective of whether they are athletic or competitive. For example, a feeling of momentum was revealed in a writing context, whereby observers believe that a writer will finish a writing assignment sooner when the writer experienced a feeling of temporary momentum compared with a feeling of continued, steady progress. Thus, PMT broadens the scope of psychological momentum from feelings of confidence that arise during athletic competitions to configuring predictions about the future (such as how soon someone will finish an assignment). In support of this perspective, researchers in visual attention found that when observers see a moving point on a screen (that subsequently disappears), they report that it travels farther than it actually did (Freyd & Finke, 1984). Similarly, a glass is more likely to be described as "half empty" when it moves from full to empty, but as "half full" when it moves from empty to full (McKenzie & Nelson, 2003). Taken together, these findings suggest that people incorporate predictions for the future (such as where the dot on a screen is heading, or whether a glass of water is about to be full or empty) into their judgments of the present, such that judgment about an object comprises not just its current state, but also its predicted future state.

This notion of psychological momentum is consistent with recent research by Hubbard (2015b), who describes psychological momentum as the process of extrapolating prior values, locations, or events into the future. In Hubbards's words (2015a), the future location of a moving object is based upon a "continuation or extrapolation in the same direction" (p. 1094). This is not unlike, in compliment, the notion of *hysteresis*, which describes quite generally a principle suggesting that the longer a state has prevailed (e.g., low unemployment), the longer it takes that state to change and reverse course due to the fact that the state itself is constantly and gradually self-reinforcing, becoming further "state-like". In economic terms, hysteresis is reflected in the saying, "the rich get richer, and the poor get poorer." Not solely an aphorism, this type of time-and-prediction-based momentum described by Hubbard has been documented in many contexts. In finance, investors predict that rising stocks will continue to rise (and falling stocks will continue to fall; Hong & Stein, 1999; Jegadeesh & Titman, 1993). In organizations, when people learn that someone has experienced an upward (vs. downward) change in status, they predict that that person will experience a future change in the same direction as the original change, emerging either as "rising stars" or "sinking ships" (Pettit, Sivanathan, Gladstone, & Carson Marr, 2013). In sales, people believe that increasing profits and sales for a company will mean higher future profits and sales (Harvey & Reimers, 2013). In sports, people often expect that streaks of past successes will continue for future events (Gilovich, Vallone, & Tversky, 1985; see also Miller & Sanjurjo, 2014). This time-oriented perspective on psychological momentum suggests that, when presented with prior trends, people engage in a process of mental simulation (see Markman, Klein, & Suhr, 2009) to consider not only where a current value lies, but where it might reasonably be headed. Thus, the construct of psychological momentum—in particular, the general lay belief that not only *physical* but also *psychological* objects in motion will continue along a consistent course—can help to understand how people interpret revisions to probability estimates.

More broadly, people evaluate a probabilistic prospect not solely as a function of its standing in the moment of evaluation, but rather upon the subjective sense of likelihood experienced when asked to make a judgment about it (e.g., Loewenstein et al., 2001). We situate our predictions within this wider context, proposing that people's thoughts and behaviors derive most readily from the subjective sense of likelihood created when they evaluate the probability of an event. The present investigation examines the relationship between changes to probability estimates for events and how people think about and act upon those events. As a result of a psychological momentum-based tendency to expect trends to continue, we predict that an increase in an event's probability to X% (vs. a decrease to X%) leads to that event feeling more likely despite the event having the same ultimate probability after an increase or decrease, influencing behavior in a range of domains related to the event. We test this prediction in 10 studies.

Overview of Studies

In Study 1, we establish the basic effect whereby an upward (vs. a downward) revision to a forecasted event causes that event to feel more likely. Specifically, we find that when the forecasted extinction of an animal increases to 30%, participants feel that the extinction is closer than when the forecast decreases to 30%. In Studies 2 through 5, we explicate the process on which we predict this effect to rely: an expectation that trends will continue into the future. In support, we find mediation evidence in Study 2 that links the basic effect (revisions to events' likelihood cause events to feel more or less likely) via a belief that, following a revision, event probabilities will change again in the future (in the same direction). In further support of the role of momentum, Study 3 adopts a moderation-of-process design that manipulates the potential of a trend to continue, thus identifying a boundary condition qualifying the basic effect. In Study 4, we additionally incorporate the size of a revision (e.g., the difference between increasing by 2 percentage points vs. 20 percentage points) into the present investigation and find that the overall effect is robust across change size, such that

upward changes to event-probabilities (vs. downward changes) cause events to feel closer irrespective of the magnitude of change. In Study 5, we broaden from subjective likelihood to closeness-related action and find that an upward (vs. a downward) probability revision to a negative event causes the event to feel closer, which in turn leads people to report a willingness to spend more money in the interest of mitigating that negative event.

The subsequent five experiments document the breadth of contexts to which probability revisions can be brought to bear. In Study 6, we examine a particular behavior known to vary with subjective distance, creativity, finding that participants envision a more or less creative alien depending upon whether they believe that the chance of alien life has decreased versus increased, respectively. In Studies 7 and 8, we test the effect of a revised probability estimate on decision making—specifically, when a more desirable outcome is associated with, respectively, an upward change or a downward change. In both these studies, a revision in those probabilities leads participants to choose in a reliable way, with more participants choosing the risky, uncertain option (over the safe, certain option) when its forecasted probability of effectiveness had increased (i.e., when the uncertain option increases in desirability; Study 7), and fewer participants choosing the risky, uncertain option (over the safe, certain option) when its forecasted probability of danger had increased (i.e., when the uncertain option decreases in desirability; Study 8). Finally, Studies 9 and 10 attest to the ecological validity of our investigation by moving to the field. In Study 9, we poll bartenders and barstaff about their expected future sales upon learning that the likelihood that a (locally favored) sports team proceeding to the next round of playoffs had either increased or decreased. In Study 10, we conduct a field study in which we ask patrons of a farmers' market to choose between two bottles of wine as a free gift, coupled with information that one wine in the choice set is possibly contaminated and that this chance had been revised upward or downward. In all, the results of our research shed light on whether revising the forecast for a future event changes the meaning of that event. Even when the revised resulting forecast is the same after an increase or decrease, the event may feel different to people, influencing how they behave toward and manage those future events. We provide a short summary of our studies in Table 1, which shows the variables constituting the paths that we test in each study.

We employed stopping rules for data collection across each of our 10 studies; moreover, our sample sizes varied because of the diverse approaches adopted in the collection of our data. For example, in Study 10, our sample was constrained by the hours of a farmers' market and the number of market goers who decided to participate in our study. Further, some approaches were more conducive to large sample sizes (e.g., Amazon's Mechanical Turk platform; a large undergraduate extra credit pool), such as in Study 8 where we sought solely males and asked them about male birth control, whereas other samples were not (e.g., recruitment of adult passersby on university campuses and public locations; a small undergraduate pool), such as in Study 6 where we sought artist participants. Consistently, we targeted the largest sample size possible while incorporating effect sizes from previous work—including each of our successive studies, as they became available—to allocate our data collection resources in the most efficient manner possible. We note that this diversity and efficiency allowed us to recruit samples of undergraduates as well as adult volunteers ranging from passersby in different cities, mTurk respondents, restaurant employees, and market goers, attesting to the robustness of our findings across different populations.

Study 1: Revisions and Closeness

Our pilot study offered initial evidence that people incorporate changes to probabilities into their decision making. In Study 1, we extended this finding by asking participants how likely an event feels after making changes to its probability using a measure of subjective closeness from past research (Caruso et al., 2013; Maglio & Polman, 2014). Participants read a scenario about a barn swallow at risk of becoming extinct; we manipulated the probability of the event such that some participants were told that the probability had increased (from 20% to 30%) whereas other participants were told that the probability had decreased (from 40% to 30%). We also included a control condition where the probability remained at 30%. All participants indicated how close the extinction event felt to them. We predicted that the extinction would feel closer among participants in the condition where the probability was revised upward, from 20% (vs. downward, from 40%).

Method

We recruited 76 passersby at a large university for this study and told each that the study related to climate change—specifically, "climate change might put migratory birds at risk for extinction because of increasing global temperatures." We randomly assigned

Table 1
Summary of Studies

Study	Sample	Context	Conceptual test
Pilot	mTurk participants	Asian Disease problem	Revision -> Risky choice
Study 1	Adult passersby	Animal extinction	Revision -> Closeness
Study 2	Extra-credit undergraduates	Rain	Revision -> Momentum -> Closeness
Study 3	mTurk participants	Animal extinction	Revision -> Closeness (with momentum moderation)
Study 4	mTurk participants	Rain	Revision -> Closeness (with velocity moderation)
Study 5	Extra-credit undergraduates	Climate change	Revision -> Closeness -> WTP
Study 6	Art students	Alien life	Revision -> Creativity
Study 7	mTurk participants	Choice between pillows	Revision -> Risky choice
Study 8	Male mTurk participants	Male birth control	Revision -> Attitude
Study 9	Bartenders and barstaff	Sales prediction	Revision -> Prediction
Study 10	Farmers' market goers	Choice between wines	Revision -> Risky choice

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

participants to a condition in which the probability of one type of migratory bird (the barn swallow) becoming extinct was presented as having been revised to be more likely (from 20% to 30%), less likely (from 40% to 30%), or equally likely (from 30% to 30%) while holding final, objective probability constant (30%). The manipulation read as follows:

> Initially, scientists estimated that there was a 20% (30%; 40%) chance that one type of migratory bird—the barn swallow—would become extinct by 2050. However, this estimate was recently revised to a 30% chance of extinction.

We next asked participants, "How close does this extinction feel to you?" Participants responded on a scale ranging from 1 (*not at all close*) to 7 (*very close*). We used this measure of closeness because in everyday, anecdotal as well as academic contexts, likelihood is often expressed in terms of how close something is to occurring; when people think about an uncertain event that is unlikely, they might declare, "it is not close to happening," or when something almost happens, they might say "that was a close call." Research on psychological distance, including probabilistic distance (the distance that we measure in the present research) is no different in this regard: Scholars often measure subjective distance by asking participants how close an event feels to them (for further discussion on closeness as a measure of probabilistic distance, see Van Boven et al., 2010).

Results and Discussion

The closeness of the barn swallow's extinction significantly differed across the three experimental conditions, $F(2, 73) = 5.57$, $p = .006$, $\eta_p^2 = .13$. To test our prediction that upward revisions increase closeness while downward revisions decrease it, we conducted a planned contrast that revealed a linear increase in closeness across the three conditions, $F(1, 73) = 10.86$, $p = .002$. Specifically, when the probability estimate was revised upward, participants felt the extinction was closer ($M = 4.04$, $SD = 1.24$) than when the estimate was revised downward ($M = 2.96$, $SD = 1.11$), and closeness ratings from the no change control condition fell between the upward and downward conditions ($M = 3.64$, $SD = 1.15$). Thus, the same objective probability (30%) of an event coming to pass loomed psychologically closer when the event was framed as having increased (vs. decreased) in likelihood.

Study 2: Revisions, Momentum, and Closeness

In Study 2, we examined the role of psychological momentum in creating the subjective closeness that arises when a probability estimate is revised. When people learn that a probability estimate has increased or decreased, we predict that they estimate that another change in the same direction will occur in the future, offering a mechanism for the relationship between revisions and subjective closeness of the (re)forecasted events. We investigated this possibility, where participants rated the extent to which they expected revisions to continue into the future, using an established measure of predicted future change (Ersner-Hershfield, Galinsky, Kray, & King, 2010) in both a different domain (weather) and with a different set of estimates (30%, 45%, 60%) than in Study 1.

Method

We recruited 328 undergraduates who agreed to participate in exchange for course extra credit. As in the previous study, we randomly assigned participants to a condition in which the probability of an event was presented as having been revised to be more likely (from 30% to 45%) or less likely (from 60% to 45%) while holding final, objective probability constant (45%). The manipulation read as follows:

> You check the forecast right when you wake up, and it estimates that there is a 30% (60%) chance of rain for the day. You spend an hour getting ready, showering and then eating breakfast. Then you check the forecast again before leaving the house, and the estimate for rain has been revised to a 45% chance.

We next provided participants with five different pictures of arrows that ranged in slope from upward-and-steep to upward-and-moderately steep to flat to downward-and-moderately steep to downward-and-steep (adapted from Ersner-Hershfield et al., 2010, Study 2). We asked participants, "Which of the five different arrows do you think represents the most likely future trajectory of the chance for rain that day?" Then we asked participants, "How close of a chance do you think there is for rain?" on a scale ranging from 1 (*not at all close*) to 7 (*very close*) in a manner identical to Study 1.

Results and Discussion

As predicted, there was a significant difference in the subjective closeness for the event of rain between the two revision conditions, $F(1, 321) = 22.13$, $p < .001$, $\eta_p^2 = .06$. Specifically, when the probability estimate was revised upward, participants felt the event of rain was closer ($M = 4.27$, $SD = 1.00$) than when the estimate was revised downward ($M = 3.75$, $SD = 1.01$).

To measure momentum, we used the same method used in previous work (Ersner-Hershfield et al., 2010), collapsing both upward responses (upward-and-steep and upward-and-moderately steep) into one item, coded as $+1$ (*upward change*), and both downward responses (downward-and-steep and downward-and-moderately steep) into a second separate item, -1 (*downward change*). Thus, one item remained for no change, 0 (*no change*). In support of our prediction, we found that when the probability estimate was revised upward, participants predicted that another upward change would occur in the future ($M = 0.79$, $SD = 0.55$), whereas when the probability estimate was revised downward, participants predicted that another downward change would occur in the future ($M = -0.59$, $SD = 0.70$), $F(1, 326) = 389.04$, $p < .001$, $\eta_p^2 = .54$.

In light of these results, we carried out a bootstrapping procedure (Preacher & Hayes, 2008) to test whether the directional change in the probability estimate influenced the extent to which participants believe that the probability will be revised again in the same initial direction, thus leading the event to feel closer. One thousand repeated random samples were taken from the data to compute the indirect effect ($\beta = .46$, $SE = .14$). The analysis indicated that the indirect effect was estimated to lie within the non-zero-containing 95% confidence interval, .21 and .76, demonstrating that an upward (vs. a downward) revision to an event's likelihood leads participants to feel as though the revision will change upward again, which in turn makes those events feel closer.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Study 3: Moderating Momentum

As initial support for our proposed process, Study 2 found mediation evidence for the effect of revising forecasts on how close those events feel via a belief that revisions will continue in the same direction. To offer convergent evidence, Study 3 was designed to moderate the effect through the use of explicit information that future revision was or was not possible. Because the effect of a revised forecast on judgment is hypothesized to operate on account of its momentum (i.e., a belief that the forecast will change again in the same direction), we propose that explicitly indicating that the trend has ended with the latest estimate should diminish the felt potential for future change and, accordingly, the effect altogether.

In the interest of testing our effect across a variety of communicative contexts, Study 3 varies two additional components of the experimental design as well. First, the experimental materials do not give a prior estimate but, instead, give only the final estimate (30%), accompanied by a statement that this estimate was the result of either an upward or a downward revision. Second, additional information is included as to justify the revising of the estimate in the first place (the emergence of new information), which provided the basis on which to manipulate the potential for future revision (i.e., whether more information was or was not expected to become available in the future).

Method

Four hundred five volunteers were recruited from Amazon's Mechanical Turk platform to participate in exchange for a small cash reward. The experimental setup and design was similar to that of Study 1, save for the addition of one separate experimental factor: We randomly assigned participants to a condition in which the revision was stated as either open (potential for future change condition) or not open (no potential for future change) to further revision. The manipulation read as follows:

> Scientists have been monitoring the population of one type of migratory bird—the barn swallow—and estimating the chance that it might become extinct by 2050. In light of new information, they recently revised this estimate upward (downward) to a 30% chance of extinction.

For participants in the potential for future change condition, the manipulation continued with, "New information is expected to continually become available, meaning that this estimate will be revised again." For participants in the no potential for future change condition, the manipulation continued with, "No new information is expected to become available, meaning that this estimate will not be revised again." As in Study 1, we next asked participants, "How close does this extinction feel to you?" Participants responded on a scale ranging from 1 (*not at all close*) to 7 (*very close*).

Results and Discussion

We conducted a 2 (revision direction: upward or downward) × 2 (potential for future change: yes or no) analysis of variance (ANOVA) on closeness ratings, which revealed a main effect of direction, $F(1, 401) = 6.05$, $p = .015$, and no effect of potential for future change ($F < 1$). Importantly, a significant interaction between these two factors did obtain, $F(1, 401) = 6.85$, $p = .009$, $\eta_p^2 = .02$ (see Figure 1). As in the earlier studies, framing the revision as having the potential for future change caused the extinction event to feel closer when it had been revised upward ($M = 4.30$, $SD = 1.56$) than when it had been revised downward ($M = 3.53$, $SD = 1.47$), $F(1, 401) = 13.18$, $p < .001$, $\eta_p^2 = .03$. The absence of such potential diminished any difference between the upward ($M = 3.82$, $SD = 1.59$) and downward ($M = 3.84$, $SD = 1.43$) revision conditions, $F(1, 401) = 0.01$, $p > .9$, thus indicating that the trend did not have the potential to continue (sapping it of psychological momentum) moderated the effect of revisions on closeness.

Study 4: Robustness Across Revision Size

In the studies presented thus far, we manipulated only the direction of the probability revision (i.e., upward or downward) without consideration of the magnitude of the revision size. However, any revision of a probability estimate requires not only a directional move (upward or downward), but also a move of some size (e.g., from a percentage point or less to many percentage points). Thus, to examine the robustness of the effect established in Studies 1 through 3, Study 4 manipulates not only revision direction but also revision size. Two (competing) hypotheses emerge for the role of revision size.

One perspective would predict that bigger revisions should exacerbate the effect of revision direction on subjective likelihood. Markman and Guenther (2007) proposed that psychological momentum, much like its physical counterpart, is the product of mass and velocity. From this perspective, our previous (and subsequent) experiments do not vary velocity (size of change), only the direction of change (upward or downward revisions). Thus, greater velocity—in the form of larger revisions—should foster greater momentum and, in turn, widen the gap between upward and downward revisions.

On the other hand, we note here a point of divergence from traditional applications of psychological momentum and how it might apply to probability revisions. Previous investigations into PMT had no salient upper bound or limit that could cap momentum: A person with momentum on her side could always

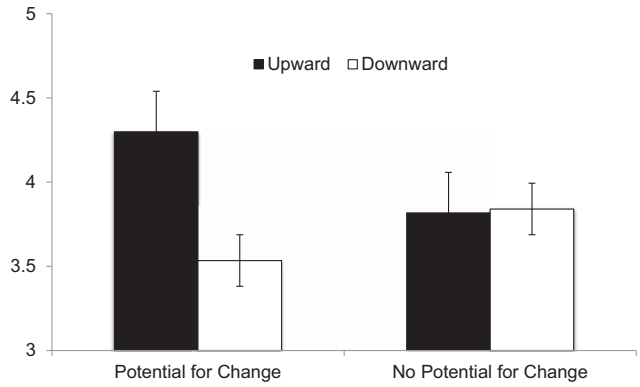

Figure 1. Subjective likelihood by revision direction and potential for future change, Study 3. Bars represent standard error.

keep improving, writing more pages or cycling faster than a competitor. However, probability estimates are accompanied by natural and unavoidable boundaries, as an event cannot be forecasted to occur with a likelihood that falls below 0% or above 100%. Thus, because probability revisions do not operate within an infinite space, perhaps people—in this specific instance—give greater weight in evaluating revised probabilities to the mere direction of the revision (upward or downward) than to the size of the revision. Indeed, this would be consistent with Study 3, in which the effect of revision direction emerged even in the absence of any information regarding the revision size. Thus, Study 4 seeks to investigate how people evaluate uncertain events when both the revision direction and magnitude (revision size) vary.

Method

Four hundred two volunteers were recruited from Amazon's Mechanical Turk platform to participate in exchange for a small cash reward. The experimental setup and design was similar to that of Study 2, in which we randomly assigned participants to a condition in which the probability of rain was presented as having been revised to be more likely or less likely while holding final, objective probability constant (40%). As a separate experimental factor, we randomly assigned participants to a condition in which the magnitude of the change in the probability revision varied (2 vs. 5 vs. 10 vs. 20 vs. 30 percentage points). The manipulation read as follows:

> Imagine that, during the course of getting ready to leave the house in the morning, you check the forecast twice. You do this because you think there is a chance that it will rain later that afternoon.
>
> Please envision that you've checked the forecast at the following time points and that, at those time points, your meteorologist reports the following probabilities for rain later that afternoon, updated in light of new information:
>
> 7 a.m.: 10%; (20%; 30%; 35%; 38%; 42%; 45%; 50%; 60%; 70%) probability of rain
>
> 8 a.m.: 40% probability of rain

In a manner similar to Study 2, we next asked participants, "How close of a chance do you think there is for rain later that afternoon?". Participants responded on a scale ranging from 1 (*not at all close*) to 7 (*very close*).

Results and Discussion

We conducted a 2 (revision direction: upward or downward) × 5 (revision size: 2, 5, 10, 20, or 30) ANOVA on closeness ratings, which revealed only a main effect of direction, $F(1, 392) = 34.43$, $p < .001$, $\eta_p^2 = .08$, with no effect of revision size nor an interaction between the two factors, Fs < 1 (see Figure 2). This pattern can be decomposed in two ways. First, we examine the influence of revision direction at each level of the revision size factor. For all but one revision size, a significant effect emerges in the expected direction, such that an upward revision caused rain to feel more likely than a downward revision, Fs > 6, ps $< .02$. Even for the revision size that did not reach a statistically reliable difference (the smallest, 2-point revision), the pattern followed the expected direction, $F(1, 392) = 2.41$, $p = .12$. Second, we examine the influence of revision size separately for both upward and downward revisions. Here, no effect was found, Fs < 1, such that subjective closeness did not vary as a function of revision size among participants considering either upward or downward revisions.

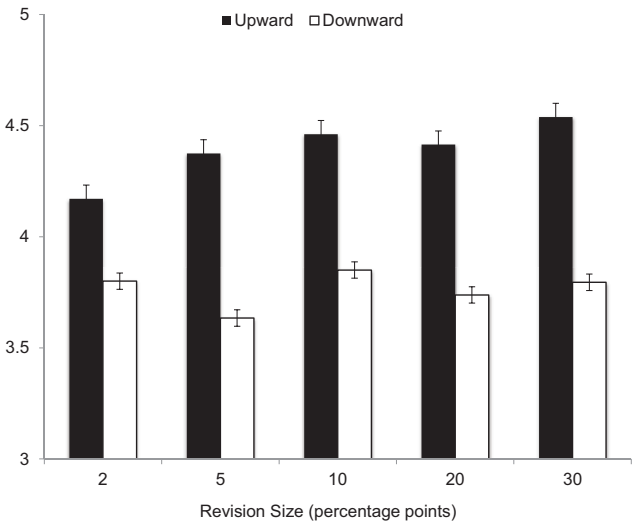

Figure 2. Subjective likelihood by revision direction and revision size, Study 4. Bars represent standard error.

In Study 4, the effect of revision direction appears robust across different sizes (of change) used in making a revision from a prior to an updated probability estimate. The absence of an effect of what might appear to reflect velocity—revision size—is not necessarily at odds with PMT. Instead, the results of Study 4 suggest that psychological momentum may witness context-dependent differences in weighting for its two primary components (mass and velocity), particularly when understanding changes to probabilities. For instance, in the psychophysics of chance (Kahneman & Tversky, 1984), people demonstrate a diminished sensitivity to changes in probability estimates for events that change from impossible to less than impossible (and from certain to less than certain). Termed *scope insensitivity*, research shows that when it comes generating feelings of likelihood, people are less attuned (more insensitive) to how much an event-probability changes, and more attuned (more sensitive) to a categorical change in a probability (Hsee & Rottenstreich, 2004)—suggesting that revision direction may eclipse the effect of the size of the revision on momentum.

Taken together, Study 4 suggests that revision direction exerts the relatively stronger role, compared to revision size, in updates to probability estimates. Accordingly, the remainder of our studies will isolate only revision direction in extending to important implications of revisions. In so doing, Study 4 also echoes a point from Study 3, in which participants were presented with the basis upon which the revision was made in the first place ("in light of new information") while also identifying the source of the communicated revision (the meteorologist).

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Study 5: Revisions, Closeness, and Event-Related Action

In Study 5, we tested the effect of revised estimates on closeness as well as a judgment expected to derive therefrom. Specifically, we devised a climate change scenario that included a probability estimate concerning permanent damage to the environment. We predicted that an upward (vs. a downward) revision to the probability of that permanent damage would lead people to feel as though the event was closer and, subsequently, to report higher willingness to pay for an environmentally friendly product that helps to mitigate environmental damage. In this vein, we are testing again whether forecast revisions affect how close events feel, and, extending the previous studies, whether closeness accounts for how people act toward revised events.

Method

Ninety-three undergraduates participated in this study in exchange for course credit. We told participants that the study related to climate change and that participants would read a passage from a newspaper article describing a scientific report on climate change impacting Earth's oceans. The title of the article was "Climate change 'making seas more salty.'" The body of the article described how rising global temperatures had increased the rate at which water evaporates from the oceans into the air, leading to a risk of permanently elevated ocean salinity and compromising the habitats of several birds and fish. Then, we randomly assigned participants to a condition in which the probability of this event was presented as having been recently revised to be more likely (from 20% to 30%) or less likely (from 40% to 30%) while holding final, objective probability constant (30%). The manipulation read as follows:

> Initially, scientists estimated that there was a 20% (40%) chance that permanent damage would occur to ocean salinity levels by 2050. However, this estimate was recently revised to a 30% chance.

We next asked participants, "How close does the event of permanent ocean damage feel to you?" Participants responded on a scale ranging from 1 (*not at all close*) to 7 (*very close*). Subsequently, we told participants that, "energy efficient (CFL) light bulbs save energy and contribute to the well-being of the planet, but they cost more than traditional light bulbs" and then asked participants how much they would be willing to pay for an energy efficient light bulb.

Results and Discussion

Participants rated the subjective distance of the permanent damage as closer when the estimate had increased ($M = 4.91$, $SD = 1.04$) than when the estimate had decreased ($M = 4.35$, $SD = 1.37$), $F(1, 91) = 5.07$, $p = .027$, $\eta_p^2 = .05$. Moreover, the direction of revision to the probability estimate significantly affected willingness to pay for the light bulb, $F(1, 91) = 8.96$, $p = .004$, $\eta_p^2 = .09$. When the probability estimate was revised upward, participants were willing to pay more ($M = \$3.33$, $SD = 1.08$) than when the estimate was revised downward ($M = \$2.57$, $SD = 1.34$).

In a mediation analysis, we considered whether the increase in subjective closeness created by an upward revision to the probability estimate accounted for the subsequent increase in willingness to pay for an energy efficient light bulb. We tested this using a bootstrapping procedure similar in design to Study 2. One thousand repeated random samples were taken from the data to compute the indirect effect ($\beta = .11$, $SE = .08$). This indirect effect was estimated to lie within the non-zero-containing 95% confidence interval, .01 and .37, suggesting that an upward (vs. a downward) probability revision to a negative event caused the event to feel closer, which in turn led people to report a willingness to spend more money in the interest of mitigating that negative event.

Study 6: Revisions and Creativity

In Study 6, we further examined the breadth of behavioral consequences resulting from revised forecasts. Specifically, we investigated creativity as resulting from (and applied to) a context in which probabilities have been revised upward or downward. We draw from the literature on creativity because it has found that distant considerations enable people to think more creatively or generatively about a topic (Henderson & Wakslak, 2010). For example, one series of studies framed a creative insight task as either *spatially* near or far, and found that participants evinced greater creativity when the task was framed as far away (Jia, Hirt, & Karpen, 2009). In another example, a set of studies framed a creative insight task as either *socially* near or far (by having participants generate creative solutions to their own problems or to others' problems), and found that participants showed more creativity when trying to solve other people's problems (Polman & Emich, 2011). Furthermore, research has found that people see more (creative) associations among items in tasks that are framed as less (vs. more) likely to happen (Wakslak et al., 2006). Thus, if downward revisions to likelihood make events feel farther away, it follows that people should conceptualize those events in a more creative manner than if those likelihoods had been revised upward. In Study 6, we tested this hypothesis using an established measure of creativity where people draw an alien (Ward, 1994). In our study, we first indicated that the probability of alien life had increased or decreased from a prior estimate; then we asked participants to draw what such an alien might look like. We predicted that participants would draw less creative aliens (aliens that more closely resemble earth-like creatures; e.g., having four limbs; two eyes above a mouth, Ward, 1994) when led to believe that the chance of alien life had increased rather than decreased.

Method

Seventy student participants were recruited from two different universities. All participants were told that, "a group of scientists recently met for a panel discussion on alien life on other planets." Then, participants were randomly assigned to a condition in which the probability of alien life was presented as having been revised by this group to be more likely (from 20% to 30%) or less likely (40% to 30%) while holding final, objective probability constant (30%). The manipulation read as follows:

> Initially, the scientists had estimated that there was a 20% (40%) chance that there are aliens in the universe. However, this estimate was revised upward (downward) to a 30% chance.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

We next asked participants to consider how such an alien might look and to take two minutes to draw the alien that they imagined.

Results and Discussion

Each participant received a creativity score for his or her alien drawing whereby higher scores indicated that a more creative alien had been drawn. The scoring was conducted by two research assistants (blind to experimental condition and with discussions to resolve discrepancies) in a manner consistent with previous research, where creativity is assessed as a tally count of how many unusual, nonearthlike features (e.g., a number of eyes other than two) the alien drawing contained (see Ward, 1994 for complete details). Participants at one of the universities drew more creative aliens ($M = 1.21$, $SD = 0.96$) than participants at the other ($M = 0.59$, $SD = 0.68$), perhaps because participants from the former were recruited from an art class. Because location did not interact with experimental condition ($p > .6$), we collapsed across this factor in our primary analysis. The direction of revision to the estimate of alien life significantly affected creativity scores, $F(1, 68) = 5.24$, $p = .025$, $\eta_p^2 = .07$. Participants drew more creative, less earth-like aliens when the chance of alien life had been revised downward ($M = 1.11$, $SD = 0.96$) than when the estimate had been revised upward ($M = 0.66$, $SD = 0.68$). The relationship between creativity and revision direction should be independent of an alternative explanation based upon effort, as all participants were given the same amount of time (2 min) in which to complete the task. This complements prior work attesting to the fact that people do not necessarily work less hard on unlikely (Wakslak et al., 2006) or distant (Henderson, Fujita, Trope, & Liberman, 2006) tasks, in addition to the fact that effort may not even predict performance on this task (because it takes presumably less effort to draw one alien eye but more effort to draw three eyes; consistent with the coding scheme, both of these kinds of aliens would be coded as higher in creativity compared with an alien with a pair of eyes). Thus, revisions to probability estimates change how people (creatively) imagine events.

Study 7: Choice Between Pillows

In Study 7, we examine the effect of revising a forecast on a choice between safe and risky options. We predicted that revisions to probabilities of events reconfigure the choices that people make in a manner consistent with shifts in subjective closeness. Specifically, Study 7 considered how people make tradeoffs between options (i.e., one safe product and one risky product). We presented participants with a choice between two options to determine which they would choose when the risky option accompanied an increase or decrease in its chance of effectiveness. Furthermore, the upward change in probability was associated with a more positive outcome, unlike the previous studies where the upward change was associated with a more negative outcome (e.g., species extinction, global warming). In this way, we test whether changes in probabilities affect behavior irrespective of the desirability of those forecasted events.

Method

Three hundred forty-six volunteers were recruited from Amazon's Mechanical Turk platform to participate in exchange for a small cash reward. We asked participants to imagine that they were looking to purchase a pillow from a set of two available options. The pillows were described as follows: "Pillow #1 has a retail value of $20 and makes no claims about improving your sleep. Pillow #2 has a higher retail value of $60 and claims that it provides a better night's sleep, helping you to fall asleep more quickly and to feel less tired throughout the day." Then, we randomly assigned participants to a condition in which the probability of Pillow 2's effectiveness was presented as having been recently revised to be more likely (from 70% to 80%) or less likely (from 90% to 80%) while holding final, objective probability constant (80%). The manipulation read as follows:

> When originally released, Consumer Reports estimated that Pillow #2 had a 70% (90%) chance of effectiveness, but they recently revised it to an 80% chance of effectiveness.

Participants then indicated which pillow they would purchase in this scenario.

Results and Discussion

The direction of revision to the probability estimate marginally affected which pillow participants chose, $\chi^2(1, N = 346) = 2.976$, $p = .085$. When the chance of effectiveness for Pillow 2 was revised upward, 92/174 participants (52.9%) chose Pillow 2 over Pillow 1, whereas when the chance of effectiveness for Pillow 2 was revised downward, fewer participants (75/172; 43.6%) chose Pillow 2 over Pillow 1. These results provide two important extensions to our general finding. First, the event under consideration—a product's effectiveness—was positive, in contrast to the negative events in Studies 1–6 (e.g., species extinction, global warming). This suggests that the effect of a revision on decision making obtains regardless of the valence of the event being revised. Second, many of our earlier experimental paradigms utilized similar numerical estimates (i.e., revisions from 20% or 40% to 30%), whereas this study used estimates substantially larger in magnitude, indicating that the effect does not depend upon a particular operationalization of revised probabilities (e.g., below 50%).

Study 8: Male Birth Control

In Study 7, the choice comprised an upward revision that was paired with a desirable outcome. In Study 8, we investigated a choice when it comprised an upward revision that was paired with an undesirable outcome. In the majority of our previous studies, an undesirable outcome was paired with an upward change; Study 8 extends these studies to a decision context where participants have to decide between a safe and a risky option. Moreover, in a departure from the previous studies, we changed the probabilities so that the differences between the old and new forecasts were much smaller (as were the probabilities themselves). Specifically, the event probability changed from 2% or 4% to 3%. In this vein, our test is particularly conservative: The (absolute) change from the original forecast to the updated one is smaller than in our previous studies, and the difference between the original forecasts in the respective upward and downward conditions is smaller as well. These changes to our design help shine a spotlight on the direction of the revision, because perhaps in this study, the only

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

material difference between the conditions is the direction of the revision (with less focus on the extent of change; see also the results from Study 4). In addition, this study used a different domain, sexual wellness, in the area of male birth control. We chose this topic because the male birth control pill is expected to change the practice of (and debate about) reproductive health. It is expected to become available in 2017, making it an especially contemporary topic.

Method

Three hundred males were recruited from Amazon's Mechanical Turk platform to participate in exchange for a small cash reward. We told participants about a male birth control pill that is to be released in 2017. We randomly assigned participants to a condition in which the chance of failure for the pill was presented as having been revised to be more likely (from 2% to 3%) or less likely (from 4% to 3%) while holding final, objective probability constant (3%). The manipulation read as follows:

> In 2017, a male birth control pill is scheduled to be released. When the pill was originally tested, scientists estimated that the pill (to be taken on a weekly basis) had a 2% (4%) chance of failure, but as more tests have been conducted, the scientists revised the rate of failure up (down) to 3%.

We next asked participants, "How open would you be to changing from your current birth control (whatever that may be; e.g., condoms, pulling out, abstinence, no birth control) to using the new male birth control pill?" Participants responded on a scale ranging from 1 (*not at all open*) to 7 (*extremely open*). We also added a "not applicable" response item should the male birth control pill be irrelevant to participants' lifestyle. To conclude, we provided a debriefing message that provided more information about the male birth control pill and the purpose of our study.

Results and Discussion

In our sample, 12.3% (37/300 participants) indicated that a male birth control pill was "not applicable" for them. Among the remaining 263 participants, we tested whether openness to the male birth control pill varied between conditions. Participants in the upward condition, where the chance of failure increased (from 2% to 3%), were less open to changing their current birth control to the male birth control pill ($M = 4.67$, $SD = 2.06$) than participants in the downward condition, where the chance decreased (from 4% to 3%; $M = 5.18$, $SD = 1.79$), $F(1, 258) = 4.65$, $p = .032$, $\eta_p^2 = .02$.

These findings are consistent with those in the previous studies: The direction of a revised forecast influenced participants' willingness to change their current birth control method. Perhaps more importantly, we found evidence of our effect among changes between forecasts that are especially small, which lends further support to the idea that it is the directionality of the revision (more so than the magnitude of change) that influences judgments and decisions. Finally, this study provided the opportunity to extend our effects to the health domain, which is undoubtedly an area that is replete with statistics and probabilities. In an area that is concerned with changing behavior, our results suggest that people may prefer the status quo when the chance of undesirable, uncertain events increases, irrespective of the absolute probability of those events.

Study 9: Field Study With Bar Sales

Our last pair of studies broadens the scope of our investigation by testing our effect in the field. In Study 9, we recruited a sample of employees working in the food service industry and asked about their sales projections for their restaurant or bar. Specifically, we recruited a sample of bartenders and waiters at sports bars during the semifinals of the 2014 National Hockey League (NHL) Stanley Cup Playoffs in a city that tends to support the Chicago Blackhawks. These respondents were told that the probability of the Blackhawks proceeding to the next round of the playoffs had been revised upward or downward (to the same final estimate). Presuming that success for the Blackhawks in reaching the next round would mean increased traffic and sales in those sports bars, we asked our respondents about their projected future bar sales for the remainder of the playoffs and hypothesized that they would predict greater sales when the probability of the Blackhawks advancing had increased rather than decreased. Additionally, this study utilized a novel method to communicate a revision to probability. Rather than stating the revision explicitly in the experimental materials, the ostensibly original estimate (that had been printed on a piece of paper) was manually crossed off (though still visible), and replaced by a handwritten estimate reflecting either an upward or a downward revision.

Method

We visited 22 sports bars in Madison, WI, during the semifinals of the 2014 NHL playoffs and asked one to two employees in each sports bar to complete a survey about the Chicago Blackhawks and bar sales ($N = 41$). At the time, the Blackhawks had recently proceeded to the quarter-finals, which presumably meant higher bar sales, as residents of that city tend to support the Chicago Blackhawks and watch the games—while eating and drinking—at these bars. We randomly assigned each sports bar (and its one to two employees surveyed) to a condition in which the materials indicated that, "Forecasters have predicted that the Blackhawks have a 10% (30%) chance of going all the way to the Stanley Cup playoffs." To reflect a recent revision, a handwritten note on the survey crossed out the typed probability estimate and indicated that the probability had (on that day) been revised to 20%. Then, we asked employees to predict their bar's future sales for the remainder of the playoffs, on a scale ranging from 1 (*the usual*) to 7 (*a lot more than usual*).

Results and Discussion

The direction of revision to the estimate of the Chicago Blackhawks proceeding to the final championship significantly affected sales forecasts, $F(1, 39) = 4.16$, $p = .048$, $\eta_p^2 = .09$. Respondents predicted higher sales when the chance of the Blackhawks proceeding had been revised upward ($M = 4.46$, $SD = 1.68$) than when the chance had been revised downward ($M = 3.45$, $SD = 1.44$), despite the final revised probability (20%) remaining the same in each case. Thus, revisions impact not only how people think and behave on their own behalf but also change how people working in an industry anticipate revenues for their organization. Of note, Study 9 echoes an important robustness check initially documented in Study 7: The upward revision in this study was

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

associated with a more desirable event, and the downward revision was associated with a less desirable event, thus further ruling out an explanation based on valence (e.g., that negative events feel more likely than positive events following upward revisions).

Study 10: Field Study With Wine

In our final study, we return to a choice paradigm similar to Study 7, only participants experienced these options as real in Study 10. In other words, we devised our final experiment so that the decisions made by individuals pertain not to hypothetical outcomes or predictions but, rather, to practical, consequential outcomes. Evidence from Studies 7 and 8 suggests that people prefer a safer option when the chance of *effectiveness* for a risky option has been revised *downward* (Study 7) or when the chance of *danger* for a risky option has been revised *upward* (Study 8). In Study 10, we bring a similar tradeoff—between safe and risky products—to the field. We partnered with a winery and a farmers' market, presenting market-goers with a choice between two bottles of wine: one ostensibly safe (but lower priced) bottle and another (higher-priced) bottle that had a chance of being contaminated. In keeping with our earlier studies, we described this likelihood as having been revised upward or downward. By buying the wine from the winery and distributing the bottles that market-goers chose for free at the farmers' market, we were able to extend the scope of our research to a naturalistic, incentive-compatible setting.

Method

One hundred fifty-nine volunteers were recruited at a farmers' market in Toronto, ON. They were told that the study related to decision making. All participants were told that their task would be to choose between two different bottles of wine and that, as compensation for their participation, they would receive one bottle of the wine they chose. In fact, their wine choice constituted our dependent variable of interest.

Participants proceeded to read descriptions of the two bottles of wine under consideration. The wines were described as follows: "Wine #1 has a retail value of $15, and there is no chance that the bottle has been contaminated. Wine #2 has a higher retail value of $40, but there is a chance that the bottle has been contaminated with a 'corked' defect (which creates undesirable smells and tastes but poses no health hazards to drinkers)." Then, we randomly assigned participants to a condition in which the probability of Wine 2 being corked was presented as having been revised to be either more likely (from 10% to 15%) or less likely (from 20% to 15%) while holding final, objective probability constant (15%). The manipulation read as follows:

> Originally, the winemaker estimated that the chance of this defect was 10% (20%), but he recently revised it to a 15% chance of defect for Wine #2.

To maintain ecological validity, we reported the actual retail values of the two wines ($15 and $40, respectively). However, the likelihood of contamination (as well as the occurrence of a revision) for the two wines was altered by the authors—that is, the true probability of corking for the wines was presumably at normal levels.

We next asked participants, "Which free bottle of wine would you like?" and they responded by indicating either "Wine 1" or "Wine 2," at which point they received one bottle of the wine of their choosing. To ensure that participants would base their choice only on the information that we provided, all of the wine bottles were placed in sealed gift boxes before conducting the experiment. Each box was labeled as containing either Wine 1 or Wine 2 so that participants received the correct wine. Furthermore, we asked participants not to open their gift box until they had left the market and not to discuss the experiment with other market-goers. Debriefing information was included on a printed card inside each box.

Results and Discussion

The direction of revision to the probability estimate marginally affected which wine participants chose, χ^2 (1, N = 159) = 2.919, p = .088. When the chance of the corked defect for (the risky) Wine 2 was revised upward, 27/79 participants (34.2%) chose Wine 2 over Wine 1, whereas when the chance of the corked defect for Wine 2 was revised downward, more participants (38/80; 47.5%) chose Wine 2 over Wine 1. Notably, we had targeted a larger sample (i.e., had sufficient wine for a sample of 250 participants), but we were limited by the number of market goers who attended the farmers' market on that day, and the nature of our debriefing made it impossible to run a second wave of data collection on a later date.

By extending our results to the field, we find that the direction of a revision shapes real choices (receiving a bottle of wine valued at $15 or $40). We also note that, given the domain of inquiry (i.e., wine contamination), we used a different set of probability estimates (10%, 15%, 20%) from our earlier experiments. Thus, even using these numbers to constitute a revision and using a context in which the choice was real instead of hypothetical evidences converging support of the effect of forecast revisions on behavior.

General Discussion

Though people face a continual stream of information that communicates revisions to probability estimates, research to date has considered likelihood mainly from the perspective of static snapshots. Because probabilities are not always constant, forecasts for these events often undergo revisions, and the present investigation has attempted to better understand the psychological mechanisms and consequences by which people interpret and act upon changes in the likelihood of events over time. Across a series of studies, we provided evidence for an effect whereby people prove sensitive to how the likelihood of an event moves in psychological space. Consistently, we offered evidence suggesting that this movement (via revisions of event-probability) influences how close or likely those events feel (Studies 1–5) on account of the psychological momentum generated by those revisions (Studies 2 and 3), changing how people think and behave with respect to those uncertain future events (Studies 1–10).

Our effects were reliable across several changes in procedure, design, and sample characteristics. We tested the effect from multiple diverse events such as species extinction (Studies 1 and 3), weather (Studies 2 and 4), climate change (Study 5), alien life (Study 6), product effectiveness in pillows (Study 7), health and

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

wellness (Study 8), bar sales (Study 9), and product failure in wine (Study 10)—as well as in the classic Asian Disease scenario (pilot study). We found a similar pattern across a range of estimates (and changes in those estimates), including low probability and small changes (changing from 2% vs. 4% to 3%, in Study 8); moderate changes (changing from 10% vs. 15% to 20% in Study 10); moderate probability and larger changes (changing from 30% vs. 60% to 45% in Study 2); and high probability (changing from 70% vs. 90% to 80% in Study 7). In strong support of the effect across different changes in estimates, Study 4 found that the size of the effect was nearly the same for changes that were 2 to 5 to 10 to 20 to 30 percentage points away from the originally estimated probability.

Moreover, our use of different probability estimates across studies helps to address a major distinction that arises in describing upward changes and downward changes: absolute versus relative degrees of change. A change in probability can be described in absolute terms, as in the case of increasing or decreasing by 10 percentage points (e.g., increasing from 20%, or decreasing from 40%) to one same final estimate (e.g., 30%). The same change might instead be described in relative terms, whereby a change from 20% to 30% reflects a 50% increase, whereas a change from 40% to 30% reflects a 25% decrease. As this example illustrates, it is impossible for the magnitude of increase to match the magnitude of decrease (between an initial probability estimate and a revised probability) in both absolute and relative terms. At first, this might cast doubt on our findings, where we always matched the absolute magnitude of change, making the magnitude of relative change different between the upward and downward revision conditions. However, in light of research that has shown that people are fairly poor at interpreting relative change and percentages more generally (e.g., Parker & Leinhardt, 1995; Venezky & Bregar, 1988), it is unlikely that the participants in our studies were influenced by the different relative extents of change in the upward and downward conditions, much less even aware of this difference between conditions. Though each isolated study in the current investigation cannot resolve whether our participants were influenced by the different relative extents of change between upward revisions and downward revisions (in contrast to our prediction, where participants are influenced by the direction of the revisions), the results from our studies were consistent across differences in relative change magnitude. For example, we found evidence supporting our prediction not only among comparatively larger differences of relative magnitude—such as in Study 2, 50% (e.g., increasing from 30% to 45%) and 25% (e.g., decreasing from 60% to 45%)—but also among comparatively smaller differences of relative magnitude—such as in Study 7, 14.2% (increasing from 70% to 80%) and 11.1% (decreasing from 90% to 80%). That the latter (Study 7) difference in relative magnitude between the upward and downward changes was only 3.1 percentage points suggests that the discrepancy between absolute versus relative magnitude is an unlikely candidate for an alternative explanation of our findings.

Finally, we tested the effect on different subject populations, and indexed behavior using both hypothetical and naturalistic measures. Our studies also included both separate and joint evaluation modes (cf. Hsee, Loewenstein, Blount, & Bazerman, 1999), where participants evaluated one sole uncertain and revised event (Studies 1–6, 8, and 9) or chose between two events where one event was revised but the other was not (Studies 7 and 10). The consistency in our findings across scenarios, measures, and samples provides confidence in their validity.

A Broader View of Psychological Momentum

People often infer, ceteris paribus, that trends will continue in a given direction. To date, psychological momentum has been brought to bear on how people apply this physical principle to expectations of future outcomes (e.g., Markman & Guenther, 2007). The present investigation takes a broader view of this psychological momentum construct, proposing that it encapsulates probabilistic distance, specifically hypothesizing and finding that a change in an event's forecast is expected to continue to change along the same trajectory in the future, impacting judgments and decisions. In the studies presented here, this forecast was always a prospect that some future, uncertain event may (or may not) come to pass, and psychological momentum emerged as a function of revised probability estimates for the likelihood of an event.

Such forecasted likelihoods often provide the most useful data to plan today for what may come tomorrow. We show how prior information—in the form of past revisions to probabilities—shapes predictions for the future and behaviors designed to navigate that future. This predilection can either help or can steer the course for systematic bias. The present investigation takes no stance as to whether this pattern of cognition, writ large, offers an overall benefit or detraction in decision making. Rather, it identifies a reliable pattern of cognition-derived judgments and decisions and offers a theoretical account for their preponderance.

From Objective to Subjective Psychological Distance

For most of its history, the construct of psychological distance has been investigated through the proxy of objective distance. Whether in time, space, social distance, or probability, researchers have by and large manipulated the objective location of a target in psychological space to examine the cognitive and behavioral consequences thereto. In so doing, the field has learned a great deal about how distance shapes judgments and decisions (Henderson & Wakslak, 2010; Liberman & Trope, 2008; Maglio et al., 2013a) but less about alternative inputs, beyond objective distance, that might similarly impact judgment and decision making (cf. Van Boven et al., 2010). Our studies held the final probability estimate (i.e., the objective distance) constant, varying only whether it had been revised upward or downward to establish an effect upon feelings of closeness among other behaviors and choices. Accordingly, we offer revision direction—in the context of probability—as a distinct factor contributing to perception.

This is not to contend that the present investigation stands alone in its consideration of dynamics in distance. Rather, it compliments existing work—albeit in separate domains of distance—that has suggested how trajectories configure subjective distance. The future feels closer than the past (Caruso et al., 2013) and locations feel closer in space when people are oriented toward them rather than away from them (Maglio & Polman, 2014). Nevertheless, these investigations assessed only subjective distance and not the consequences that closeness might predict. Therefore, we believe that the present investigation makes a contribution not only in considering dynamics in a novel dimension of psychological dis-

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

tance, but also in considering the impact of a novel variable (revisions) on feelings of psychological closeness (Studies 1–5) and momentum (Studies 2–3), as well as on hypothetical (Studies 1–5, and 7–8) and, importantly, consequential or naturalistic behaviors (Studies 6, 9, and 10).

From Distance to Abstraction

The present investigation targeted psychological distance through the lens of probability to examine the consequences of events being appraised as more or less likely. However, any investigation about psychological distance would remain incomplete if it failed to mention one major outcome of distance: a higher level of mental construal (Liberman & Trope, 2008; Trope & Liberman, 2010). People think in more broad and all-encompassing terms about things that feel far from (vs. closer to) their egocentric experience. However, this domain remains limited in much the same way as the larger field of likelihood: to static snapshots. One commonality among research on distance and construal level theory is that people, prospects, and places tend to remain frozen in their (probabilistic) location, either subjectively close to or far from the individual considering them. As a result, when any such object is far away, it is considered more abstractly; when an object is close, people think about it concretely.

But what about when a prospect—such as the likelihood of the weather proving advantageous or a purchase turning out to be a dud—moves, in probabilistic terms, from less likely to more likely (or vice versa)? Assuming that it arrives at the same point, our results suggest that people would think more concretely about a prospect that moved upward (vs. downward) in its likelihood and, for instance, take action toward it sooner (Liberman, Trope, McCrea, & Sherman, 2007; McCrea, Liberman, Trope, & Sherman, 2008) and prioritize short-term considerations (Fujita & Han, 2009; Fujita, Trope, Liberman, & Levin-Sagi, 2006). We interpret recent findings from Hsee and colleagues (Hsee, Tu, Lu, & Ruan, 2014) as offering indirect support for this contention: People exhibit *approach aversion*, evaluating stimuli more negatively when those stimuli are moving closer (in space, in time, or in probability). Our findings suggest that approaching stimuli feel closer, leading people to construe them more concretely. Given the association between closeness and concrete construal, and between closeness and other related concepts such as adoption of a prevention focus (Pennington & Roese, 2003) and a tendency to focus on the cons of an action more than the pros (Eyal, Liberman, Trope, & Walther, 2004), it is possible that subjective closeness (and, in turn, concrete, prevention- and con-focused thinking) offers one potential explanation for their results.

Limitations and Future Directions

Though the evidence was consistent across each of our studies, the strength of the effect varied depending upon our outcome measures. In particular, the expectation for past trends to continue into the future was large (i.e., events felt subjectively more or less likely according to whether those events' probability had increased or decreased, respectively), yet the downstream consequences of changing forecasts, such as the effect on choice, was smaller and, at times, failed to reach conventional levels of statistical significance (the pillow choice in Study 7; the wine choice in Study 10). When people make choices between options defined by various attributes, they consider the attribute information that comprises their alternatives, and each attribute exerts some degree of influence on what people eventually choose, whereby each piece of information (and its corresponding influence) is weakened as more information is added (Russo, Meloy, & Medvec, 1998). For example, when decision makers have strong preexisting preferences (e.g., for higher-priced wines), a forecast revision may not substantially sway their decisions. In this same vein, when participants make consequential choices (e.g., planning for how much to staff a bar), they may engage in relatively careful reflection, which could give rise to the incorporation of other pieces of information (Polman & Russo, 2012). And when participants are motivated to call information to mind and incorporate it into their decision, then the effect of probability revision information—one attribute among many—may have a smaller effect. Nonetheless, our set of 10 studies shows that revisions to probability estimates appear to have a reliable effect on judgments and decisions. In support, we conducted a mini meta-analysis for the primary comparison in each of our 10 studies (e.g., collapsing across the revision sizes in Study 4) by calculating the mean effect size (Cohen's d) using the random-effects model procedure suggested by Field and Gillett (2010). We used the more conservative random-effects model over the fixed-effects model. The null hypothesis of effect size homogeneity was not rejected, $\chi^2(9) = 8.37$, $p = .49$, despite the fact that our studies contained different stimuli, contexts, dependent measures, and samples (e.g., mTurk participants, students, artists, bar staff, market-goers). The results reveal a quite reliable effect—the mean effect size is $d = .44$, $p < .001$.

Our participants did not exhibit the effect when the estimate seemed less subject to further revision. Rather, we found support for an explanation based on psychological momentum: By measuring the extent to which people believe trends will continue (Study 2) and in curbing momentum by manipulating the potential for future revision (Study 3), we found that in cases where a future revision appears unlikely, a change to the forecasted probability of an event did not make it feel more or less likely. Thus, the results from Study 3 in particular indicate that our findings are not simply a matter of the potential contrast evoked by upward and downward revisions, as if a 30% forecast feels more likely because it seems larger when following a smaller (20%) forecast than when following a larger (40%) forecast. Because our revision manipulation in Study 3 did not explicitly state what the prior estimate had been (only that it had been revised upward or downward), and because the effect weakened in the condition in which no further revision was possible, any alternative account based on contrast seems less plausible, if not impossible. That said, we believe that other factors might modulate the relationship between revision direction and subjective closeness and its associated behavioral consequences.

Confidence. In two of our studies, participants were provided with an ostensibly reasonable explanation for the revision ("in light of new information"; Studies 3 and 4); in the other studies, no such justification was provided, and perhaps our participants drew upon conversational norms (i.e., demanding that communicative statements be informative, truthful, and relevant; Grice, 1975) to infer that the forecaster had sufficient knowledge to be making probability estimates and had chosen to make and share a revised estimate. We have assumed a uniform level of confidence in the estimates made at the successive time points despite the fact that

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

variation in the estimator's confidence of the estimates across time points might separately impact psychological momentum and, in turn, our effect.

Individual differences. Our findings might depend on people's lay conceptualizations of change (e.g., incremental vs. entity theories; Dweck, Chiu, & Hong, 1995) such that individuals who see ability as malleable versus fixed may believe that revised events will be subject to further or no revision, respectively (Butler, 2000). Relatedly, the present investigation remains limited in its examination only of Western participants. As our effect hinges on the prediction that a trend will continue its given course, it may well reverse if people adopt a naturalistic tendency to expect that what goes up must necessarily go down (rather than remain steadfast along its upward or downward trajectory). As a result, perhaps the tendency to expect equilibrium (i.e., characterizing Eastern cultures, Alter & Kwan, 2009; Ji, Nisbett, & Su, 2001) might show not only an attenuation but indeed a reversal of the effect documented herein.

Experience. Just as culture might shape how people interpret changes, so too might experience within particular domains (e.g., knowledge about weather or wine). We cannot be certain that people do not utilize their experience or familiarity (known to exert a separable impact on judgments and decisions; Hertwig & Erev, 2009). People may possess knowledge that a certain event tends to occur with an approximate probability (i.e., its presumed base rate), as was the case when Windschitl and Weber (1999) investigated how people responded to a 5% chance of rain in either London (typically rainy) or Madrid (typically arid). From our perspective, base rate knowledge might be seen as an initial probability estimate, with the explicitly stated 5% probability comprising a revision thereto. Why, then, might a *downward* revision in this case (in the event of rain for London) be evaluated as relatively *more likely*? First, in our studies, the probability estimates that we used were probably not that different from what people might believe to be the ordinary, base rate probability. Second, we diverge from Windschitl and Weber's work in the source of the prior or initial estimate. Perhaps, when a revision is made to a self-generated prior (as in Windschitl & Weber, 1999), people anchor on and insufficiently adjust from such a prior estimate (Epley & Gilovich, 2001), which biases their subjective likelihood of that event in the direction of the initial estimate.

Dissonance and control. In our studies, participants were given revision information for pillows and wines *before* making a choice between options, but what would happen if the revision information was provided *after* they had made their choice? The desire to see chosen options favorably (Festinger, 1957) might well exert an independent force on how they interpret probability revisions and trajectories. For example, people might wish to know what the prior estimate(s) had been (in cases where they are not provided with such information). Any such desire to learn about momentum would provide a new perspective both on PMT and our model, suggesting—consistent with hysteresis—that the history of a system (e.g., a forecast's trajectory over time) is seen as providing a unique source of knowledge about it. This thought experiment suggests, more broadly, that the locus of control might moderate our effect. Much like the person who has already chosen a pillow or wine may distort postchoice information in favor of his or her chosen option, spectators watching a cycling competition (without control to impact the race) were faster to see shifts toward positive (vs. negative) momentum in cyclists whom they were supporting (Briki, Den Hartigh, Markman, & Gernigon, 2014), evidence of a self-serving bias. However, in contrast, *participants* in a cycling competition were faster to see shifts toward negative (vs. positive) momentum (Briki, Den Hartigh, Markman, Micallef, & Gernigon, 2013). Thus, when the individual has the potential to take action, it is possible that negative or threatening information looms larger in motivating subsequent action (e.g., Cole, Balcetis, & Dunning, 2013) and, accordingly, biases interpretation of momentum-related occurrences.

Memory and momentum. Not only might people desire to learn prior probability estimates, but likelihood (as experienced in the present) might also bias memory for probability when recalled later. In our studies, participants considering upward (vs. downward) revisions thought and acted as if they believed the event to be subjectively more likely. But how might they remember the probability when reflecting upon it later in time? After a short delay, it stands to reason that almost everyone would be able to report the objective probability. However, a substantial time delay might compromise their memory for this information as a result of the momentum felt by the movement in probabilities. This recalls the witnesses watching a video of a car accident in Loftus and Palmer's (1974) study on memory: Asked, "How fast were the cars going when they smashed into each other?"—contrasted with other conditions that replaced the word "smashed" with either "collided," "bumped," "hit," or "contacted"—participants recalled the cars as having been moving slower with each respective replacement. In this same vein, it is possible that people might remember the updated probability estimate as higher or lower (when it is recalled later) when it is accompanied by a previous estimate that creates momentum.

Norms. Finally, our research points to ways that interventions could be created to prompt pro-social behavior. For example, descriptive norms can be used to influence behavior, because when a high proportion of people behave in a desirable way, then communicating this high proportion typically leads to more people behaving in line with the desirable norm (Cialdini, Reno, & Kallgren, 1990). However, this strategy is only useful when there is already a high proportion of people behaving in that desirable way; it does not work should the majority of people behave in an undesirable way. Our research suggests a potential solution to this problem—that if the descriptive norm describes a high proportion of people behaving undesirably, then one might be wiser to instead communicate the extent of change in behavior. For example, if few people in a community recycle, it might be possible to communicate that there will be an increase in chance of climate damage should people not recycle. Alternatively, if few people recycle but more people are starting to recycle, or even wanting to recycle more in the future, then it might be possible to communicate this norm (positive growth in recycling behavior) over the descriptive norm that communicates that few people recycle. Indeed, people's predictions of the future may be more influential than information about the past and present (Tormala, Jia, & Norton, 2012) such that messages about potential future outcomes can galvanize the development of promotional messages directed at changing people's behavior.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Conclusion

Feelings of uncertainty arise not only from where uncertain events are situated in psychological space but also from where those events appear to be headed. Probability estimates fall within the broader framework of psychological distance, moving closer or farther, and we elucidate the mechanism connecting probability revisions to thought and action by extending psychological momentum to the domain of probability. Our findings allow for practical applications deriving therefrom, including subjective distance estimates as well as the behavioral, downstream consequences that result from such feelings.

In all, our research sheds light on whether revising the probability estimate of an event changes the psychological meaning of that event. Although the final probability estimate can arrive at the same point after an increase or decrease, the perception of an event may feel different and influence behavior and action regarding those events. Throughout, we tested the circumstances under which revisions to probability estimates for uncertain events influence how people make decisions in relation to those events. Specifically, we tested whether revisions to an event's probability shape not just people's perception of those events' likelihood but also the willingness to think, spend, choose, and take action regarding those events. We have explored how, why, and under which conditions revised probability estimates for uncertain events lead people to understand and interpret those events. By identifying these conditions, this research speaks to the multifaceted dynamics by which change, in its everyday form, occurs.

References

Alter, A. L., & Kwan, V. S. (2009). Cultural sharing in a global village: Evidence for extracultural cognition in European Americans. *Journal of Personality and Social Psychology, 96,* 742–760. http://dx.doi.org/10.1037/a0014036

Bagchi, R., & Li, X. (2011). Illusionary progress in loyalty programs: Magnitudes, reward distances, and step-size ambiguity. *Journal of Consumer Research, 37,* 888–901. http://dx.doi.org/10.1086/656392

Boroditsky, L. (2000). Metaphoric structuring: Understanding time through spatial metaphors. *Cognition, 75,* 1–28. http://dx.doi.org/10.1016/S0010-0277(99)00073-6

Briki, W., Den Hartigh, R. J., Markman, K. D., & Gernigon, C. (2014). How do supporters perceive positive and negative psychological momentum changes during a simulated cycling competition? *Psychology of Sport and Exercise, 15,* 216–221. http://dx.doi.org/10.1016/j.psychsport.2013.11.006

Briki, W., Den Hartigh, R. J., Markman, K. D., Micallef, J.-P., & Gernigon, C. (2013). How psychological momentum changes in athletes during a sport competition. *Psychology of Sport and Exercise, 14,* 389–396. http://dx.doi.org/10.1016/j.psychsport.2012.11.009

Butler, R. (2000). Making judgments about ability: The role of implicit theories of ability in moderating inferences from temporal and social comparison information. *Journal of Personality and Social Psychology, 78,* 965–978. http://dx.doi.org/10.1037/0022-3514.78.5.965

Caruso, E. M., Gilbert, D. T., & Wilson, T. D. (2008). A wrinkle in time: Asymmetric valuation of past and future events. *Psychological Science, 19,* 796–801. http://dx.doi.org/10.1111/j.1467-9280.2008.02159.x

Caruso, E. M., Van Boven, L., Chin, M., & Ward, A. (2013). The temporal Doppler effect: When the future feels closer than the past. *Psychological Science, 24,* 530–536. http://dx.doi.org/10.1177/0956797612458804

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58,* 1015–1026. http://dx.doi.org/10.1037/0022-3514.58.6.1015

Cole, S., Balcetis, E., & Dunning, D. (2013). Affective signals of threat increase perceived proximity. *Psychological Science, 24,* 34–40. http://dx.doi.org/10.1177/0956797612446953

Denes-Raj, V., & Epstein, S. (1994). Conflict between intuitive and rational processing: When people behave against their better judgment. *Journal of Personality and Social Psychology, 66,* 819–829. http://dx.doi.org/10.1037/0022-3514.66.5.819

Denes-Raj, V., Epstein, S., & Cole, J. (1995). The generality of the ratio-bias phenomenon. *Personality and Social Psychology Bulletin, 21,* 1083–1092. http://dx.doi.org/10.1177/01461672952110009

Dweck, C. S., Chiu, C.-y., & Hong, Y.-y. (1995). Implicit theories and their role in judgments and reactions: A word from two perspectives. *Psychological Inquiry, 6,* 267–285. http://dx.doi.org/10.1207/s15327965pli0604_1

Epley, N., & Gilovich, T. (2001). Putting adjustment back in the anchoring and adjustment heuristic: Differential processing of self-generated and experimenter-provided anchors. *Psychological Science, 12,* 391–396. http://dx.doi.org/10.1111/1467-9280.00372

Ersner-Hershfield, H., Galinsky, A. D., Kray, L. J., & King, B. G. (2010). Company, country, connections: Counterfactual origins increase organizational commitment, patriotism, and social investment. *Psychological Science, 21,* 1479–1486. http://dx.doi.org/10.1177/0956797610382123

Eyal, T., Liberman, N., Trope, Y., & Walther, E. (2004). The pros and cons of temporally near and distant action. *Journal of Personality and Social Psychology, 86,* 781–795. http://dx.doi.org/10.1037/0022-3514.86.6.781

Festinger, L. (1957). *A theory of cognitive dissonance*. Oxford, England: Row, Peterson.

Fiedler, K., Jung, J., Wänke, M., & Alexopoulos, T. (2012). On the relations between distinct aspects of psychological distance: An ecological basis of construal-level theory. *Journal of Experimental Social Psychology, 48,* 1014–1021. http://dx.doi.org/10.1016/j.jesp.2012.03.013

Fiedler, K., Jung, J., Wänke, M., Alexopoulos, T., & de Molière, L. (2015). Toward a deeper understanding of the ecological origins of distance construal. *Journal of Experimental Social Psychology, 57,* 78–86. http://dx.doi.org/10.1016/j.jesp.2014.11.002

Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *British Journal of Mathematical and Statistical Psychology, 63,* 665–694. http://dx.doi.org/10.1348/000711010X502733

Freyd, J. J., & Finke, R. A. (1984). Representational momentum. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 126–132. http://dx.doi.org/10.1037/0278-7393.10.1.126

Fujita, K., & Han, H. A. (2009). Moving beyond deliberative control of impulses: The effect of construal levels on evaluative associations in self-control conflicts. *Psychological Science, 20,* 799–804. http://dx.doi.org/10.1111/j.1467-9280.2009.02372.x

Fujita, K., Henderson, M. D., Eng, J., Trope, Y., & Liberman, N. (2006). Spatial distance and mental construal of social events. *Psychological Science, 17,* 278–282. http://dx.doi.org/10.1111/j.1467-9280.2006.01698.x

Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of Personality and Social Psychology, 90,* 351–367.

Gallistel, C. R., Krishan, M., Liu, Y., Miller, R., & Latham, P. E. (2014). The perception of probability. *Psychological Review, 121,* 96–123. http://dx.doi.org/10.1037/a0035232

Gilovich, T., Vallone, R., & Tversky, A. (1985). The hot hand in basketball: On the misperception of random sequences. *Cognitive Psychology, 17,* 295–314. http://dx.doi.org/10.1016/0010-0285(85)90010-6

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics* (Vol. 3, pp. 41–58). New York, NY: Academic Press.

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Harvey, N., & Reimers, S. (2013). Trend damping: Under-adjustment, experimental artifact, or adaptation to features of the natural environment? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39,* 589–607. http://dx.doi.org/10.1037/a0029179

Henderson, M. D., Fujita, K., Trope, Y., & Liberman, N. (2006). Transcending the "here": The effect of spatial distance on social judgment. *Journal of Personality and Social Psychology, 91,* 845–856. http://dx.doi.org/10.1037/0022-3514.91.5.845

Henderson, M. D., & Wakslak, C. J. (2010). Over the hills and far away: The link between physical distance and abstraction. *Current Directions in Psychological Science, 19,* 390–394. http://dx.doi.org/10.1177/0963721410390802

Hertwig, R., & Erev, I. (2009). The description-experience gap in risky choice. *Trends in Cognitive Sciences, 13,* 517–523. http://dx.doi.org/10.1016/j.tics.2009.09.004

Hong, H., & Stein, J. C. (1999). A unified theory of underreaction, momentum trading, and overreaction in asset markets. *The Journal of Finance, 54,* 2143–2184. http://dx.doi.org/10.1111/0022-1082.00184

Hsee, C. K., Loewenstein, G., Blount, S., & Bazerman, M. (1999). Preference reversals between joint and separate evaluations of options: A review and theoretical analysis. *Psychological Bulletin, 125,* 576–590. http://dx.doi.org/10.1037/0033-2909.125.5.576

Hsee, C. K., & Rottenstreich, Y. (2004). Music, pandas, and muggers: On the affective psychology of value. *Journal of Experimental Psychology: General, 133,* 23–30. http://dx.doi.org/10.1037/0096-3445.133.1.23

Hsee, C. K., Tu, Y., Lu, Z. Y., & Ruan, B. (2014). Approach aversion: Negative hedonic reactions toward approaching stimuli. *Journal of Personality and Social Psychology, 106,* 699–712. http://dx.doi.org/10.1037/a0036332

Hubbard, T. L. (2015a). The varieties of momentum-like experience. *Psychological Bulletin, 141,* 1081–1119. http://dx.doi.org/10.1037/bul0000016

Hubbard, T. L. (2015b). Forms of momentum across time: Behavioral and psychological. *The Journal of Mind and Behavior, 36,* 47–82.

Iso-Ahola, S. E., & Dotson, C. O. (2014). Psychological momentum: Why success breeds success. *Review of General Psychology, 18,* 19–33. http://dx.doi.org/10.1037/a0036406

Iso-Ahola, S. E., & Mobily, K. (1980). Psychological momentum: A phenomenon and an empirical (unobtrusive) validation of its influence in a competitive sport tournament. *Psychological Reports, 46,* 391–401. http://dx.doi.org/10.2466/pr0.1980.46.2.391

Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance, 48,* 65–91. http://dx.doi.org/10.1111/j.1540-6261.1993.tb04702.x

Ji, L.-J., Nisbett, R. E., & Su, Y. (2001). Culture, change, and prediction. *Psychological Science, 12,* 450–456. http://dx.doi.org/10.1111/1467-9280.00384

Jia, L., Hirt, E. R., & Karpen, S. C. (2009). Lessons from a faraway land: The effect of spatial distance on creative cognition. *Journal of Experimental Social Psychology, 45,* 1127–1131. http://dx.doi.org/10.1016/j.jesp.2009.05.015

Jones, B., & Rachlin, H. (2006). Social discounting. *Psychological Science, 17,* 283–286. http://dx.doi.org/10.1111/j.1467-9280.2006.01699.x

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American Psychologist, 39,* 341–350. http://dx.doi.org/10.1037/0003-066X.39.4.341

Kyung, E. J., Menon, G., & Trope, Y. (2010). Reconstruction of things past: Why do some memories feel so close and others so far away? *Journal of Experimental Social Psychology, 46,* 217–220. http://dx.doi.org/10.1016/j.jesp.2009.09.003

Liberman, N., & Trope, Y. (2008). The psychology of transcending the here and now. *Science, 322,* 1201–1205. http://dx.doi.org/10.1126/science.1161958

Liberman, N., Trope, Y., McCrea, S., & Sherman, S. (2007). The effect of level of construal on the temporal distance of activity enactment. *Journal of Experimental Social Psychology, 43,* 143–149. http://dx.doi.org/10.1016/j.jesp.2005.12.009

Liberman, N., Trope, Y., & Stephan, E. (2007). Psychological distance. In A. W. Kruglanski & E. T. Higgins (Eds.), *Social psychology: Handbook of basic principles* (2nd ed., pp. 353–381). New York, NY: Guilford Press.

Liviatan, I., Trope, Y., & Liberman, N. (2008). Interpersonal similarity as a social distance dimension: Implications for perception of others' actions. *Journal of Experimental Social Psychology, 44,* 1256–1269. http://dx.doi.org/10.1016/j.jesp.2008.04.007

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as feelings. *Psychological Bulletin, 127,* 267–286. http://dx.doi.org/10.1037/0033-2909.127.2.267

Loftus, E. F., & Palmer, J. C. (1974). Reconstsruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning & Verbal Behavior, 13,* 585–589. http://dx.doi.org/10.1016/S0022-5371(74)80011-3

Maglio, S. J., & Polman, E. (2014). Spatial orientation shrinks and expands psychological distance. *Psychological Science, 25,* 1345–1352. http://dx.doi.org/10.1177/0956797614530571

Maglio, S. J., Trope, Y., & Liberman, N. (2013a). The common currency of psychological distance. *Current Directions in Psychological Science, 22,* 278–282. http://dx.doi.org/10.1177/0963721413480172

Maglio, S. J., Trope, Y., & Liberman, N. (2013b). Distance from a distance: Psychological distance reduces sensitivity to any further psychological distance. *Journal of Experimental Psychology: General, 142,* 644–657. http://dx.doi.org/10.1037/a0030258

Markman, K. D., & Guenther, C. L. (2007). Psychological momentum: Intuitive physics and naive beliefs. *Personality and Social Psychology Bulletin, 33,* 800–812. http://dx.doi.org/10.1177/0146167207301026

Markman, K. D., Klein, W. M., & Suhr, J. A. (Eds.). (2009). *The handbook of imagination and mental simulation*. New York, NY: Psychology Press.

McCrea, S. M., Liberman, N., Trope, Y., & Sherman, S. J. (2008). Construal level and procrastination. *Psychological Science, 19,* 1308–1314. http://dx.doi.org/10.1111/j.1467-9280.2008.02240.x

McKenzie, C. R., & Nelson, J. D. (2003). What a speaker's choice of frame reveals: Reference points, frame selection, and framing effects. *Psychonomic Bulletin & Review, 10,* 596–602. http://dx.doi.org/10.3758/BF03196520

Miller, J. B., & Sanjurjo, A. (2014). A cold shower for the hot hand fallacy. *Working Paper No. 518IGER*. Bocconi University.

Parker, M., & Leinhardt, G. (1995). Percent: A privileged proportion. *Review of Educational Research, 65,* 421–481. http://dx.doi.org/10.3102/00346543065004421

Pelham, B. W., Sumarta, T. T., & Myaskovsky, L. (1994). The easy path from many to much: The numerosity heuristic. *Cognitive Psychology, 26,* 103–133. http://dx.doi.org/10.1006/cogp.1994.1004

Pennington, G. L., & Roese, N. J. (2003). Regulatory focus and temporal distance. *Journal of Experimental Social Psychology, 39,* 563–576. http://dx.doi.org/10.1016/S0022-1031(03)00058-1

Perreault, S., Vallerand, R. J., Montgomery, D., & Provencher, P. (1998). Coming from behind: On the effect of psychological momentum on sport performance. *Journal of Sport & Exercise Psychology, 20,* 421–436.

Pettit, N. C., Sivanathan, N., Gladstone, E., & Marr, J. C. (2013). Rising stars and sinking ships: Consequences of status momentum. *Psychological Science, 24,* 1579–1584. http://dx.doi.org/10.1177/0956797612473120

Polman, E., & Emich, K. J. (2011). Decisions for others are more creative than decisions for the self. *Personality and Social Psychology Bulletin, 37,* 492–501. http://dx.doi.org/10.1177/0146167211398362

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Polman, E., & Russo, J. E. (2012). Commitment to a developing preference and predecisional distortion of information. *Organizational Behavior and Human Decision Processes, 119,* 78–88. http://dx.doi.org/10.1016/j.obhdp.2012.05.004

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40,* 879–891. http://dx.doi.org/10.3758/BRM.40.3.879

Richardson, P. A., Adler, W., & Hankes, D. (1988). Game, set, match: Psychological momentum in tennis. *The Sport Psychologist, 2,* 69–76.

Russo, J. E., Meloy, M. G., & Medvec, V. H. (1998). Predecisional distortion of product information. *Journal of Marketing Research, 35,* 438–452. http://dx.doi.org/10.2307/3152163

Todorov, A., Goren, A., & Trope, Y. (2007). Probability as a psychological distance: Construal and preferences. *Journal of Experimental Social Psychology, 43,* 473–482. http://dx.doi.org/10.1016/j.jesp.2006.04.002

Tormala, Z. L., Jia, J. S., & Norton, M. I. (2012). The preference for potential. *Journal of Personality and Social Psychology, 103,* 567–583. http://dx.doi.org/10.1037/a0029227

Trope, Y., & Liberman, N. (2000). Temporal construal and time-dependent changes in preference. *Journal of Personality and Social Psychology, 79,* 876–889. http://dx.doi.org/10.1037/0022-3514.79.6.876

Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review, 117,* 440–463. http://dx.doi.org/10.1037/a0018963

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211,* 453–458. http://dx.doi.org/10.1126/science.7455683

Van Boven, L., Kane, J., McGraw, A. P., & Dale, J. (2010). Feeling close: Emotional intensity reduces perceived psychological distance. *Journal of Personality and Social Psychology, 98,* 872–885. http://dx.doi.org/10.1037/a0019262

Venezky, R. L., & Bregar, W. S. (1988). Different levels of ability in solving mathematical word problems. *The Journal of Mathematical Behavior*.

Wakslak, C. J., Trope, Y., Liberman, N., & Alony, R. (2006). Seeing the forest when entry is unlikely: Probability and the mental representation of events. *Journal of Experimental Psychology: General, 135,* 641–653. http://dx.doi.org/10.1037/0096-3445.135.4.641

Ward, T. B. (1994). Structured imagination: The role of category structure in exemplar generation. *Cognitive Psychology, 27,* 1–40. http://dx.doi.org/10.1006/cogp.1994.1010

Weber, E. U., & Hilton, D. J. (1990). Contextual effects in the interpretations of probability words: Perceived base rate and severity of events. *Journal of Experimental Psychology: Human Perception and Performance, 16,* 781–789. http://dx.doi.org/10.1037/0096-1523.16.4.781

Windschitl, P. D., & Weber, E. U. (1999). The interpretation of "likely" depends on the context, but "70%" is 70%—right? The influence of associative processes on perceived certainty. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 1514–1533. http://dx.doi.org/10.1037/0278-7393.25.6.1514

(*Appendix follows*)

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.

Appendix

Materials for Pilot Study

Gain Frame

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program A. If Program A is adopted, 200 people will be saved.

Program B. If Program B is adopted, there is a 1/3 probability that 600 people will be saved, and a 2/3 probability that no people will be saved.

Gain Frame and Downward Change

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program A. If Program A is adopted, 275 people will be saved—but this is later revised downward to 200 people being saved.

Program B. If Program B is adopted, there is a 46% probability that 600 people will be saved, and a 54% probability that no people will be saved—but this is later revised downward to a 33% probability that 600 people will be saved, and a 67% probability that no people will be saved.

Loss Frame

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program C. If Program C is adopted 400 people will die.

Program D. If Program D is adopted there is a 1/3 probability that nobody will die, and a 2/3 probability that 600 people will die.

Loss Frame and Downward Change

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program C. If Program C is adopted, 475 people will die—but this is later revised downward to 400 people dying.

Program D. If Program D is adopted, there is a 79% probability that 600 people will die, and a 21% probability that nobody will die—but this is later revised downward to a 67% probability that 600 people will die, and a 33% probability that nobody will die.

Received October 21, 2015
Revision received May 9, 2016
Accepted May 9, 2016 ■

This document is copyrighted by the American Psychological Association or one of its allied publishers.
This article is intended solely for the personal use of the individual user and is not to be disseminated broadly.