

EMPIRICAL ARTICLE

# When deciding creates overconfidence

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## Abstract

To the known causes of overconfidence in decisions and judgments, we reveal another source that derives from a bias during the act of decision making. While this bias, the predecisional distortion of information, is well studied, its impact on overconfidence is not. We demonstrate how the distortion of information creates overconfidence in those professionals often regarded as singularly overconfident, entrepreneurs. When these professionals use a sequence of relevant information to make an accept-reject decision about a business opportunity, a cycle of confidence-distortion-confidence builds unjustified confidence in the chosen action – and does so whether that action is to accept or reject the venture. Overconfidence is a well-recognized cause of flawed decision making. Our work demonstrates the paradoxical converse of this claim, that flawed decision making can be a cause of overconfidence.

## 1. Introduction

This work has two goals. The primary one is to reveal a previously unrecognized cause of overconfidence (OC) that emerges during the decision process. A secondary goal is to demonstrate its presence among those professionals often considered to be among the most overconfident in their decisions, entrepreneurs.

### 1.1. Overconfidence

OC in decisions and judgments has been found to be widespread and often detrimental. “Overconfidence may be the most consequential of the many biases to which human judgment is vulnerable, both because of its ubiquity and because of its role in facilitating other biases and errors” (Moore & Schatz, 2017, p. 3552). Although OC in decision makers is sometimes treated as a common, innocuous, and even attractive personal attribute, it carries substantial costs. First, it has been shown to lead directly to suboptimal choices (e.g., Adebambo & Yan, 2018; Andreou et al., 2019; Feiler & Tong, 2021; Gaba et al., 2023). Second, in the many decisions that require how much money, personnel, or time to commit to the identified best action, OC risks committing too much of these limited resources. Third, because confidence is often a crucial input to the decision of when to stop seeking more information, OC risks premature stopping and the consequent commitment to an insufficiently considered alternative.

Though often simple to describe and demonstrate, OC is a metacognitive phenomenon (e.g., Metcalfe & Shimamura, 1994; Rosenbaum et al., 2022; Schwarz, 2015) that is neither simple to understand (Shekhar & Rahney, 2024) nor to ameliorate (Hu & Simmons, 2023). There are various causes, like those in the cognitive, environmental, motivational, and physiological categories of Russo and Schoemaker (2018). There are also multiple manifestations, like the overestimation, overplacement, and overprecision of Moore and Healy (2008; see also Moore & Schatz, 2017, and in the context of entrepreneurs, see Voros, 2024).

Our empirical work examines decisions based on subjectively evaluated information acquired over time. These subjective sequential decisions may be personal, like the choice of a vacation destination; professional, like which job applicant to hire; or societal, like a jury's verdict. In such decisions, OC can manifest not only as the familiar unjustified belief in the superiority of the chosen option but also as the confidence in that superiority develops over the course of the decision process. Our focus, including our empirical evidence, is the tracking of the level of confidence during a decision process through to its end. We claim that subjective sequential decisions tend to be susceptible to a specific bias in the evaluation of information that leads to OC. That bias is known as the predecisional distortion of information or simply information distortion (ID) (DeKay, 2015; Russo, 2015; Russo et al., 1998).

## ***1.2. Information distortion***

ID is a bias toward evaluating new information as too supportive of whichever alternative is currently leading in preference. Thus, as each unit of decision information is acquired, its diagnostic value is biased (or distorted) toward an evaluation of the currently leading alternative that is more favorable than can be justified objectively. Because the decisions of entrepreneurs that we focus on, and, indeed, nearly all important decisions, involve the subjective evaluation of the available information, it is often difficult to claim that any single ID-biased choice is objectively inferior. How can one legitimately challenge an individual's choice of a vacation destination, a manager's support for a particular job candidate, or a jury's verdict?<sup>1</sup> Instead, we focus on the confidence in the chosen option, not whether it was the best alternative. Our claim is that the bias of ID will create unjustified OC in whichever option is eventually chosen.

ID is a remarkably robust phenomenon. It has been observed in decisions made by professionals (physicians, Nurek et al., 2014; public auditors, Wilks, 2002; salespersons, Russo et al., 2000), in decisions made by other adults (e.g., citizens endorsing public policies, DeKay et al., 2009; prospective jurors judging liability, Carlson & Russo, 2001), and, of course, in choices made by college students (e.g., choosing between two job offers, Simon et al., 2004). Although initially studied in the context of binary choices, ID has been observed in evaluations of a single alternative (Bond et al., 2007) as well as choices among multiple alternatives (Blanchard et al., 2014) and in decisions involving risky options (DeKay et al., 2012; Miller et al., 2013; Russo & Yong, 2011). Regardless of the decision domain or decision type, or even how it is measured (e.g., DeKay et al., 2014), observed ID is not negligible. On a scale ranging from 0 to 100% (where 100% is the maximum possible distortion), the mean ID was 15.2% for physicians, 15.5% for auditors, 20.0% for sales representatives, and 31.0% for mock jurors.

Why is ID so pervasive and substantial? There are two causes. The first is the omnipresent goal of cognitive consistency among related beliefs (Russo et al., 2008). During an ongoing decision, this appears as the desire for the current, tentative preference for one alternative (Belief A) to be consistent with the evaluation of the next unit of information (Belief B). Most of the time, this quest for consistency manifests as a bias in the evaluation of the new information (Belief B) toward support for the presently leading option (Belief A). However, cognitive consistency does not choose sides. It does not care which belief has to change in order to accommodate the other. It only requires that the two beliefs be made consistent or, at least, more consistent. Although in a decision, ID is a change in the

<sup>1</sup>We recognize how evidence that only appears later can alter a decision, such as a judicial reversal of a jury's verdict.

evaluation of new information (Belief B) toward supporting the emerging preference (Belief A), such pro-preference distortion need not occur. When the new information supports the trailing alternative strongly enough, the decision maker switches to it as the new leading option. The trailing option now becomes the leading option. Thus, the goal of cognitive consistency can be achieved either by biasing the evaluation of the new information to support the current leader (producing ID) or by switching to another option as the tentative leader (reversing leaders). The existence of systematic ID during sequential decisions reflects the fact that in the conflict between the two beliefs of the current leader and new information, the former usually dominates and the latter usually accommodates.

The second reason that ID is pervasive is that it is not recognized, especially when it is actually occurring during a decision. The lack of awareness of the presence of ID during decisions has been confirmed several times, with self-reports of the presence of distortion consistently failing to correlate with the magnitude of observed ID (e.g., Russo et al., 2000; Russo et al., 2006; Russo & Yong, 2011). A consequence of this lack of awareness is that awareness-based interventions will not prevent ID from developing while a decision is being made. Ameliorative tactics require a different approach, as we address later.

ID tends to be substantial, as attested by the levels reported above for both professionals and citizens like prospective jurors. The question of what makes ID substantial is the question of what drives the magnitude of ID, and that question leads us back to confidence. The answer, found uniformly across ID studies, is that the level of confidence in the currently leading alternative drives the magnitude of the distortion of the next item of information (e.g., Russo, 2015). The more strongly decision makers believe that the currently leading alternative is superior to its competitor(s), the greater is the ID of the next item of information to bolster belief in that leading alternative.

### 1.3. *The confidence-ID-confidence cycle*

Our core claim is that ID is a cause of OC. That is, the greater the magnitude of the ID of a unit of information, the greater will tend to be an unjustified increase in confidence in the leading option. The increase is unjustified because the unit of information can be designed to be nondiagnostic (as will be seen shortly).<sup>2</sup> However, as described above, there is a related process in which prior confidence drives ID. That is, the confidence in the leading option prior to new information determines the magnitude of the ID of that new unit of information. This other sequential process completes a cycle of confidence-ID-confidence. As new information is received and evaluated, the current (pre-information) confidence drives the ID of that new information (Step 1 of the cycle), and then the resulting ID increases the post-information confidence (Step 2). This cycle of confidence-ID-confidence is repeated for each item of new information. Because ID creates unjustified confidence, the two steps of the cycle, when repeated over multiple units of information, are likely to lead to substantial OC in the final decision. We recognize that sometimes the new information will be evaluated as unsupportive of the leading option and even lead to a reversal of the leading option. However, even in those cases, the cycle can resume with ID creating false confidence in the new leading (previously trailing) option.

### 1.4. *Entrepreneur OC*

There is a fascination with entrepreneurs, both because their activities are important to society (e.g., Bednarzik, 2000) and because they differ from other business managers (Hisrich et al., 2007; Nicolaou et al., 2008; Rauch & Frese, 2007). One dimension on which they differ seems to be a general tendency toward OC (Busenitz, 1999). Entrepreneurs have been found to be more overconfident than managers in large organizations (Busenitz & Barney, 1997), and this OC is considered a stable individual difference (Forbes, 2005; Pirinsky, 2013). Fully one-third of the entrepreneurs studied by Cooper et al. (1988)

<sup>2</sup>Overconfidence and unjustified confidence have been distinguished both conceptually (Parker & Stone, 2014) and in their effects (Stone et al., 2023). Because the present study uses only nondiagnostic information, the predicted overconfidence is also unjustified confidence.

were 100% confident that their own business (or “venture”) would succeed, with 85% judging they had better than even odds (i.e., 50–50). This striking confidence contrasts sharply with their estimates of the success of another “*business like yours succeeding*” [emphasis in original] (p. 103). In this general situation, just 11% were “dead certain” of success, and a reduced 48% claimed a better than even chance.

Despite its status as an obvious bias, entrepreneurs’ OC can be viewed as a key contributor to their success. Evidence exists that higher levels of entrepreneur confidence influence others in their decision to provide financial support to the ventures (e.g., Adomdza & Astebro, 2012; Busenitz & Barney, 1997; Dushnitsky, 2010). Entrepreneurial OC is also commonly considered to benefit society (e.g., Bernardo & Welch 2001). Dosi and Lovallo (1997) refer to entrepreneurs as “optimistic martyrs” for the role their mistakes play in increasing collective knowledge. Without entering the debate over the value of entrepreneurs’ OC to either their own benefit or that of society, we focus on its role in their investment decisions. To that end, we recruited entrepreneurs, who were presented information for a venture decision while we tracked their confidence in their leading action (to accept or reject the venture) as each unit of information was evaluated.

## 2. Method

### 2.1. Task and procedure

To study ID and OC in entrepreneurs, two hypothetical ventures were created and offered as potential business opportunities. One was a specialty laundry additive. The other was a “bio-laminate” product for the surfaces of wood furniture. Both ventures were based on successful ongoing enterprises that were likely to be unknown to any of our study participants. Despite being hypothetical in nature, employing current businesses helped to enhance the realism of the decision tasks and, especially, of the information presented to participants. Each of the two business opportunities was conveyed by five separate items of information, an introduction followed by four attributes (shown in Appendix A).

Each participant was presented with only one of the business opportunities. As their first unit of information, the entrepreneurs read a detailed (250–400 word) introduction to the business venture. For those who received the laundry additive venture, the introduction began:

The new business venture opportunity facing you is the production and marketing of a special laundry product that is added in a small quantity to a regular load of laundry and detergent. The product works by going into the small areas in the super-fine synthetic fibers and chemically releasing the sweat droplets trapped there. Ordinary laundry detergents by themselves can’t do this because their molecules are too large. ...

After reading the complete introduction to the venture, the four other items of information were described as the relevant attributes. They were distribution, market size, production, and promotion. With the exception of the introduction, each subsequent item of information was written, pretested, and rewritten to favor neither accepting nor rejecting the business opportunity. That is, each of the four attributes was neutral or “nondiagnostic” in the Bayesian sense of contributing zero to belief updating in favor of or against the currently leading option. Nondiagnostic attributes have been used in many past studies of ID (Russo et al., 1996, 1998).<sup>3</sup> Thus, each attribute contained both some evidence favoring accepting the venture opportunity and some evidence favoring rejecting it. Together, they were designed to balance each other out and yield information that was nondiagnostic or net “neutral.”

After each item of information, participants provided a measure (described below) that reflected their belief that the information supported one option, the other option, or both equally. This diagnostic

<sup>3</sup>Not all studies conducted on ID used neutral items of information (e.g., Russo et al., 1998). Neutrality simply makes any distortion more apparent. The only requirement of any measurement of ID is that the diagnostic value of each item of information be known.

leaning provided the basis of the numerical estimate of ID, whose calculation is described shortly. Following this assessment of the current preference was a measure of confidence that the current preference would be the final choice. These two measures allowed us to track both ID and the growth of confidence (and its occasional reduction) throughout the venture decision. Both measures, along with the sequential presentation of information, have been used extensively in past studies (e.g., Boyle et al., 2012; Chaxel & Han, 2018; for a review see Russo, 2015).

**ID measure.** After each of the five items of information, the entrepreneurs were first asked, “Given just the information on this page, consider the extent to which you agree with the following statement: This information makes the new venture attractive to me.” They then rated their level of agreement on a 9-point scale anchored by 1 (“Strongly disagree”) and 9 (“Strongly agree”).<sup>4</sup> As in many past studies (e.g., Carlson & Pearo, 2004; Russo et al., 1998), the midpoint of the scale (i.e., 5 “neither agree nor disagree”) was deemed the neutral value based on the balance of information supporting both options (as verified through pretesting).

These neutral values provided the evaluation of information as one input to the calculation of ID. For example, an absolute difference between 5 and a rating on the 1-to-9 scale of, say 7, would yield 2. When a rating was in the direction of the leading option (say, accepting was the leading action), then the absolute difference was signed positively (+2). If rejecting the venture had been leading, the signed difference would have been −2. Note that a negative value meant that the entrepreneur evaluated the information as supporting the trailing (not the leading) action. For each item, ID was calculated in the two steps illustrated above. First, the absolute difference between the entrepreneur’s rating on the 1-to-9 scale and the “neutral value” of the same information was calculated. Then this difference was signed according to whether the observed deviation from neutrality supported (+) or did not support (−) the currently leading option.

**Confidence measure.** After evaluating an item of information, participants provided a second response, their confidence that they would eventually commit to the venture: “Based on all the information you’ve seen so far, and recognizing that more information may be available in the future, what are the chances that you will commit to the new business venture?” Responses were indicated on an 11-point scale anchored by 0 (“Absolutely certain I will not commit”) and 100 (“Absolutely certain I will commit”). The intervening points were marked in multiples of 10, with the midpoint of 50 labeled “50–50 I could go either way.” The confidence scale implicitly revealed the leading option—to reject when the rated confidence was below 50 and to accept when it was above 50. This measure followed every item of information, including the introduction, so as to identify the currently leading option and simultaneously to provide the current level of confidence in it.

**The decision.** After the last item of information (the fourth and final attribute) and its ID and confidence measures, entrepreneurs indicated their decision to accept or reject the business opportunity. “At this point you have viewed all available information for the business venture opportunity, and you *must* make a decision.” Next, final confidence was assessed using a scale from “Very uncertain/Complete toss-up (50–50)” to “Very certain/No doubt in my mind (100%),” with the nine intervening points on this scale marked in multiples of 5.

**Additional measures.** Besides common demographics (age and gender), three further responses were required: dispositional optimism, awareness of the ID bias, and entrepreneurs’ acceptance of the “realism” of the business ventures. Because being optimistic may not be related to an upward bias in estimating the likelihood of an event (Millet et al., 2021), we attempted to design a measure of dispositional optimism that focused directly on likelihood estimates in the context of entrepreneurial judgments. We asked participants, “[of] 10 uniquely different business venture opportunities, [h]ow many ... would you estimate would likely be worth pursuing?” Second, to determine whether

<sup>4</sup>The measurement of ID was omitted from the first (introductory) page of information because distortion could be computed only after a leading option could be identified. In the same vein, ID was not computed if confidence in the leading option was “50–50” as that value was interpreted conservatively to mean that the entrepreneur had no leading option at this point in the decision process.

entrepreneurs were aware of any ID bias as they evaluated the units of information, they were asked, “While you were examining the information about the new business venture, do you think you were able to evaluate the information without being biased toward either committing to or not committing to the venture?” They responded on a scale from 1 (not at all biased) to 7 (highly biased).<sup>5</sup> Finally, as a qualification for accepting the realism of the task, participants were asked, “How realistic do you consider the business venture you just evaluated to be?” Again, a 1 (not at all realistic) to 7 (highly realistic) response scale was used. We note that the questionnaire was administered via pencil and paper.

## 2.2. Analyses

To trace how confidence in the leading alternative changed over the decision, the two-sided raw scale was recoded into two one-sided 0-to-100 scales, one for how much the response indicated accepting the venture, and one for how much the response indicated rejecting it. Via this recoding, both the “chance that you will commit to the new business venture” and the “chance that you will not commit to the new business venture” ranged from 0 to 100 on a typical likelihood scale, with the two values always adding to 100. For final confidence, which was captured on a 50–100 scale (anchored by “Very uncertain/Complete toss-up” and “Very certain/No doubt in my mind”), responses were similarly recoded to two 0–100 scales, one reflecting the likelihood of the final acceptance of the offered venture and one of its rejection. Again, the two values always added to 100.

The five reports of confidence that followed a unit of information were used to estimate a linear trend that we predicted would increase over time. The five confidence values were the initial confidence (following the introductory scenario) and the current confidence after each of the four succeeding units of information (the four attributes).<sup>6</sup> Note that the final confidence was not included in the linear trend because it was not preceded by new information. (It was based on an entrepreneur’s evaluation of all the acquired information from the introduction on.) For each entrepreneur, their confidence trend was computed as follows:  $\text{LinSlope} = (-2 \times \text{initial confidence}) + (-1 \times \text{confidence at attribute 1}) + (0 \times \text{confidence at attribute 2}) + (1 \times \text{confidence at attribute 3}) + (2 \times \text{confidence at attribute 4})$ . However, entrepreneurs’ initial confidence differed widely, from zero confidence to complete certainty (100). This large range of initial confidence meant that the measured increase in confidence depended on the possible range for each participant. Therefore, we adjusted the LinSlope as a function of its possible range by dividing it by the difference between the maximum possible confidence (100) and the initial confidence. This AdjLinSlope is partially normalized for the large differences in the possible increases from initial to final confidence.

**Disqualifications.** Participants were disqualified for one of three reasons. First, since 8 entrepreneurs never had a leading alternative, they never had any ID. Because no test of an ID-driven increase in confidence was possible, these 8 participants were necessarily eliminated. Second, based on the introduction alone, 12 entrepreneurs were completely certain (an initial confidence of 100) of their preference for accepting or rejecting the venture. They expressed this total certainty despite knowing that “more information may be available in the future” and seeing the additional pages (one unit of information per page) in the stimulus packet. No test of an ID-driven increase was possible when the initial confidence, prior to seeing the four venture attributes, started at 100. In addition, the main measure to be predicted, AdjLinSlope, could not be computed when initial confidence was 100 (it would have meant dividing by 0.) Third, using participants’ response to the realism of the proffered venture, we disqualified the 15 with a low value on the 7-point scale (4 with a value of 1 and 11 with a value of 2). When such participants rejected the venture (all 15 did), we could not know whether that decision reflected their perceived low credibility in the venture itself or the result of a considered

<sup>5</sup>These data were not collected from one sample, the US entrepreneurs, Sample 2 below.

<sup>6</sup>We thank a member of the review team for suggesting this measure.



decision process that was the empirical basis of our claim that ID drove an increase in confidence. (Among the 12 participants who rated the venture's realism as 3 on the 1-to-7 scale, only 9 chose to reject it.) Because of overlap among the three criteria, only 31 participants were disqualified. All analyses were based on the remaining 68 qualified participants.<sup>7</sup>

### 2.3. Sample

Participants were recruited from entrepreneur networks. Attendees at a regular network meeting were invited to participate in a study to evaluate a new business opportunity/venture. Two samples of participants came from a large city in Korea and one sample from a large city in the U.S. Although these were convenience samples, participants were screened for entrepreneurial experience or intent. The screening questions were: Have you ever started your own business? Are you currently running a business you started? Are you currently starting a business? Do you expect to start your own business? A "yes" response was required to at least one of these four questions.

Sample 1. Thirty individuals at an entrepreneur network's meeting in a large city in Korea responded to a request to decide whether to commit to a venture involving a specialty laundry additive. The study was conducted entirely in the language of the participants (see Appendix A for a description of how the questionnaire was translated from English to Korean). Based on their responses to the verification questions, all were deemed suitable because of their entrepreneurial experience. However, two of the entrepreneurs, while otherwise fully completing the questionnaire, failed to indicate their final venture decision and were excluded from the sample. Of the remaining 28 entrepreneurs, 23 reported currently running a business they had started, while the other 5 reported having started their own business in the past. The average age of the respondents was 40.9 years, with 89% male.

Sample 2. Participants at an entrepreneur network's meeting in a large city on the West Coast of the U.S. responded to a request to decide whether to commit to the same laundry additive venture. Thirty-seven members volunteered to complete the study. All provided affirmative responses to one or more of the entrepreneur-verification questions. Of the 37 volunteering entrepreneurs, 22 were currently running a business they had started, and the other 15 had started a business in the past. The average age of the respondents was 45.9 years, and 76% were male.

Sample 3. Thirty-five individuals were recruited from another entrepreneur network's meeting in a large city in Korea. They were presented with a different venture decision, one for a new "bio-laminate" product for the surfaces of wood furniture. (Appendix B provides details about the venture and its construction.) A second venture helped to verify that any ID was not an artifact of one specific decision task. As with using different nationalities of entrepreneurs, different ventures offered the potential for the generalizability of any effect of ID on confidence. Except for the change of venture, the procedure followed that of the other two samples. The study was conducted entirely in the Korean language of the participants. Based on their responses to the entrepreneur-verification questions, all were deemed suitable because of their entrepreneurial experience or intent. However, one of the entrepreneurs failed to complete the task and was eliminated from further analyses. Of the remaining 34 entrepreneurs, 32 reported they had started their own business; the other 2 reported planning to start a business. The average age of the respondents was 38.0 years, with 82% male.

Tests for differences across the three samples of entrepreneurs revealed no significant differences on relevant dimensions (e.g., mean ID, initial and final confidence,  $p > .05$  for all). Thus, the samples were aggregated into a single dataset for the benefit of statistical power.

<sup>7</sup>Our entrepreneur participants were likely not familiar with experimental protocols like ours. Most, if not all, were not the experienced participants often recruited from online participant pools. In addition, our task took uncompensated time from whatever activities had been planned at their meeting. It should not be surprising that some of them might have taken the task as something to "get through" with minimum effort/involvement and would be politely labeled "careless responders" (Stosic et al., 2024).

### 3. Results

The results were organized into five parts. The first two assured both the presence of ID and an increase in confidence. The latter was the phenomenon on which all important hypothesis tests depended. Third, we confirmed that greater confidence did drive the expected increase in the next ID, the first and more familiar half of the confidence-ID-confidence cycle. Fourth, we tested our central claim that ID increased confidence, the second half of the confidence-ID-confidence cycle. The final analyses searched for systematic differences between those entrepreneurs who accepted versus rejected the offered venture.

#### 3.1. ID

We first confirmed the presence of ID over the course of the decision. Mean ID was substantial, 1.43 ( $t(67) = 7.78, p = .000$ ), or 35% of the 0–4 range of ID. As expected, the entrepreneurs systematically biased their evaluation of equivocal information to support their current leaning toward accepting or rejecting the business venture.

Recall that we attempted to assess participants' awareness of ID by asking whether they were "able to evaluate the information without being biased toward either committing to or not committing to the venture." The correlation between their rating of bias and the magnitude of ID was essentially zero ( $r = -.039, t(46) = -0.264, p = .793$ ). Thus, and as found in all prior measures of awareness (Russo, 2015), participants were unaware of their substantial ID bias.

#### 3.2. Confidence

The other preliminary result was the presence of an increase in entrepreneurs' confidence over the course of their venture decision. On the 0–100 scale, the initial and final confidences, respectively, were 31.47 and 53.09. Their difference (21.68) was reliably greater than 0 (paired  $t(67) = 6.00, p = .000$ ).<sup>8</sup>

#### 3.3. Impact of prior confidence on ID

Previous studies have repeatedly verified the finding that the magnitude of prior confidence predicts the magnitude of the ID of the next item of information (e.g., Carlson & Russo, 2001; Kostopoulou et al., 2012; Russo et al., 1998). This relation is the first half of the postulated confidence-ID-confidence cycle. To reconfirm its presence, we regressed the mean ID of the four items of information for each participant on the mean level of confidence before seeing that new information. (An individual confidence was included in the calculation only when there was a corresponding ID, resulting in 27 means with fewer than four observations.) The resulting slope was reliably greater than zero ( $t(66) = 6.98, p = .000$ ). This finding confirmed Step 1 of the confidence-ID-confidence cycle and conformed to the positive result for all prior tests of its presence.

#### 3.4. Impact of ID on confidence

We then examined how confidence increased over the course of the decision as a consequence of ID. This tested our core claim that ID drove an increase in confidence and was Step 2 of the confidence-ID-confidence cycle. First, and to parallel the regression of ID on (prior) confidence, we regressed the mean increase in confidence over the four units of information on the corresponding mean ID. The

<sup>8</sup>Of the 68 participants, 7 included a change of preference. For example, one participant began with a likelihood of 20 leaning toward rejection but reported a final confidence of 60 toward acceptance. Their change in confidence could be calculated as 80 rather than 40. The mean increase calculated by including these reversals, 28.09, was greater than the difference between the initial and final confidence reported above (21.68). Naturally, this less conservative calculation of the increase in confidence was also highly reliable, paired  $t(67) = 7.12, p = .001$ .



resulting slope was reliably greater than zero ( $t(66) = 2.21, p = .030$ ). We then turned to the test based on the orthogonal contrast, AdjLinSlope. We regressed this measure of a linear increase in confidence on mean ID. The resulting  $t$ -test yielded  $t(66) = 2.70, p = .009$ . Thus, greater levels of ID were associated with greater increases in confidence, confirming the full confidence-ID-confidence cycle.

### 3.5. *Accepters versus rejecters*

Because each individual entrepreneur made their own decision regarding the offered venture, they partitioned themselves into accepters and rejecters. We could then search for any differences between these two groups. However, before this search, we noted that the validity of the entrepreneurs' self-identification was undercut by two phenomena.

First, there were some responses of zero confidence in the final decision. We conservatively interpreted these responses as equivalent to no preference for either accepting or rejecting the venture. (Zero confidence is the same criterion that was used during the decision to identify cases of no prior leaning toward accepting or rejecting and, therefore, no possibility of ID.) When the equivalence of zero confidence to no clear preference was applied to the final choice, 8 participants (1 accepter and 7 rejecters) were considered not to have a sufficiently reliable final choice.

A second troubling phenomenon was an inconsistency between (a) an entrepreneur's stated preference after the fifth and last unit of information and (b) their following accept-reject decision. In the absence of any new information, the two expressions of preference should not have differed. Yet they did for 20 of the 68 participants (5 accepters and 15 rejecters). Applying both disqualifying criteria, there were 24 total participants whose identification of accepting versus rejecting was unreliable. The breakdown was 8 due to zero final confidence plus 20 due to a conflict between the final two expressions of preference, minus the 4 participants who failed both criteria. This left 44 participants (29 accepters and 15 rejecters) whose final decision met both qualifying criteria for a reliably identified final decision.<sup>9</sup>

Before answering the question of whether the accepters and rejecters differed, we acknowledge that our disqualifications were mainly rejecters, both those described immediately above and also for the earlier group that reported a low rating of task realism (15 disqualified, all rejecters). If rejection were based on grounds other than a meaningful choice process, there could have been no ID at all. More realistically, if some of the rejecters did not use a choice process, the mean ID of the entire group of rejecters should have been lower than that of the accepters. Starting with the full sample of 68 participants, the mean ID was 1.929 for the 35 accepters and 0.723 for the 33 rejecters,  $t(50.57) = 4.477, p = .000$ <sup>10</sup>. The former did not differ from the 2.0469 ID of the 29 "valid" accepters,  $t(61.27) = 0.685, p = .496$ . However, for rejecters, the full sample value was about half of the 1.44 ID of the valid rejecters, a difference that was almost significant,  $t(25.16) = 1.612$ , one-sided  $p = .060$ . We take this as an indicator that the rejecters were substantially more likely than the accepters to have made their decision on grounds other than a considered choice process. Thus, it was important to qualify them using the two criteria described above.

Differences between Accepters and Rejecters. We can now address the question of whether the accepters and rejecters differed. In brief, there were few differences in our hypothesized decision process but a clear difference in how accepters and rejecters got to their decisions. There were no reliable differences between accepters and rejecters for initial confidence (40.7 and 38.1) or final confidence (84.3 and 80.2). Even the difference in ID (1.92 and 1.44) was only almost significant,  $t(22.80) = 1.79, p = .089$ . The test of prior confidence driving ID yielded a significant regression coefficient for both accepters ( $t(27) = 5.092, p = .000$ ) and rejecters ( $t(13) = 5.216, p = .000$ ) and a significant difference between them,  $t(40) = 2.620, p = .012$  that we cannot explain. The crucial test of ID driving an increase in confidence revealed an almost significant regression of AdjLinSlope on ID

<sup>9</sup>We note that the disqualifications may not have caught every suspicious pattern of results. For instance, one participant reported confidences of 60, 80, 80, 40, and 20, but then gave 90 as their final confidence.

<sup>10</sup>Because the standard deviations of the accepters and rejecter differed, Welch's  $t$ -test was used.

for accepters ( $t(27) = 1.691$ , one-sided  $p = .051$ ), a significant regression coefficient for rejecters ( $t(13) = 3.384$ ,  $p = .005$ ), and no difference between them,  $t(40) = 0.384$ ,  $p = .703$ .

The mostly similar hypothesis tests for accepters and rejecters were not matched by their underlying processes in one telling characteristic. For the accepters, but not the rejecters, the preferences expressed during the decision process were consistent from beginning to end. Among the 29 accepters, 27 (.93) listed accepting as their initial preference (2 were neutral). However, among the 15 rejecters, only 9 (.60) initially leaned toward rejection (4 neutral and 2 accepting). As the decision proceeded, changes in preference were either small (between neutral and accepting/rejecting) or large (a complete reversal of preference between accepting and rejecting). Among the 116 possible shifts in preference for accepters ( $29 \times 4$ ), there were only 6 (.05) such changes, and all were small. Among the 60 possible shifts in preference for the rejecters ( $15 \times 4$ ), 30 (.50) occurred, and they included 5 reversals (and 25 small changes). Thus, the decision to accept the venture was characterized by consistent acceptance from the first leaning through to the final decision. In contrast, the decision to reject was characterized by changes in preference throughout the choice process. Despite the rejecters' varying preferences during their decisions, their ID remained high, and their conformation to the confidence-ID-confidence cycle was largely supported.

### 3.6. *Optimism*

Did our entrepreneur-specific likelihood measure of dispositional optimism influence the decision process? If so, its effect might most probably have been to increase initial confidence. It did not. The correlation between optimism and initial confidence was not even positive,  $r = -0.088$ ,  $t(65) = -.715$ ,  $p = .477$ . Nor did optimism correlate with final confidence ( $r = .032$ ) or ID ( $r = .0810$ , both values of  $p > .50$ ).

However, there was a significant difference in our optimism measure between the accepters and rejecters. For the qualified 29 accepters and 15 rejecters, the mean number of 10 "business opportunities like these" that they expected to succeed were, respectively, 3.41 and 1.82,  $t(41) = 2.59$ ,  $p = .013$ .

Our conclusion is that our context-specific measure of dispositional optimism may have reflected a systematic tendency to accept our ventures. However, there is no evidence that it influenced the decision process itself, starting with no relation to initial confidence.

## 4. General discussion

The present work provides a novel explanation for OC in decisions where the relevant information is acquired over time and evaluated subjectively. The predecisional distortion of information (ID) and the current confidence in the leading action sequentially reinforce each other over the course of a decision. This cycle of confidence-ID-confidence produces the observed high levels of final confidence in the decision even when the available information is equivocal and the resulting increments in confidence cannot be justified.

Turning to the participation of actual entrepreneurs, the confidence-ID-confidence cycle helps to account for the OC commonly ascribed to that group. However, although the reported evidence is limited to entrepreneurs making a venture decision that is necessarily hypothetical, the phenomenon of ID-driven OC should occur widely. That is, in any subjective, sequential decision, ID is likely to produce OC and its concomitant risks of deciding too soon or committing too many resources. Indeed, the confidence-ID-confidence cycle was a factor in the rise in decision confidence regardless of whether entrepreneurs' conclusion was positive (accepting the venture) or negative (rejecting it).

### 4.1. *Remediation*

Can ID-driven false confidence be prevented or at least reduced? Researchers have developed several strategies to counter ID. We focus on the four that seem most applicable to the category of subjective, sequential decisions.

The first counterstrategy takes advantage of the fact that ID requires a leading option. If there is no intermediate leader during a decision, there can be no ID (and, therefore, no ID-driven OC). One lab-based study presented information to decision makers either sequentially, as in our studies, or simultaneously, that is, all at once (Carlson et al., 2006). Presenting all information at the same time was designed to prevent any alternative from attaining the status of intermediate leader. The final decisions of those who saw all the information simultaneously were less biased than those receiving the same information one item at a time. Because such a strategy of simultaneous presentation forestalls the step-by-step emergence of a leading option, to the extent practical decision makers should endeavor to evaluate the entire set of information only after it has been gathered instead of via a continual, piecemeal updating.

A second counterstrategy, also tested in a controlled setting, involves having decision makers establish the value of an item of information prior to the process of choosing an option (Carlson & Pearo, 2004). Again, ID levels dropped substantially when decision makers had committed to an evaluation prior to seeing the same information in the context of a decision. One limitation of the tactic of precommitting to an evaluation is that often new information cannot be judged in isolation from what is already known. Admittedly, these two strategies, simultaneous presentation and precommitment of evaluations, may be challenging to implement in many typical decisions.<sup>11</sup> The natural flow of information in such decisions tends to be in a sequence over time, with the nature of the information itself often unknowable in advance.

For this reason, we offer two further counterstrategies that can deal with information received sequentially. Work by Chaxel and Han (2018) directed toward reducing ID indicates that individuals may benefit from a counterargument mindset. Such a mindset requires that decision makers attempt to refute (i.e., counterargue) their own emerging preference for an option. Obviously, counterargument runs counter to biasing the evaluation of new information to support the existing preference.

A final tactic entails the participation of at least one other decision maker who prefers a different option (at least tentatively). When groups of four business students had to agree on a single two-alternative decision, ID and confidence both remained very low for as long as different group members preferred different options (Boyle et al., 2012). That is, for as long as each alternative had at least one advocate, the group's agreed evaluation of new information exhibited no significant ID. The use of groups has also been shown to reduce OC directly (Moore et al., 2017). For an individual who wishes to reduce the impact of ID on a decision, evaluating the relevant information in concert with someone holding the opposite position promises to be an effective strategy.<sup>12</sup>

The presence of ID in decision making leads both to choosing inferior alternatives (Russo et al., 2006) and doing so with unjustified confidence, as the present work demonstrates. The lack of awareness of one's own ID renders warnings and similar "educational" remediations less utile. Thus, we see as important the last two tactics, a counterargument mindset and the use of groups that continue to support differing preferences. Both can be adopted across a full range of decision contexts.

## 5. Conclusion

The behavioral study of JDM has focused on biases in the decision process that lead to errors of the chosen alternatives ("suboptimality"). While our work also relies on a bias in the decision process (ID), our focus is not on the optimality of the chosen options but on the confidence in those choices. Thus, we call attention to OC as one natural consequence of sequential, subjective decisions, like those of our entrepreneurs, where there may be no standard of optimality. There are two compelling reasons to believe that OC impairs subjective decision making.

<sup>11</sup>One reason for the sequential approach to information seeking is that the optimal strategy for seeking the next unit of information may depend on what has been learned from the most recent unit or all prior information.

<sup>12</sup>Preserving advocacy for different alternatives is a natural source of disconfirmation and of conflict within groups (e.g., Eisenhardt et al., 1997)

First, confidence plays a crucial role in the decision of when to stop seeking information. While most laboratory-based studies of JDM use a fixed set of items of information, many naturally occurring decisions are not so limited. Instead, these decisions, and especially the more consequential ones, include the option of seeking as much information as the decision maker believes is valuable. OC directly influences and, therefore, may bias these stopping decisions. Indeed, in such sequential choices, is not the real decision when to stop? “[A]lthough the observable act of decision making is selecting one alternative, the real decision may be when to terminate the distinction process and commit to the leading alternative” (Russo and Carlson, 2002, p. 376).

A second reason for a greater focus on confidence is that it fits naturally into a goal-centered view of decisions (e.g., Carlson et al., 2008; Fishbach & Ferguson, 2007; van Osselaer & Janiszewski, 2012). While accuracy of the chosen alternative is usually the dominant goal, it is not the only one. Decision makers also want to save effort, to be able to justify their choices, and sometimes to feel confident in the validity of their decisions (e.g., Rosenbaum et al., 2022). Work within the goals paradigm is facilitated by a better understanding of every goal, and particularly one as omnipresent as the decision maker’s confidence that they have identified the best alternative.

It is widely accepted that OC is a cause of flawed decision making. Our work demonstrates that claim’s paradoxical converse, that the act of decision making can be a source of OC.

**Supplementary material.** The supplementary material for this article can be found at <http://doi.org/10.1017/jdm.2024.39>.

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## Appendix A. Decision information

### *Laundry detergent additive – 1st information item (introduction)*

The new business venture opportunity facing you is the production and marketing of a special laundry product that is added in a small quantity to a regular load of laundry and detergent. The product works by going into the small areas in the super-fine synthetic fibers and chemically releasing the sweat droplets trapped there. Ordinary laundry detergents by themselves can't do this because their molecules are too large. If the sweat droplets remain in the fibers, bacteria feed on them, producing a bad smell, even though the garment is washed repeatedly with normal detergent.

With the trend toward healthier lifestyles developing all around the world, more and more people are engaging in active sports such as tennis, golf, biking, and hiking. Most of the people who do these sports buy not only the equipment, like golf clubs, but also the sportswear that goes along with these active sports. Usually the sportswear is made of a synthetic material that has many valuable aspects, such as being lightweight, stretchable, and breathable. However, as so many people have learned, when sweat droplets get into the spaces between the super-fine fibers of the synthetic material, it is extremely hard to get the sweat odor out of the garment by ordinary washing.

The trend toward engaging in more activities and buying and wearing more sportswear is spreading all over the world. And the demand is growing every year. In China alone, there are millions of people who are starting to realize it is both fashionable and healthful to engage in active sports. Currently, no company in the world has exactly the same technical know-how to produce this special laundry product except you.

### *2nd Information item (production)*

The ingredients to produce the new laundry product are not more expensive than the ingredients that the large laundry detergent companies use to produce their well-known brands. But the smaller batches that will be produced mean there will not be the same kinds of economies of scale that the much larger companies have from producing vastly more of their product. Because of the higher costs of producing



the new laundry product, its price will be about 17% higher than the price of the leading brands, so the average laundry detergent buyer is not likely to buy the new laundry product for doing a regular wash. But there is considerable potential in the market for those consumers who have the income to indulge in buying expensive sporting gear and clothing. For them, the additional price will be small compared to the cost of their equipment.

### ***3rd Information item (promotion)***

Most large laundry detergent companies spend vast amounts of money on advertising their brands to the public. Because of this, their brands are very visible and well-known. However, as a small startup company, you will have a very limited advertising budget. One strategy is to send samples of the new laundry product to all the major sportswear manufacturers (such as Nike) for them to try out. You have heard from one sportswear manufacturer that they would be willing to endorse your product (that is, recommend it to customers of their own products) if it performs well in their own tests. Of course the sportswear manufacturer would almost certainly recommend competing detergents as well if those detergents performed well, too.

### ***4th Information item (distribution)***

Distribution of new products in grocery stores (which are usually key locations for major laundry detergent producers) is difficult for any new product, especially one without a large advertising budget designed to bring customers into the store. As a small startup company, you will be expected to at least pay large up-front fees to the major grocery retailers just to get on their shelves. Another strategy is to send your new laundry product to sporting goods stores that usually carry sportswear. The goal would be to establish a partnership with the smaller sporting goods stores that would be difficult to develop with the larger grocery store chains.

### ***5th Information item (market)***

The market for a specialty sportswear detergent is limited in scope, at least compared to the overall market for laundry detergent. That is one of the reasons the major detergent brand producers have not gotten involved in producing a specialty product like yours. However, the number of people engaging in sports and buying sportswear is increasing every year. And of course, the new laundry product works fine to wash regular clothing as well, so its market may actually extend beyond merely sportswear laundry. If the market for the new laundry product gets large enough, a serious concern is that it will become an attractive opportunity for the large laundry detergent manufacturers, who might then decide to enter the sportswear market with their own well-known established brands to compete against your product.

### ***Bio-laminate product – 1st information item (introduction)***

The new business venture opportunity facing you is the production and marketing of a new type of material for making furniture. The special thing about the new material is that it would be a new bio-product made out of corn.

Traditionally, furniture (for example, desks, shelves, and cabinets) has been made out of solid wood. But as the world's natural wood resources have decreased, manufacturers have turned to producing furniture products out of a material known as fiberboard. Fiberboard is basically a sheet of small wood chips held together by strong glues. The sheets, which are about 2 centimeters thick, can be used to make furniture just like real wood. As you can imagine, given the demand for furniture throughout the world, the quantity of fiberboard that is needed is huge.

However, fiberboard by itself is not durable or attractive enough to use in furniture. Instead, it is usually covered by a smooth, hard, plastic-like substance known as plastic laminate. Plastic laminate is a thin sheet made from petroleum products, and it is glued to the surface of the thicker sheets of fiberboard (in other words, the fiberboard is sandwiched between the two sheets of plastic laminate). Once applied, the combined sheets of fiberboard and laminate can be cut, shaped, and assembled into all manner of attractive furniture products.

Your new bio-product made out of corn would replace the plastic laminate. In most ways, the new bio-product would be virtually identical to plastic laminate. It would have the same thickness, appearance, durability, and ease of application. However, it would be different from and better than plastic laminate in one important way: it would be an all-natural, bio-safe product.

Compared to regular plastic laminate, there would be several advantages to your new bio-laminate product. First, it would be produced from a renewable source of material, corn, unlike traditional plastic laminate, which is made from depletable petroleum reserves. Second, it would be all-natural, which would appeal to a large and growing market of consumers around the globe who prefer to have natural products in their homes. Another important difference is that because your product is made from an all-natural product, corn, it is biodegradable. Unlike regular plastic laminate, which takes more than 100 years to biodegrade, your bio-laminate product would begin to biodegrade just 2 years after being buried in the ground. Currently, no company in the world has the exactly the same technical know-how to produce this bio-safe replacement for plastic laminate except you.

### ***2nd Information item (characteristics)***

One limitation of the new bio-laminate product is that it is less flexible, so it cannot be applied to highly curved surfaces. However, the new product can be produced in many different colors and patterns. Almost any pattern that can be created in plastic laminate can also be created in the bio-laminate. In terms of wear, the bio-laminate is just about as durable as plastic laminate. It also resists moisture and sunlight as well as plastic laminate.

### ***3rd Information item (safety)***

New furniture products have to pass what is known as a “burn-test.” In a burn test, a flame is held to the furniture material to see how long it takes to ignite. There is also another test that examines the smoke created by the burning material. All products must pass the tests. Products that ignite too quickly, or that create too much smoke, will fail the test. One of the unique features of your new bio-laminate product is that, unlike plastic laminate fiberboard products, it burns with very little smoke. From a safety point of view, that is a very desirable feature in a furniture product. However, bio-laminate ignites more quickly—but this is less of a concern partly because people have more time to escape from a fire if the fire is not a smoky one.

### ***4th Information item (market)***

There is a demand for all-natural, bio-safe products to be used in the construction of new homes. In the U.S. alone, there are more than 5,000,000 new housing units built per year. Each one of these new housing units is a potential customer for bio-laminate to be used for the construction of built-in shelving, closets, and kitchen cupboards. Therefore, the potential demand is large for this market. One of the things that makes it challenging for bio-laminate to access this market is that usually the construction companies make the decision as to what materials will be used in the construction of the housing units. The construction companies usually prefer to use the products that are the cheapest. But bio-laminate is about 22% more expensive than regular plastic laminate fiberboard, so contractors are understandably reluctant to pay the extra cost. However, there is good reason to believe that some home buyers would be willing to pay a price premium for a housing unit that included bio-safe products, especially if the

buyers have children. That means the contractors could possibly make more profit if they built with bio-laminate, even though it is more expensive to install. But educating the contractors about these potential profit opportunities will require substantial effort on your part.

### ***5th Information item (production)***

You can produce your new bio-laminate anywhere in the world, and it can be shipped to locations where other companies apply laminate to fiberboard. Bio-laminate can be applied to fiberboard using exactly the same machinery that is used to apply plastic laminate, so it is completely compatible with existing production facilities around the world. Producing bio-laminate requires special machinery that would cost \$3.4 million to purchase. It would also require a site of approximately 2 acres for the production facility. However, the sheets of bio-laminate are compact and can be economically shipped around the world to any company that produces fiberboard to be covered in any kind of laminate.

### ***Korean language versions of the surveys***

Korean language versions of the two ventures were developed using the following protocol: The questionnaire was first translated from English into Korean, then back-translated from Korean to English by two native speakers of Korean working independently who had either been educated in the U.S., currently reside and work professionally in the U.S., or both. Both translators agreed that the Korean versions of the two questionnaires were excellent counterparts of the English versions.

## **Appendix B. Validation of venture-relevant information**

The same procedure for constructing venture-relevant items of information was employed in both the detergent-additive (sub-samples 1 and 2) and bio-laminate (sub-sample 3) ventures. Each of the four items of information following the initial information item describing the venture itself was written to be neutral overall, providing a balance of confirming and disconfirming evidence of the desirability of engaging in the venture. Neutrality allowed ID, if it occurred, to be more transparent (Russo et al., 1998) while strengthening our claim that any elevated levels of confidence as a result were overstated. Following Russo et al. (1996), we judged an item of information as neutral when its mean evaluation on a scale from  $-4$  (strongly favors rejecting the option) to  $+4$  (strongly favors accepting the option) did not exceed 1.0 in absolute value. Items of information that did not initially meet this criterion were rewritten and pretested until they did. Three sets of revisions were necessary to achieve the goal of four neutral items of information for each venture. These were the “constructed neutral” values equal to 5 for all eight attributes.

### ***Pretests using business students***

The pretests were conducted using undergraduate business students in three courses with approximately 25 students in each. In contrast to the actual study, no decision was required in the pretests. Further, the development of a preferred position (i.e., leaning toward accepting or toward rejecting) was prevented by using a different identifying letter for each item of information (e.g., Company L in the first item, Company N in the second, and so on). The change of identifying letters prevented the cumulative emergence of a preferred position, which might have biased the item evaluations and introduced distortion into the process of creating an unbiased evaluation (Russo et al., 1998).