Confidence and the Description–Experience Distinction

Abstract

In this paper, we extend the literature on the description–experience gap in risky choices by focusing on how the mode of learning—through description or experience—affects confidence. Specifically, we explore how learning through description or experience affects confidence in (1) the information gathered to make a decision and (2) the resulting choice. In two preregistered experiments we tested whether there was a description–experience gap in both dimensions of confidence. Learning from description was associated with higher confidence—both in the information gathered and in the choice made—than was learning from experience. In a third preregistered experiment, we examined the effect of sample size on confidence in decisions from experience. Contrary to the normative view that larger samples foster confidence in statistical inference, we observed that more experience led to less confidence. This observation is reminiscent of recent theories of deliberate ignorance, which highlight the adaptive benefits of deliberately limiting information search.

Keywords: confidence, confidence in choice, confidence in information, decisions under risk, decisions under uncertainty, experience-based choice, description-based choice, description–experience gap, sampling

Confidence and the Description–Experience Distinction

Decision makers rely on confidence to make decisions under uncertainty (Bang & Fleming, 2018b). For example, a manager will wait until the information they have acquired is sufficiently reliable and trustworthy before making an important strategic decision. They may communicate their estimates of the reliability of the information in a way that reflects their confidence in an important decision, which can be useful in negotiations or leadership roles. Indeed, confidence is a critical element in social interaction: It helps with influencing the opinion of a group (Laughlin & Ellis, 1986; Zarnoth & Sniezek, 1997), in negotiation (Brown & Baer, 2011), and in other leadership tasks (Radzevick & Moore, 2011).

A person's confidence depends on several task-irrelevant factors (Broihanne, Merli & Roger, 2014; Pleskac & Busemeyer, 2010; Yu, Pleskac, & Zeigenfuse, 2015). It is influenced by gender, with men generally being more confident than women (Niederle & Vesterlund, 2011); by personality traits (Ais, Zylberberg, Barttfeld, & Sigman, 2016); and by culture, with individuals from Western, individualistic cultures from the United States, Australia, and New Zealand being more confident than their counterparts in East Asian, group-oriented cultures from Japan, Hong Kong, and Taiwan (Mann et al., 1998).

While many studies have examined the role of confidence and the task-irrelevant factors that influence levels of confidence, comparatively little research has explored how confidence depends on task-specific factors. The literature shows that confidence increases with the reliability of sensory stimuli (Meyniel, Sigman, & Mainen, 2015) and the probability of being correct (Navajas, Hindocha, Foda, Keramati, Latham, & Bahrami, 2017), but the mode in which people acquire information before making a decision (Hertwig, Hogarth, & Lejarraga, 2018) has not yet been thoroughly addressed.

This is a relevant area of inquiry because information used to make decisions in the workplace can be acquired through either experience or description, each with different effects on a decision maker's mental representation of the options (Lejarraga & Müller-Trede, 2017), which in turn affects their confidence in their decisions and in the options they favor—and argue for—in a group setting. Given the substantial impact that expressions of confidence have in social interactions (Bang et al., 2017; Zarnoth & Sniezek, 1997;), understanding the link between the mode of information acquisition and confidence may help us understand why some people's opinions and expressions receive more weight in social interactions. Moreover, understanding how task-specific factors affect confidence is important because, unlike task-irrelevant factors, task-specific factors can be designed to preemptively alter confidence.

Consider two product development managers assessing whether to launch a new product. One manager has come to a decision based on her personal experience with previous product launches; the other, a novice manager without experience, has relied on descriptive reports based on consumer metrics. The two managers differ in their estimate of the new product's likelihood of success and, importantly, in their confidence when they express their choice to the chief product officer (CPO) in a board meeting. Which mode of learning—through experience or description—is more trustworthy or perceived as more reliable? Which manager will express more confidence in their choice during the group discussion with the CPO?

In this study, we explore experimentally how the mode of learning—through experience or description—affects confidence in both the information used to make a decision and the resulting choices. The central research question, experimental design,

and procedures of the three experiments described in this paper were preregistered at the Open Science Framework (OSF) and are available online.[1]

Two Types of Confidence in Decisions Under Uncertainty

Decision scientists have defined confidence as the "feeling of knowing" that accompanies decision making (Navajas et al., 2017); it reflects the correspondence between reality and people's beliefs (Pleskac & Busemeyer, 2010). Although scholars have mostly treated confidence as a single construct guiding people's choices, some authors have disaggregated confidence into two dimensions (Boldt, Blundell, & De Martino, 2019; Griffin & Tversky, 1992; Kvam & Pleskac, 2016). *Confidence in information* reflects the credence or trustworthiness of the information used to make a decision (Griffin & Tversky, 1992). *Confidence in choice* reflects the degree to which the evidence favors one alternative over the others and facilitates choice. This distinction is relevant because in many inference tasks, it is important to separate the evaluation of sensory inputs (e.g., information) from the valuation of alternatives when making a choice. Consider the example offered by Bang and Fleming (2018a): a tennis umpire judging whether a ball bounced in or out. If the ball travels fast, the information signal to make the judgment is less reliable than if the ball travels slowly. The latter generates more confidence in the information signal than the former. At the same time, however, the ball can land half an inch from the line or two feet away. The latter will facilitate the choice and make the umpire more confident in their decision. In sum, both the reliability of information (whether the ball can be seen easily because it travels

[1] The project was created in OSF on October 24, 2017; the most recent edition was uploaded on June 25, 2018. Documents are available at https://osf.io/nkzhj/.

slowly) and the decisiveness of the evidence (the distance of the bounce to the line) influence confidence judgments.

Confidence From Experience and Description

People can learn about the consequences of their decisions in two ways: by making a decision and experiencing the consequences, or by reading a description of the options' potential consequences (Hertwig, Barron, Weber, & Erev, 2004; Wulff, Mergenthaler-Canseco, & Hertwig, 2018). *Decisions from experience* have been examined based on various experimental paradigms (Hertwig & Erev, 2009). In the sampling paradigm, participants see two buttons (or options) on a screen, each representing an unknown gamble. For example, one button represents a gamble offering 4 with 0.8 probability and 0 otherwise, whereas the other button represents a gamble offering 3 with a probability of 1. Participants explore the gambles by clicking on the buttons. Each click results in a random draw from the respective gamble. Participants can sample as many outcomes as they want and then decide which button to press to make a single draw for an actual payoff. By contrast, in *decisions from description* the participant reads an explicit description of the gambles before making a choice.

A recurrent observation in decision-making research is that decisions from experience differ systematically from decisions from description. This pattern has been described as the "description–experience gap" (Hertwig et al., 2004; Hertwig et al., 2018). The description–experience gap was found to measure 20.2 percentage points when a choice involved a risky and a safe option—the choice problem that is often used to assess risk preference—and the gap was larger the less probable the risky outcome was (Wulff et al., 2018). In other problem structures, such as a choice between two risky options, the gap is less prevalent (Wulff et al., 2018). Research has also explored

how description and experience have different effects on fundamental aspects of decision making, such as risky behavior, probability-weighting patterns, decision accuracy, relative attention to gains and losses, and exploratory search (Hertwig et al., 2018; Lejarraga, Pachur, Frey, & Hertwig, 2016a; Lejarraga, Woike, & Hertwig, 2016b). Yet little is known about how these two modes of learning affect confidence.

Using a risky investment task, Kaufmann, Weber, and Haisley (2013) examined how described information and experience influence participants' willingness to take risks and, importantly, measured their confidence in their investments. Participants in their study 2 allocated $100 between a risky fund and a risk-free fund, where the information about the risky fund could be learned through (a) experience sampling, which allowed participants to simulate multiple outcomes of a proposed allocation before committing to the investment; (b) a description, which informed participants about the expected return and variance of the allocation; (c) a distribution of possible returns of the selected allocation; or (d) a "risk tool," in which participants engaged in experience sampling and where each observed return sequentially formed the histogram of possible returns. Kaufmann et al. (2013) observed that "confidence about investing in the risky fund" was higher in the experience-sampling condition than in the description condition (4.74 vs. 4.25, in a 1–7 Likert scale), but the highest confidence was observed in the "risk tool" (4.89) which combined both experience and description.

Relatedly, Camilleri and Newell (2019) explored how learning from description or experience affects a form of overconfidence called overprecision. Participants learned about the performance of two factory workers across several periods. Participants who learned from description obtained a summary of the workers' performance over the past 10 days, and participants who learned from experience observed performance for each day sequentially. Their task was to choose one of the

two workers to keep, and to indicate 90% confidence intervals around each worker's expected average future performance by specifying the lower and upper bounds. Participants who learned from experience were less confident than were those who learned from description. Confidence intervals from participants who learned from experience included the right response more often than did those of participants who learned from description. However, predictions that miss the 90% confidence interval can be caused by either a too-narrow interval or because the interval is in the wrong location on the response scale. Camilleri and Newell (2019) noted that the overprecision observed in participants who learned from description was more likely to be caused by poor location of the interval than by the interval being too narrow.

Research on decisions where people have both experience and description indicates that they tend to make decisions as if they rely mostly on experience (Lejarraga & Gonzalez, 2011), but they do not completely discount descriptions when these contradict their experiences (Weiss-Cohen, Konstantinidis, Speekenbrink, & Harvey, 2016)—suggesting that what is learned from experience could be more reliable than what is learned from description, translating into more confidence in experience than description. Similarly, when asked to choose whether to see a description of gambles or learn about them from experience, people tend to prefer a description if gambles are simple, but increasingly prefer to experience the gambles as they become more complex (Lejarraga, 2010).

In sum, while Kaufmann et al. (2013) observed higher confidence in investment decisions from experience, Camilleri and Newell (2019) found more overconfidence—in the form of overprecision—after learning from description. Similarly, people seem to have more trust in what they have learned from experience when they have both experience and description (Lejarraga & Gonzalez, 2011), but prefer descriptions over

experience if gambles are simple (Lejarraga, 2010). Whether description or experience fosters more confidence remains uncertain. Our work builds on these findings by exploring two dimensions of confidence: confidence in information and confidence in choice.

Next, we discuss the relationship of the description–experience distinction and confidence in information. We then explore how that distinction could impact confidence in choice, and discuss two factors in decisions from experience that could affect confidence: the sample size, which represents the amount of experience, and the probability of the rarest event in a decision.

Confidence in Information

Several mechanisms may affect the relationship between the mode of learning and confidence in information. One relates to the *concreteness* of information. Information acquired through experience "is concrete as opposed to symbolic, and it has immediate authority for the experiencing individual. It is empirical and rests on the certitude that it has occurred" (Hertwig et al., 2018, p. 124). In contrast, a description of possible outcomes and their probabilities, such as a warning or a description of a lottery, is an abstract statement. As such, it is yet to be proven by empirical observation (Hertwig et al., 2018). Consider the following example. One of the side effects of ibuprofen is kidney failure, which happens with a 1% probability. For a person who takes pain relievers regularly and has experienced kidney failure, the information gathered from experience is likely to be more cogent than for a person who learns about the side effect by reading the packet insert, and for whom side effects remain

hypothetical. This mechanism suggests that experience will generate higher confidence in information than descriptive information.

A second mechanism relates to the *familiarity* of the choice situation. Research on perception of control shows that an illusory sense of control is particularly likely to emerge in settings characterized by familiarity and personal involvement (Thompson, 1999). When people are personally involved in gathering information from experience they are likely to develop a sense of familiarity with the choice situation, which may be absent when they access information from descriptions (e.g., information generated by third parties). Under this view, learning from experience may promote more confidence in the information collected compared to learning from descriptive information, which can be detached from the choice situation. The familiarity gained through experience should therefore lead to higher confidence in information than when information is gathered through description.

A third mechanism relates to the *completeness* of information. A description can convey more complete information about a choice scenario because it can refer to all possibilities, even to those that have never occurred (Hertwig et al., 2018; Pinker, 2007). By contrast, experience can hardly inform individuals about all possible outcomes of a particular choice: "Anchored in the reality of the individual, its interpretation can be ambiguous (e.g., when samples are small or the causal structure of experience is complex)" (Hertwig et al., 2018, p. 124). Confidence in descriptive information could be higher than confidence in information obtained through experience because descriptions are more complete than a collection of experiences.

The final mechanism relates to the *sequential nature of experience* and the nonsequential nature of descriptions. Learning through experience requires people to take information in piece by piece, updating their beliefs about the underlying

distribution of outcomes as they acquire new information. Research on Bayesian reasoning has shown that when people are allowed to revise their probability estimates as they acquire new evidence, their estimates are more accurate than when they must evaluate all pieces of information together (Lejarraga & Hertwig, 2020). Similarly, the sequential nature of experience is likely to be the reason decisions from experience tend to be more aligned with expected-value maximization compared to decisions from description (Wulff et al. 2018). Because experience is associated with more accurate learning and better choices, it is reasonable to expect that experience fosters more confidence than does description.

In sum, the arguments and empirical evidence discussed in this section do not speak with a single voice. There is no clear indication of whether confidence in information will be higher in people who learn from experience or description.

Confidence in Choice

The influence of the mode of learning on confidence in choice is even muddier, in part because confidence in choice is not dissociated from confidence in information, which is likely to emerge earlier and condition confidence in choice (Bang & Fleming, 2018b). However, one mechanism through which the mode of learning can affect confidence in choice is through the *perceived differences between options*. Hertwig and Pleskac (2010) argued that small samples tend to amplify differences between options, making choices easier. To illustrate, consider the choice between a risky gamble that offers 4 with 0.8 probability and a safe option that offers 3. From description, these options can be compared by the difference in their expected values, namely, 0.2 (3.2 – 3). Now consider a person who samples 3 times from each option, and observes 4, 4, 4 and 3, 3, 3. The difference between expected values (i.e., the difference in the mean

experienced outcome) is now 1, and the choice is easier.[2] Because decisions from experience that rely on small samples tend to amplify the perceived difference between options, they may lead to more confidence than do decisions from description.

Sample Size and Confidence

The relationship between sample size and confidence is mostly a concern in decisions from experience[3]. A statistical view of confidence suggests that confidence in information should depend on the sample size, as long as each individual observation is drawn randomly. By the law of large numbers, larger samples provide a more accurate representation of the decision problem, thereby leading to higher confidence in the information gathered.

The relationship between sample size and confidence in choice, however, is less clear. In principle, larger samples provide more accurate information about the options, and decisions based on better information should increase confidence in choice. But there is a competing mechanism that may drive confidence in the opposite direction. Let us return to the amplification effect of small samples (Hertwig & Pleskac, 2010), and to the choice example between a risky gamble (A) that pays 4 with 0.8 probability and a safe option (B) that pays 3. With a small sample, the decision maker may experience 4, 4, 4, from A and 3, 3, 3 from B, and feel confident that A is superior to B. But someone drawing a larger sample may encounter a more complex picture: 4, 4, 4, 0, 4, 4 for A, and 3, 3, 3, 3, 3, 3 for B. A larger sample makes it less obvious which of the two options is superior and, as a result, confidence in choice may decrease.

[2] The same can be said if the sequence of outcomes of the risky option involved a 0 outcome.

[3] However, certain description-based protocols offer sample size information, which could affect confidence in information.

This property of sampling between two gambles illustrates a more widespread phenomenon noted by Charles Darwin as early as 1871: "Ignorance more frequently begets confidence than does knowledge" (p. 3). For these reasons, people may deliberately limit information search to simplify choice. *Deliberate ignorance* is a mechanism for emotion regulation (Hertwig & Engel, 2016) that has been shown to play a role in domains such as financial investments (i.e., ignoring one's portfolio during market downturns; Karlsson, Loewenstein, & Seppi, 2009).

Confidence and the Possibility of Rare Events

Experienced and described information may cause differences in levels of confidence when choices involve a rare event. By its very nature, a rare event is infrequently experienced (Taleb, 2007; Weber, 2006). People learning from experience may never see a rare event, and may therefore discount or neglect the possibility of a rare event ever occurring. Remaining ignorant about a possible rare negative event may therefore keep confidence high. In contrast, descriptions of risky options list all outcomes, even those that are extremely unlikely. According to the "mere presentation effect" (Erev, Glozman, & Hertwig, 2008), the very mention of a possible outcome increases its impact on behavior. This effect is harmless when all possible outcomes are frequent, but can direct too much attention to rare outcomes that are unlikely to occur. Thus, a person who samples outcomes from a gamble and observes a sequence of 0, 0, 0, –3, 0, 0, 0, 0, 0, 0 may be more confident in information and the resulting choice than a person who learns that the gambles pays –3 with 0.1 probability and 0 otherwise.

In sum, experience may breed confidence in information and in choice because (a) it is concrete; (b) people can familiarize themselves with the problem; (c) people can

learn sequentially; (d) experience often amplifies differences between options (particularly if samples are small), thereby making choices easier; or (e) there may be no mere presentation effect for negative rare events. But experience reveals only part of the picture. Description, while lacking the authority of experience, can be more complete. Descriptions can include all possible consequences, even if they are extremely rare, and precise probabilities. In short, whether experience or description promotes more confidence in information and choice remains an open question.[4] The following studies were designed to explore how the mode of learning affects confidence in information and in choice.

Study 1: Between-Subjects Design

Seventy-seven undergraduate students (35% male) saw the 20 decision problems displayed in Table 1. Problems 1 to 6 were taken from Hertwig et al. (2004), problems 7 to 12 from Hertwig and Pleskac (2010), and the remaining problems from Glöckner, Fiedler, Hochman, Ayal, and Hilbig (2012). The problems included gambles in the gain, loss, and mixed domains, and gambles with and without a rare event.

Table 1

Decision Problems

Problem	A-H	A-pH	A-L	B-H	B-pH	B-L
1	4	0.8	0	3	1	0
2	4	0.2	0	3	0.25	0
3	-0.3	1	0	-3.2	0.1	0
4	-0.3	1	0	-0.4	0.8	0

[4] Therefore, no specific hypotheses were preregistered on OSF.

5	32	0.1	0	3	1	0
6	32	0.025	0	3	0.25	0
7	-0.3	0.25	0	-0.4	0.2	0
8	16	0.2	0	3	1	0
9	10	0.1	0	1	1	0
10	10	0.9	0	9	1	0
11	-1	0.9	0	-0.9	1	0
12	10	0.05	0	1	0.5	0
13	5.2	0.94	13.65	6.3	0.63	0.1
14	13	0.09	5.2	5.85	0.6	2.05
15	3.5	0.91	9	1.7	0.61	11.9
16	3.65	0.93	11.9	1.95	0.6	11.5
17	6.9	0.55	3.1	5.3	0.45	4.85
18	3.05	0.39	7.5	9.1	0.4	0.85
19	2.05	0.5	6.7	6.45	0.5	5.7
20	1.95	0.65	10.9	2.95	0.63	8.75

Note. A-H denotes the high outcome of option A, A-pH is the probability of A-H, A-L is the low outcome of option A, with probability 1-A-pH. The remaining columns indicate the properties of option B.

Forty-one participants saw the problems described in Table 1 in a random order (description condition) and made a total of 820 choices. For example, one decision problem offered the choice between a safe option of €9 and a risky option of €10 with a probability of 0.9, €0 otherwise. After seeing the description of the options, participants chose one. The other 36 participants (experience condition) saw two buttons on a screen, each associated with a gamble. They received no descriptive information about potential outcomes or associated probabilities. Instead, they could sample each gamble

by clicking a button and immediately obtaining information about that option's payoff. Participants in the experience condition were informed that they could spend as much time as they wanted sampling the options before proceeding to make an incentivized choice. They made a total of 720 choices. At the outset, all participants were reminded that their objective was to maximize the amount of money obtained across all choices.

After every fourth choice, participants in both conditions were prompted to report their confidence in their information and in their choice:

(1) "Rate your confidence in the information used for the choice you just made. Use the sliding bar to rate how reliable you think the [described/sampled] information is for informing your choice (choose a value from '0' to '100')."

(2) "Rate your confidence in the choice you just made. Use the sliding bar to rate how confident you are that you made the right choice (choose a value from '0' to '100'."

The first rating captured participants' confidence in the information they received as an input for their choice. The second captured participants' confidence in their choice. In neither the description nor the experience condition did participants receive feedback about the choices they made. Participants were paid a show-up fee of €5, plus or minus the outcome of a randomly selected choice. The expected value of all choices in the experiment was €2.75. The average compensation was €8.10, SD = 3.8.[5] Twelve decisions (of a total of 1,540) were excluded from the analyses because participants (in the experience condition) failed to sample from one of the two options. As expected, both dependent variables (confidence in information and in choice) correlated highly ($r_p = 0.73, p < 0.01$).

[5] Both Study 1 and Study 2 were preregistered at www.osf.io.

Is There a Dependency Between Mode of Learning and Confidence?

To address this question we fitted a linear mixed-effects model to participants' reports of confidence.[6] The model had confidence in information as a dependent variable. As random effects, we had intercepts for participant and problem, and as fixed effects we had problem order and condition. Models were estimated by maximum likelihood, and p-values for the estimated coefficients were obtained by likelihood ratio tests of the full model with the effect in question against the model without that effect (Luke, 2017). We found that participants who learned from description had higher confidence in their information than did those who learned from experience, $\chi^2(1) = 3.9, p = 0.047$ (Figure 1). The same model was fitted to reports of confidence in choice. Here again, confidence in choice was higher in decisions from description than in decisions from experience $\chi^2(1) = 7.9, p = 0.005$. Taken together, these results show that people who learned from description were more confident—in the information they used for their decisions and in the choices they made—than were those who learned from experience.

[6] We used R (R Core Team, 2019) and lme4 (Bates, Maechler, & Bolker, 2012).

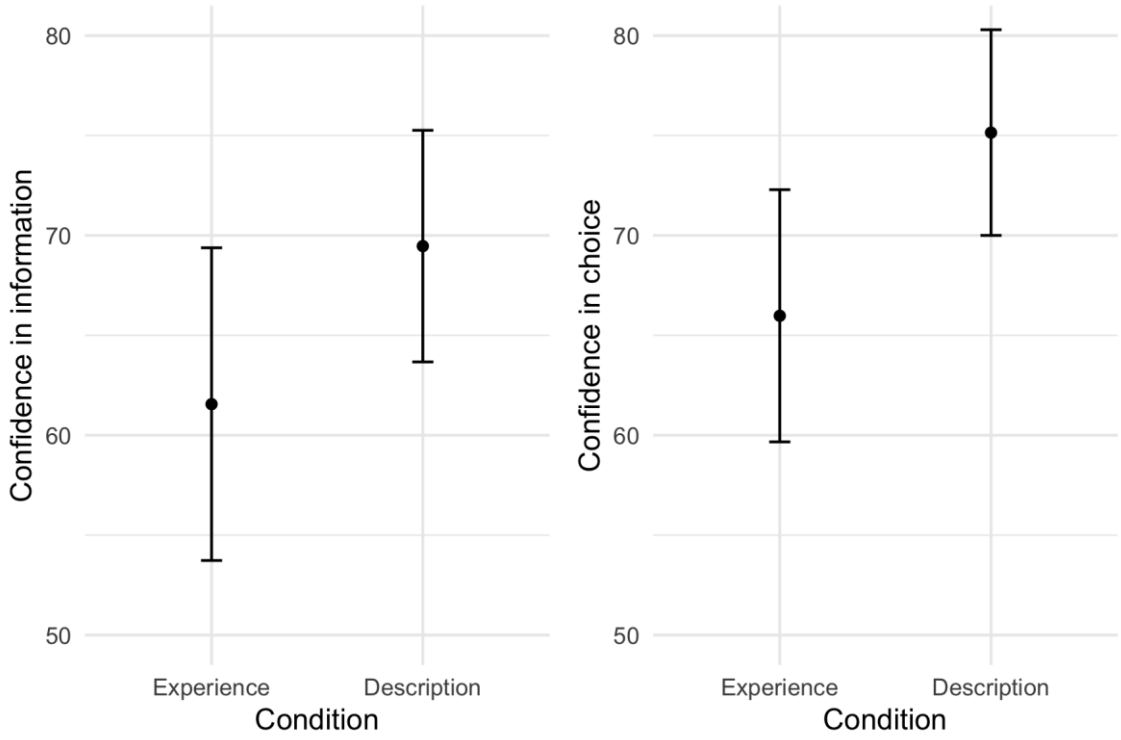

Figure 1. Coefficients and their corresponding 95% confidence intervals for confidence in information and confidence in choice, by condition, controlling for participants and problems. Units in the y-axis are ratings of confidence ranging from 0 to 100.

Do Larger Samples Make People More Confident?

The median sample in decisions from experience was 17 observations per option—very close to the median sample of 20 observations that Wulff et al. (2018) found in an exhaustive meta-analysis of decisions from experience. Figure 2 illustrates the relationship between sample size and confidence. Each point represents a participant's measure of confidence in one problem. Because confidence was measured five times for each participant, the graph shows five points for each participant. On aggregate, confidence in information does not appear to be related to sample size, while confidence in choice decreased slightly as sample size increased. To examine this relationship more stringently, we fitted a linear mixed-effect model controlling for individual and problem variation, with intercepts for participant and problem as random

effects, and sample size as a fixed effect. We also included problem order as a fixed effect, because the size of the sample tends to decrease in later problems[7] (Lejarraga, Hertwig, & Gonzalez, 2012). Results confirmed that sample size had little or no influence on confidence: After controlling for individual and problem variation, results suggested that sample size had a negative but only marginally significant relationship with confidence in information, $\chi^2(1) = 3.7, p = 0.054$, and was not significantly related to confidence in choice, $\chi^2(1) = 2.06, p = 0.15$. If anything, people were less, not more, confident with larger samples. These observations, though counterintuitive from a statistical perspective, may stem from the fact that it was up to participants themselves to decide when to stop sampling; they may simply have stopped when they were sufficiently confident. The wider dispersion of confidence in decisions from experience, as illustrated by the 95% confidence intervals in Figure 1, suggests that different individuals in the experience condition were satisfied with different levels of confidence.

Although confidence in information increased in later problems, $\chi^2(1) = 5.1, p = 0.023$, confidence in choice remained constant across the presentation of problems, $\chi^2(1) = 0.01, p = 0.96$.

[7] Models with random slopes for each fixed effect had problems of identifiability.

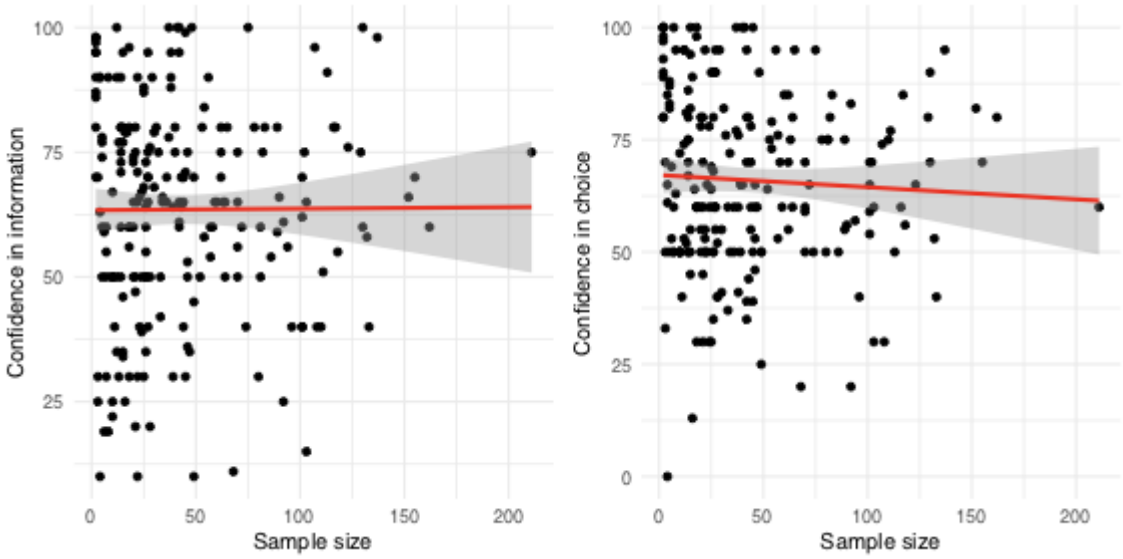

Figure 2. Confidence in information and confidence in choice plotted against sample size. Each point represents a participant in a problem in which confidence was measured. Each participant appears five times in the plot. Units in the y-axis are ratings of confidence ranging from 0 to 100.

How Do Rare Events Influence Confidence?

The description–experience gap is largest and most prevalent in decision problems that involve the possibility of a rare event—for example, when one of the options offers an outcome with a probability equal to or lower than 0.2 (Hertwig et al., 2004). We examined the influence of rare events on confidence in information and in choice, in problems where participants chose between a risky and a safe option. In the description condition, if a problem included the possibility of a rare event, all participants were aware of it. In the experience condition, however, only participants who experienced a rare event were aware of it. We therefore conducted this analysis separately for the description and experience conditions.

For participants in the description condition, we again fitted a linear mixed-effects model, with intercepts for participants as random effects and problem order and a variable indicating the objective (true) probability of the rarest outcome in the

problem (i.e., in either of the options, following the analysis conducted by Wulff et al., 2018) as fixed effects. Results show that probability of the rarest event had no influence on confidence in information, $\chi^2(1) = 0.06, p = 0.79$, and none on confidence in choice, $\chi^2(1) = 0.07, p = 0.78$.

We conducted the same analysis for participants in the experience condition, but instead of using the objective probability of the rarest event in the problem, we used the observed probability derived from the relative frequency of the individual sample observed by the participant in each problem. In our analysis we include only choices in which participants observed both outcomes from the risky option—that is, when the risky option was experienced as risky. For example, if a participant draws 5 samples from an option with outcomes 0, 4, 0, 0, 0, then the observed probability of 4 is 0.2. This analysis excludes participants who, due to their small sample and the particular results of their gambles, saw only one outcome per option. Results show that neither confidence in information, $\chi^2(1) = 0.01, p = 0.96$, nor confidence in choice, $\chi^2(1) = 0.45, p = 0.50$, depended on the observed rarity of outcomes.

Does Having Seen All Possible Outcomes Influence Confidence?

For participants in the experience condition, we examined whether having seen all possible outcomes in the problem affected confidence. We again fitted a linear mixed-effects model, with intercepts for participant and problem as random effects and problem order and a dummy variable indicating whether or not the participant had encountered all possible outcomes while sampling as fixed effects. Figure 3 shows that having experienced all possible outcomes was associated with lower confidence (relative to not having experienced all possible outcomes) in both information, $\chi^2(1) = 6.13, p = 0.01$, and choice, $\chi^2(1) = 6.31, p = 0.01$.

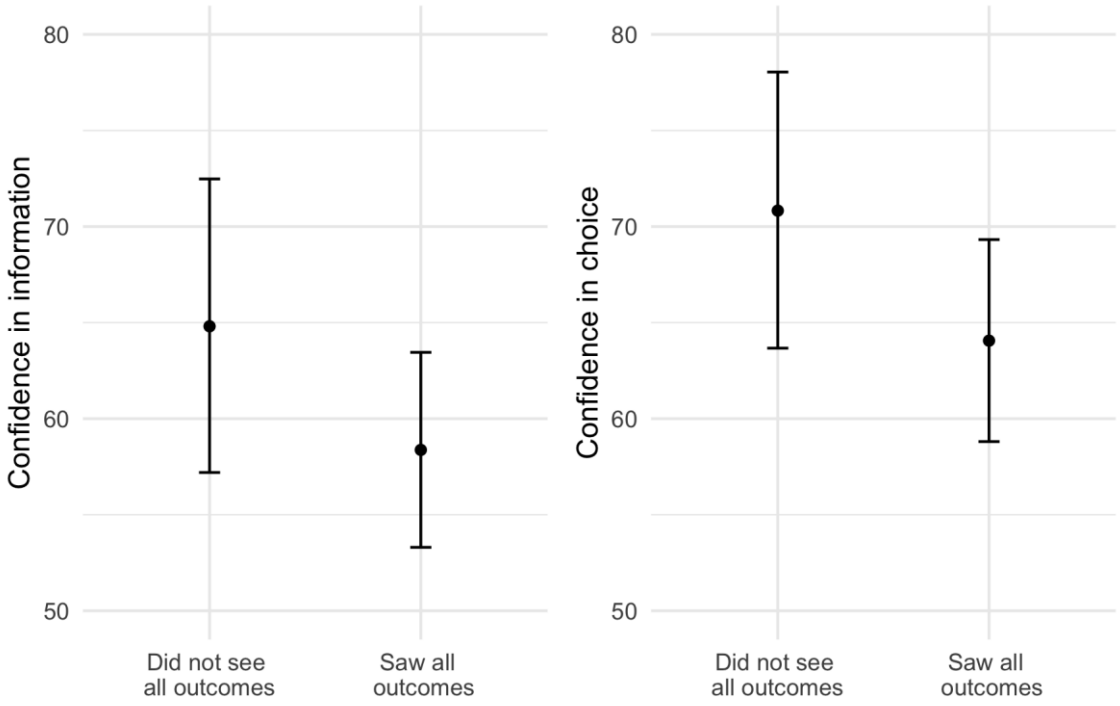

Figure 3. Coefficients and their corresponding 95% confidence intervals for confidence in information and confidence in choice, by whether or not participants saw all possible outcomes in the problem, controlling for participants and problems. Units in the y-axis are ratings of confidence ranging from 0 to 100.

Does Confidence Influence Choices?

Before addressing whether confidence affected choices, we examined whether the choice patterns exhibited a description–experience gap—that is, whether decisions from description differed from decisions from experience in terms of whether participants preferred one option over the other (e.g., A over B in Table 1). In decisions from experience, choices are "as if" rare outcomes were underweighted (Hertwig et al., 2004). Therefore, the description–experience gap principle predicts that decisions from experience will be higher than decisions from description in options that are favored when the rare event does not occur (Wulff et al., 2018). To illustrate, let us consider

problem 1: Option A offers 4 with 0.8 probability or the rare event of 0 with 0.2 probability. The nonoccurrence of 0 in the samples gathered from experience makes option A more attractive. Thus, according to the pattern described by the description–experience gap, participants making decisions from experience should select option A more often than should participants making decisions from description. We therefore coded whether participants chose the option that was favored by the nonoccurrence of rarest outcome in the problems that involved a choice between a risky and a safe option (problems 1, 3, 4, 5, 8, 9, 10, and 11 in Table 1). We then fitted a generalized linear mixed-effects model to the choices made by participants. The dependent variable was whether or not the participant chose the option favored by the nonoccurrence of the rare outcome. The model included intercepts for participant and problem as random effects, and problem order and condition as fixed effects. Learning about the problem from description or experience was a significant predictor of people's choices. Decisions from experience were higher than decisions from description for options that were favored by the nonoccurrence of the rare event—that is, choices were "as if" rare events had been underweighted—$\chi^2(1) = 3.84, p = 0.049$. Participants in the description condition chose the option favored by the nonoccurrence of the rare event with a probability of 0.48, while participants in the experience condition did so with a probability of 0.61.

Experience and description promote different levels of confidence in information and choice, but do those levels of confidence affect participants' choices? Note that our measures of confidence relate to the problem as a whole, not to each individual option. While it would be reasonable to expect that choices are affected by the confidence that a decision maker has in one option over the other, it would be surprising if confidence in the choice problem as a whole affects the particular choices that are made. The types of

confidence that we measure here are orthogonal to the actual choices participants made and we did not expect that confidence affects preferences for one option over the other. We again fitted the generalized linear mixed-effects model described above, with intercepts for participants and problems as random effects and problem order, condition, and confidence as fixed effects. As expected, confidence in information was not related to the preference of one option over the other, $\chi^2(1) = 1.14, p = 0.29$, nor was confidence in choice, $\chi^2(1) = 1.20, p = 0.27$.

Discussion of Study 1

Descriptions are likely to provide a more complete account of a decision problem than experience, which affords only a partial account (Hertwig et al., 2018). Does this lead to more confident decision makers? We found that information obtained from description fostered more confidence than did information gathered from experience, and participants making decisions from description were also more confident in their choices than were participants making decisions from experience.

Confidence in information and in choice were not positively related to sample size. This is consistent with Obrecht, Chapman, and Gelman's (2007) finding that when choosing between two options, people give little consideration to sample size and judgments are mostly driven by the mean differences between options. If anything, confidence in information decreased as sample size increased, but this relationship was marginally significant. This observation could reflect a possible selection process: Participants with a priori low confidence could be inclined to draw larger samples, driving a negative relationship between confidence and sample size. We return to this issue in Study 3.

The intricate relationship of confidence and sample size in decisions from experience is further illustrated by our finding that observing all possible outcomes of a gamble made people less, not more, confident. Participants who observed all outcomes, and therefore had complete information about the options, had less confidence in their information and their choices. One phenomenon that relates to this pattern of results is that as participants sample an option to evaluate its outcomes, encountering a rare outcome could disrupt the valuation of the option. Because rare outcomes tend to be more extreme in their magnitudes compared to more common outcomes, observing an extreme rare outcome could indicate to participants that information gathered from experience is uncertain, even if the sample reveals a relatively safe pattern of outcomes.

Study 2: Within-Subjects Design

In a second preregistered study, we conducted a within-subjects version of Study 1. The objective was to test whether the results obtained in Study 1 hold when participants are exposed to both modes of learning. Participants in this within-subjects design could compare across conditions and possibly make a more informed assessment of their confidence.

Sixty-nine participants (46% male) saw the same 20 gambles as in Study 1. The procedure followed exactly the same steps as in Study 1 except that every participant encountered the 20 decision problems twice[8]: once as a decision from description and once as a decision from experience. The 40 problems were presented in a random order for each participant and experience-based and description-based problems were intermixed. As in Study 1, confidence ratings appeared after every fourth problem,

[8] The fact that several decision problems had the same possible outcomes makes very unlikely that participants were able to identify which decision problem they were encountering.

generating a total of 700 ratings for confidence in choice and in information. The mean final payment was €7.60, SD = 3.6. One participant was removed from the analysis because they reported confidence without having sampled the options.

As in Study 1, confidence in information was significantly correlated with confidence in choice ($r_p = 0.64, p < 0.01$).

Is There a Dependency Between Mode of Learning and Confidence?

Figure 4 shows the mean confidence ratings by condition. We fitted a linear-mixed effects model with random intercepts for participant and problem, and problem order and mode of learning as fixed effects. As in Study 1, confidence in information was significantly higher in problems where participants learned from description, $\chi^2(1) = 15.88, p < 0.01$. Mean confidence in choice was also higher in the description condition, but this relationship was not significant, $\chi^2(1) = 0.68, p = 0.41$.

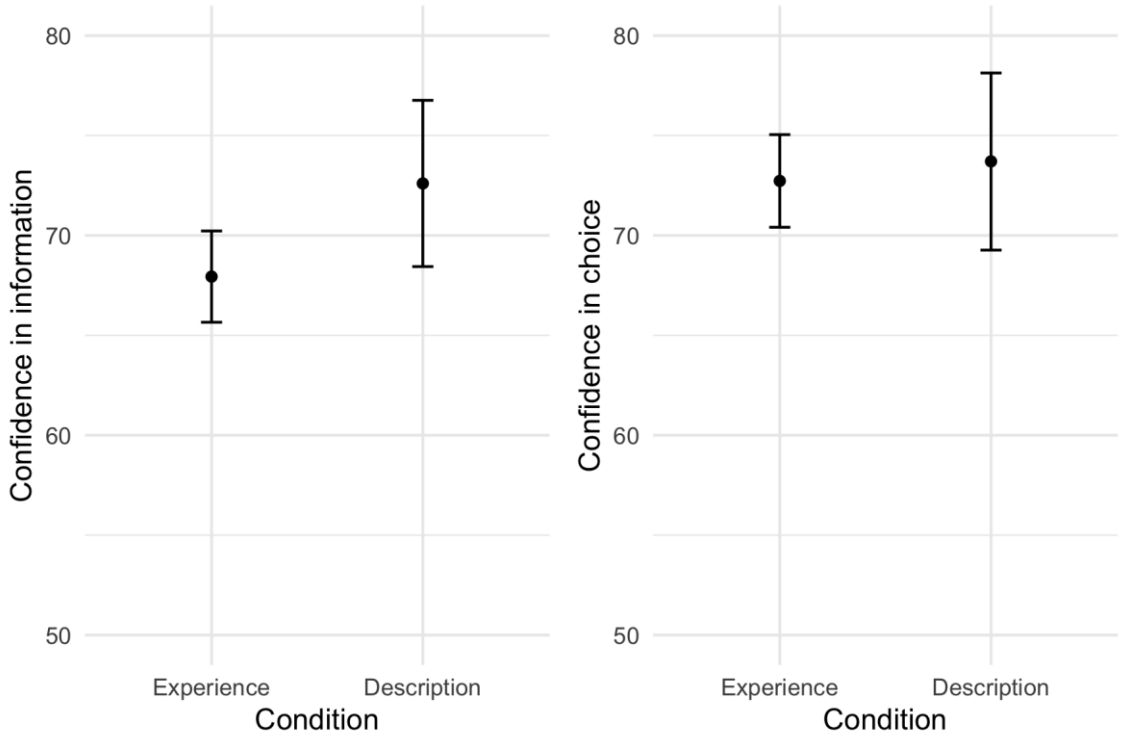

Figure 4. Coefficients and their corresponding 95% confidence intervals for confidence in information and confidence in choice, by condition, controlling for participants and problems. Units in the y-axis are ratings of confidence ranging from 0 to 100.

Do Larger Samples Make People More Confident?

The suggestive negative relationship between sample size and confidence in decisions from experience that emerged in Study 1 became clearer in this within-subjects study. Confidence in information was significantly lower the larger the sample, $\chi^2(1) = 6.30, p = 0.012$. This result is open to interpretation, however, because here again participants decided themselves when to stop sampling, which may introduce problems of selection.

Previous research has shown that decisions from experience based on small samples are easier than decisions based on larger samples, because smaller samples amplify differences between the options (Pleskac & Hertwig, 2016). Our results are

consistent with this observation. Confidence in choice was higher the smaller the sample, $\chi^2(1) = 4.69, p = 0.030$.

How Do Rare Events Influence Confidence?

As in Study 1, whether or not a problem involved a rare event had no influence on confidence in information when making decisions from description, $\chi^2(1) = 1.39, p = 0.24$, but had a marginally significant effect on confidence in choice, $\chi^2(1) = 5.98, p = 0.05$. In decisions from experience, confidence in choice was lower the lower the probability of the rarest outcome. As in Study 1, observing the probability of the rarest outcome in decisions from experience had no effect on either confidence in information, $\chi^2(1) = 1.33, p = 0.24$, or confidence in choice, $\chi^2(1) = 0.54, p = 0.46$.

Does Having Seen All Possible Outcomes Influence Confidence?

Contrary to Study 1, having seen all possible outcomes did not reduce confidence in information, $\chi^2(1) = 0.98, p = 0.32$, nor did it reduce confidence in choice,$\chi^2(1) = 1.88, p = 0.17$.

Does Confidence Influence Choices?

We again examined whether decisions revealed a description–experience gap in choices—that is, in the preference of one option over the other. Indeed, the probability that a participant in the experience condition selected the option that was consistent with underweighting rare events was 0.67, significantly higher than 0.58, the probability in the description condition, $\chi^2(1) = 7.23, p = 0.007$. As in Study 1, confidence in

information had no impact on choices, $\chi^2(1) = 0.89, p = 0.34$; confidence in choice did not impact choices either, $\chi^2(1) = 2.15, p = 0.14$.

Discussion of Study 2

Results from Study 2 corroborate the finding from Study 1 that learning from description leads to more confidence in information than does learning from experience. Similarly, learning from description led to more confidence on choice, as in Study 1, but the effect was not significant in this within-subjects study.

Also consistent with Study 1, confidence was not dependent on the rarity of events (except for a marginally significant effect of the observed rarity on choice) or on having seen all possible outcomes of the gamble. And here again, choices did not differ across levels of confidence in information or choice.

Finally, Study 2 also showed that, as suggested by the near-significant results of Study 1, larger samples lead to lower confidence in information and choice. As discussed above, this result may be driven by the fact that participants could stop sampling at their will. Study 3 was designed to address this issue.

Study 3: Manipulating Sample Size

To study the causal effect of sample size on confidence in information and in choice, we conducted a preregistered experiment using a within-subjects design in which participants made the same choices from experience as in Study 1 and Study 2 but were asked to sample each option a fixed number of times. In the large sample condition, participants sampled 40 times from each option before making a choice (as in Ungemach, Chater, & Stewart, 2009). In the small sample condition, participants sampled 5 times from each option before making a choice. Eighty-six participants (34% male) were presented with the 20 choice problems shown in Table 1 twice: once after

observing a small sample and once after observing a large sample. The order of problems and of the small and large samples were randomized within participants, ensuring that each problem was encountered under both sample conditions. Participants were paid €6 plus the outcome of a randomly chosen choice. The mean final payment was €8.8, SD = 3.6.

Do Larger Samples Foster Confidence?

Figure 5 shows the mean confidence ratings by condition. We fitted a linear-mixed effects model with random intercepts for participant and problem, and mode of learning as a fixed effect. As in Studies 1 and 2, confidence in information was significantly higher in problems where participants learned from small samples, $\chi^2(1) = 8.23, p < 0.01$. Small samples also led to more confidence in choice than did large samples, $\chi^2(1) = 9.99, p < 0.01$.

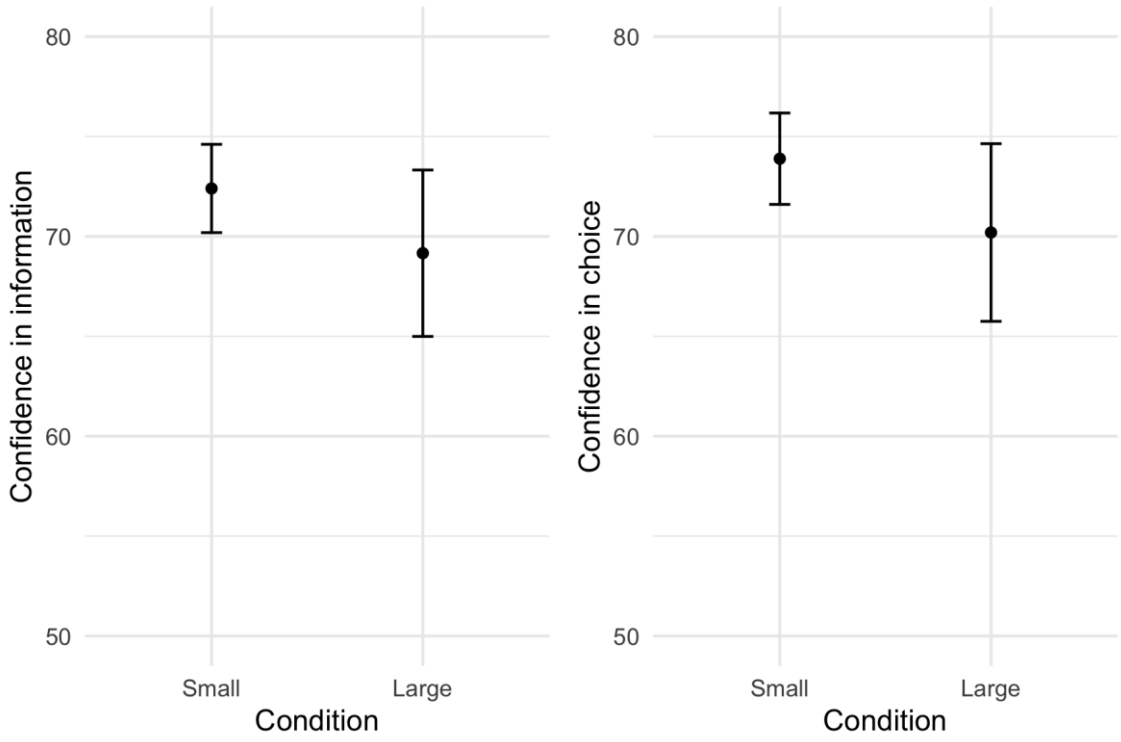

Figure 5. Coefficient estimates and their corresponding 95% confidence intervals of confidence in information and confidence in choice, by conditions of different sample

size, controlling for participants and problems. Units in the y-axis are ratings of confidence ranging from 0 to 100.

General Discussion

We investigated how the mode of learning, either through descriptions of all information or direct experience of the consequences of the options, affects confidence. Exploring this relationship is necessary for at least two reasons. First, description–experience gaps have been observed in a range of domains, including financial risk taking (Lejarraga et al., 2016b), consumer choice (Wulff, Hills, & Hertwig, 2015), intertemporal choice (Dai, Pachur, Pleskac, & Hertwig, 2019), strategic decision making (Martin, Gonzalez, Juvina, & Lebiere, 2014), and decisions under ambiguity (Dutt, Arló-Costa, Helzner, & Gonzalez, 2014; Güney & Newell, 2015). It is therefore crucial to explore whether a description–experience gap also emerges in confidence, which plays an important role in judgment and decision making. Second, judgments and preferences expressed with more confidence have been shown to more heavily affect decisions in social contexts, such as organizational settings (Westley & Mintzberg, 1989) and negotiation (Brown & Baer, 2011); it is critical to understand whether the mode of learning that shapes those judgments and preferences bears a relationship to confidence.

Our study goes beyond traditional research in confidence, which has predominantly focused on confidence in choice—which reflects the belief that the chosen option is correct (Boldt et al., 2019; Pleskac & Busemeyer, 2010). We adopted a view of confidence that distinguishes between two dimensions: confidence in information, which tracks the reliability of informational input, and confidence in choice, which reflects the perceived probability of having made the right choice (Boldt et al., 2019; Pouget, Drugowitsch, & Kepecs, 2016). To do so, we did not approximate

individuals' confidence through eliciting confidence intervals (Camilleri & Newell, 2019); instead, we elicited confidence judgments directly using a graded response scale.

The main finding in our between-subjects and within-subjects studies is a robust description–experience gap in both dimensions of confidence. In line with the recent findings by Camilleri and Newell (2019), who observed that learning from experience produced less overconfident (and more specifically, less overprecise) estimates, our participants who learned from description were more confident in the information they obtained and in their decisions than were participants who learned from experience.

Our expectation, based on the statistical view of confidence, was that larger samples would be associated with higher levels of confidence in information. This expectation was not corroborated. A suggestive negative relationship emerged in Studies 1 and 2: Larger samples were associated with lower confidence in information. However, it is possible that because our participants decided for themselves when to stop sampling, those who were a priori more confident were simply satisfied with smaller samples. Therefore, in a third study we examined the causal relationship between sample size and confidence by manipulating the sample size that participants observed before making a choice and a judgment of confidence. Here again, observing smaller samples made participants more confident than did larger ones: Participants who sampled 5 times from each option reported more confidence in information and choice than did participants who sampled 40 times. This result is consistent with the observation that people give little consideration to sample size when making pairwise comparisons of products (Obrecht, Chapman, & Gelma, 2007).

One interpretation of these results relates to the phenomenon of deliberate ignorance, by which decision makers in certain circumstances are more comfortable with less information, even if acquiring that information has no cost (Hertwig & Engel,

2016). Indeed, in an exhaustive meta-analysis of decisions from experience (Wulff et al., 2018), the median sample drawn for each option was 10; most participants did not search exhaustively and were satisfied with a relatively small, potentially biased sample of information. Even when a task demands that participants experience large samples, as in the feedback paradigm (Barron & Erev, 2003), reliance on small samples has been shown to be a key process driving decisions (Erev, Ert, Plonsky, Cohen, & Cohen, 2017).

A negative relationship between confidence in choice and sample size, however, can be explained by the observation that smaller samples amplify differences between options, making choices easier (Pleskac & Hertwig, 2016). Indeed, Study 3 showed that participants were more confident in their choices when they only sampled 5 times from each option than when they sampled 40.

The contrast between experienced and inexperienced colleagues can be observed in nearly any workplace. Consider two candidates competing for a leadership position. One candidate is a recent graduate from a reputable program who makes decisions based on exhaustive information. The other tends to rely on their years of experience. Who gets the job, and why? Our research suggests that the recent graduate is more likely to show the confidence in their decisions that will impress their superiors. Indeed, research has shown that people tend to prefer confident candidates to cautious ones when selecting advisers, collaborators (Radzevick & Moore, 2011; Tenney, Spellman, & MacCoun, 2008), or leaders (Conger & Kanungo, 1987). To the extent that confidence serves as a valuable signal in social interactions, our results have important implications. Learning through descriptive information fosters more confidence than does learning by experience. Contrary to the widely held belief that experience breeds confidence, we observed that the more experience people had with the options, the less

confident they felt about the information they had gathered and the choices they had made.

Limitations and Future Research

While our findings suggest that descriptions cultivate more confidence than does experience, real-life situations differ from laboratory settings in two important ways. One difference is that descriptions are rarely exhaustive and may not include all possible outcomes or expected payoffs. For example, a manager relying on a detailed industry report to make an investment decision could argue that they are basing their decision on descriptive information, but the report is unlikely to include all possible contingencies and precise probabilistic information. This could decrease confidence in descriptive information and in the decisions made based on that information. A second difference is that experience is often inseparable from the acquisition of expertise, such as management skills. For example, an employee who gains experience in product development not only learns about possible outcomes and their chances of occurring, but will also learn to manage the development process. It is likely that this expertise, or even perceived expertise, boosts confidence (Trafimow & Sniezek, 1994) beyond the levels observed in our study in which subjects are not likely to develop expertise in the task. Our studies reveal the baseline relationship between information format and confidence, stripped from other effects that are usually present in more realistic settings.

Future research is required to explore other task-specific variables that could potentially affect confidence, such as simultaneous exposure to both experience and description (Lejarraga & Müller-Trede, 2017), the stability of the environment in which the experience is gathered (Lejarraga, Lejarraga, & Gonzalez, 2014; Avrahami, Kareev,

& Fiedler, 2017), or how the dimensions of confidence are combined (Bang & Fleming, 2018b) for different modes of learning.

In modern organizations, many decisions that were once made based on experience—for instance, when to launch a new product, in which market to place it, or which candidate to hire—are now more likely to be informed by descriptive information such as consumer metrics and data analytics. According to our study, descriptive information can make people more confident in their decisions than they would be had they made their decisions based on experience. Irrespective of whether the choices are objectively correct, more confidence may lead to higher stakes, such as larger investments. By contrast, more experience seems to make people more cautious—as if the more they learn, the more they realize how much they do not know.

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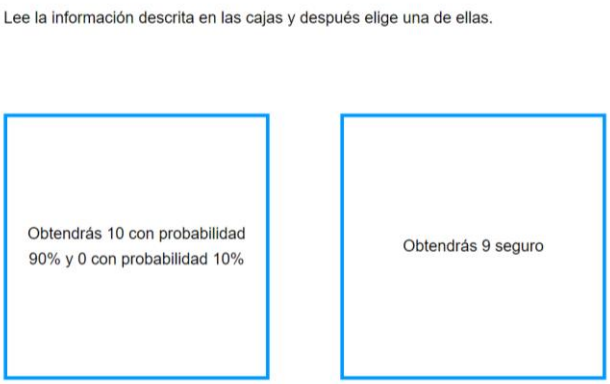
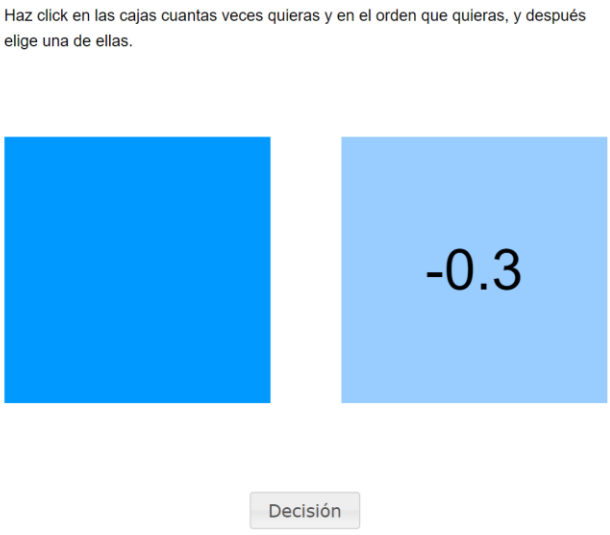
Appendix

Original experimental materials from Study 1 (In Spanish)

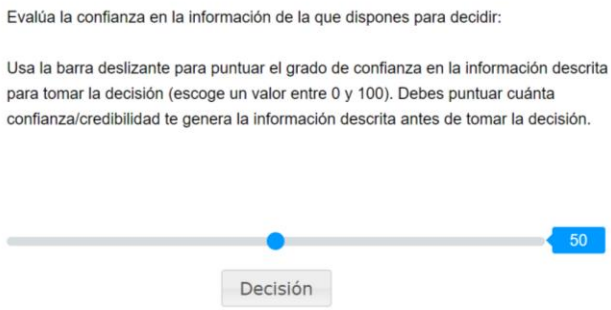
Description condition, choice stage



Experience condition, choice stage



Description and experience conditions, ratings of confidence in information



Description and experience conditions, ratings of confidence in choice