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Two Tales of Uncertainty: Calibrating Overprecision With Self-Regulated Entrepreneurial Learning

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ABSTRACT

Entrepreneurial success strongly depends on decision-making under uncertainty. Uncertainty is particularly pronounced when entrepreneurs are confronted with novel situations characterized by an absence of information. While cognitive biases, such as overprecision, can have a negative impact on decision-making processes by distorting information-processing, self-regulated entrepreneurial learning (SREL) has been found to be beneficial when navigating the uncertain entrepreneurial environment, but its potential to calibrate overprecision remains unclear. This study addresses this gap by investigating whether an SREL intervention can calibrate overprecision, a highly detrimental form of overconfidence in entrepreneurship.

1 | Introduction

Entrepreneurs often make decisions under conditions of radical, or “extreme uncertainty” (3), which are characterized by the absence of qualitative or quantitative information (Kurdoglu et al. 2023). Research has identified various approaches to entrepreneurial decision-making under uncertainty, including effectuation (Sarasvathy 2001), engaging in scientific experimentation (Zellweger and Zenger 2023), relying on meta-cognitive processes (Bastian and Zucchella 2022), motivated reasoning (Kurdoglu et al. 2022), intuition and heuristic reasoning (Gigerenzer 2008; Gilbert-Saad et al. 2023) and self-regulation (Trevelyan 2011). However, approaches such as heuristics and intuition have limited applicability under radical uncertainty, as they draw on pattern recognition and prior experience, both of which are hindered when information is entirely novel or completely absent (Kurdoglu et al. 2022). These situations expose the limits of what can be known and require individuals to learn and adapt to avoid negative repercussions (Alvarez and Porac 2020). To support such adaptation, self-regulated entrepreneurial learning (SREL) has been proposed as a structured process that enables entrepreneurs to actively monitor, regulate, and adjust their cognitive processes and behavior under

uncertainty (Winkler et al. 2023). SREL may thus offer an alternative to reactive judgment strategies under radical uncertainty by helping entrepreneurs engage more consciously with their learning processes.

Judgement and decision-making can be distorted by cognitive biases such as overconfidence (Zhang and Cueto 2017). Overconfidence is the most influential bias in entrepreneurship (Thomas 2018) and occurs in three forms: overestimation, overplacement, and overprecision (Moore and Schatz 2017). We focus on overprecision, which is defined as the exaggerated belief in knowing the truth (Moore and Healy 2008). Overprecision reflects a miscalibrated alignment between confidence in knowledge and actual knowledge (Forbes 2005). Although underprecision rarely occurs, this definition of miscalibration comprises individuals who underestimate their knowledge (Moore 2020). Overprecision can be particularly problematic as it distorts how entrepreneurs process information (Kraft et al. 2022). As a result, overprecision can have severe consequences, including venture failure (Gudmundsson and Lechner 2013; Kraft et al. 2022). Despite this impact, overprecision remains the least understood form of overconfidence (Moore et al. 2015). An unresolved research

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Summary

- This paper finds that a self-regulated entrepreneurial learning (SREL) training intervention is effectively improving SREL capabilities of entrepreneurs. Moreover, the intervention improves their calibration of overprecision.
- SREL enables entrepreneurs to exercise agency over their learning process and to manage their cognition, motivation, behavior, and their environment. SREL fosters self-awareness and cognitive adaptability and can thus be instrumental in navigating the uncertainties of the entrepreneurial environment.
- Overprecision describes an exaggerated belief in knowing the truth. This bias is a common phenomenon in entrepreneurship, distorting information processing by neglecting or misinterpreting relevant information.
- SREL training was found to modestly improve the calibration of overprecision, helping entrepreneurs better align their confidence with actual knowledge.
- SREL offers a structured learning approach that supports decision-making under radical uncertainty, where both analytical reasoning and heuristics may become unreliable.

challenge is that most studies find overprecision to be highly robust (Mannes and Moore 2013), while some evidence points to the possibility for reducing overprecision through self-monitoring (Pulford and Colman 1997). To address this gap of how overprecision can be mitigated, we investigate whether SREL training can improve knowledge calibration among entrepreneurs. SREL is defined as “self-generated thoughts, feelings, and actions that are proactively planned and cyclically adapted to the attainment of personal entrepreneurial goals” (Winkler et al. 2023, 2072). It describes a systematic approach to proactively managing one's cognition, motivation, emotion, and behavior (Fust et al. 2018). Furthermore, SREL provides a structured process through which entrepreneurs can proactively plan, reflect, and adapt, especially under conditions of uncertainty. Prior work has emphasized the importance of SREL in uncertain environments (e.g., Fust et al. 2018), but its potential to improve the calibration of overprecision has not yet been explored. Therefore, we conducted a quasi-experiment using a pre–post control group design to test the effects of an SREL training intervention on both SREL capabilities and knowledge calibration.

Our study confirms earlier findings that pointed towards the effectiveness of SREL interventions on SREL capabilities (Fahrbach et al. 2025). Moreover, we found that SREL had a modest yet consistent impact on improving knowledge calibration among entrepreneurs. Thereby, this study contributes to entrepreneurial cognition research in several ways. First, we contribute to the cognitive biases and SREL literatures by demonstrating that overprecision can be mitigated through an SREL intervention. Second, we contribute to the literature on entrepreneurial decision-making under radical uncertainty by showing how planned learning activities and structured

reflection can foster adaptive decision-making where approaches such as heuristics or intuition may fail. Third, our findings have practical implications for entrepreneurs and entrepreneurship education. SREL provides entrepreneurs and entrepreneurship educators with an empirically grounded framework for improving knowledge calibrations, which reduces the negative effects of overprecision. The remainder of the paper is structured as follows. We first lay the theoretical foundations of overprecision and SREL. We then develop two hypotheses, followed by a description of the quasi-experimental design and intervention. After presenting and discussing the results, we outline the implications for research and practice and provide a brief conclusion.

2 | Theoretical Background

2.1 | Overprecision and Information Processing

Information-processing theory is concerned with information acquisition, interpretation, and the subsequent use of information for judgments (Kraft et al. 2022). On a meta-level, the dual process theory of information-processing distinguishes between a fast, intuitive, and automatic System 1 and a slow and analytical System 2 (Kahneman 2003; Stanovich and West 2000). According to the heuristics and bias view, cognitive biases occur when the analytical and deliberate thinking processes of System 2 fail to control System 1 processes (Kahneman 2011; Milkman et al. 2009). In this tradition, heuristics are seen as mental shortcuts that simplify and accelerate judgment under uncertainty but can lead to systematic errors or misjudgments by hampering accurate information processing (Tversky and Kahneman 1974). A different perspective is taken by the fast and frugal heuristics view, which emphasizes the ecological rationality of heuristics, that is, they are effective tools in real-world environments where time, information, or cognitive resources are limited (Gigerenzer 2008; Gilbert-Saad et al. 2018). From this perspective, heuristics are not flawed substitutes for rational thought but efficient adaptive strategies that lead to accurate decisions, even when information is limited. Given the dynamics in the entrepreneurial environment, it is not surprising that many entrepreneurs prefer intuitive System 1 thinking (Cohee and Barnhart 2024) and often rely on heuristics (Gilbert-Saad et al. 2023). Entrepreneurs frequently encounter uncertain situations with little information, which constrains the possibility for accurate System 2 type processing (Kraft et al. 2022; Stanovich and West 2000). This holds particularly true in situations of radical uncertainty, where no meaningful information is available (King and Kay 2020). When both quantitative and qualitative cues are absent, not only analytical thought processes but also heuristic reasoning is hampered. Previously formed rules of thumb may become inapplicable or misleading, as they require recognizable patterns and relevant prior experience (Kurdoglu et al. 2022, 2023). An alternative perspective on decision-making under radical uncertainty refers to “eristics” (763), which are motivated shortcuts aimed at reducing discomfort (Kurdoglu et al. 2023). Eristics are irrational when hedonic tendencies such as obsessive passions or illusions driven by self-deception take prevalence over finding accurate solutions to challenges (Kurdoglu et al. 2022).

In this sense, overprecision can be viewed as a consequence of irrationally motivated heuristics, as it provides entrepreneurs with a comforting sense of control and emotional well-being (Kurdoglu et al. 2023; Zhang and Cueto 2017).

When entrepreneurs are overly convinced that they know the truth, they search for and evaluate information differently (Kraft et al. 2022; Robinson and Marino 2015). Overprecise entrepreneurs tend to be convinced that their level of information is sufficient to make a sound decision and are thus not inclined to search for new information (Zhang et al. 2020). As a consequence, they may invest limited time in the information search process, failing to become aware of alternative information and viewpoints (Robinson and Marino 2015). Second, overprecision impacts how entrepreneurs evaluate information (Kraft et al. 2022). Even if additional information is gathered, entrepreneurs might remain ignorant toward it (Bastian and Zucchella 2022; Salamouris 2013). Overprecise entrepreneurs may instead overemphasize existing information and interpret newly acquired information in a manner that confirms their existing convictions, or downplays the relevance of information that could challenge those convictions (Russo and Schoemaker 1992; Vörös 2024).

2.2 | Self-Regulated Entrepreneurial Learning

SREL provides strategies to mitigate overprecision. It refers to a systematic and self-directed learning process in pursuit of entrepreneurial goals and is concerned with *how* entrepreneurs learn (Winkler et al. 2023). Through SREL, entrepreneurs develop deliberate strategies to independently plan, monitor, and reflect on their learning efforts, acquire and critically evaluate new knowledge, and continuously refine their decisions in contexts characterized by uncertainty (Bellwald et al. 2023). More specifically, SREL enables entrepreneurs to consciously structure their learning processes through proactive planning, intentional actions, and reflective adaptation embedded in everyday entrepreneurial practice.

SREL is conceptualized as a cyclical process comprising three distinct yet interrelated phases: forethought, performance, and self-reflection (Winkler et al. 2023). Each phase encompasses a cognitive, metacognitive, and motivational dimension (Fahrbach et al. 2025). The full potential of SREL unfolds through the coordinated interplay of these phases and dimensions, which form a dynamic learning cycle (cf. Zimmerman 2000). It is through this synergistic and cyclical interaction that entrepreneurs are able to align their learning efforts with the demands of uncertain and complex decision-making environments. An entrepreneur with high SREL capabilities is able to engage effectively in this cyclical learning process and ensures that actions are aligned with goals (Winkler et al. 2023). Drawing on the broader theory of self-regulated learning, SREL capabilities denote the extent to which individuals can purposefully activate and integrate cognitive, metacognitive, and motivational processes in pursuit of their learning objectives (Boekaerts 1999; Paris and Winograd 2013; Zimmerman 2002). Research shows that these SREL capabilities can be developed through targeted interventions (Fahrbach et al. 2025). It follows that SREL

training interventions can foster the adoption of SREL capabilities and enhance entrepreneurs' ability to learn effectively and continuously. This, in turn, allows entrepreneurs to remain adaptive under conditions of radical uncertainty, where informational cues are absent and potential outcomes of situations are unknown. As situations of radical uncertainty require the ability to learn and adapt (Alvarez and Porac 2020), SREL capabilities are critical for entrepreneurs (Winkler et al. 2023). It is important to note that radical uncertainty differs from risk and Knightian uncertainty. When operating under risk, entrepreneurs can assign probabilities to known outcomes, while under Knightian uncertainty, outcomes may be known but probabilities are not (Doroban et al. 2025; Knight 1921). In contrast, radical uncertainty describes situations in which decision-makers lack meaningful information, face unstable environments, and cannot define potential outcomes or probability distributions (Alvarez and Barney 2007; Milliken 1987). For entrepreneurs, this translates into navigating environments that are inherently unpredictable and uncontrollable, such as entering unfamiliar markets. In precisely these situations, SREL becomes a critical adaptive resource. For example, having identified a knowledge gap about cultural differences in a new market, an entrepreneur may set the learning goal to better understand local customer preferences before making the decision to enter. The entrepreneur can decide to conduct interviews with potential partners as a learning strategy. If the interviews close the knowledge gap and reveal that the existing product diverts from local needs, SREL enables the entrepreneur to update the initial assumptions about local preferences.

Given the dynamics of the entrepreneurial environment, entrepreneurial learning must be self-initiated, reflective, and continuously regulated. Otherwise, decision-making may rely on unchecked assumptions and insufficient knowledge (Sarasvathy 2001). SREL serves as a structuring meta-competency that enables entrepreneurs to proactively manage their learning processes in the face of ambiguity and flux (Boekaerts and Corno 2005). It enables entrepreneurs to define learning goals, systematically seek out relevant information, challenge preexisting assumptions, and adapt strategies in response to evolving conditions. In other words, SREL is a deliberate strategy for navigating uncertainty. Entrepreneurs have a high degree of decision autonomy and operate in high-risk, high-reward environments, making their decisions highly consequential (Trevelyan 2011). Additionally, they may lack external feedback mechanisms to regulate their decisions. SREL offers an internal frame of reference that supports entrepreneurs to make informed decisions despite ambiguity. By fostering structured knowledge acquisition and decision-making in ill-structured environments, SREL compensates for a potential lack of external scaffolding with self-directed learning processes such as clearly articulated learning goals, metacognitive monitoring, and motivational self-regulation (Winkler et al. 2023).

Importantly, SREL may also help mitigate overprecision. Through systematic reflection, critical self-examination, and the adaptive evaluation of information, SREL promotes a calibrated awareness of the boundaries of one's knowledge, which is essential when navigating radically uncertain environments.

Because SREL seeks to render entrepreneurial learning more systematic, reflective, and adaptive, it provides a concrete mechanism for identifying and correcting distorted self-perceptions. The ability to critically evaluate one's own judgments and interpret uncertainty as an opportunity for learning is a core element of SREL (Winkler et al. 2023). This is where SREL directly connects to the calibration of overprecision. Overprecision refers to an inflated confidence in the correctness of one's judgments or knowledge (Moore and Healy 2008). In conditions of high uncertainty, such overprecise judgments can lead entrepreneurs to act prematurely, neglecting alternative perspectives or failing to challenge their underlying assumptions (Kraft et al. 2022). In this context, SREL functions as a cognitive–metacognitive safeguard, enhancing the quality of entrepreneurial decision-making by countering self-deceptive tendencies and remaining motivated to continuously learn as new information emerges.

3 | Hypotheses

Prior research suggests that SREL capabilities can be developed through targeted interventions that enhance entrepreneurs' cognitive, metacognitive, and motivational learning abilities across the three phases of the SREL process—forethought, performance, and self-reflection (Fahrbach et al. 2025). Such interventions are designed to strengthen entrepreneurs' capacity to self-regulate their learning in uncertain environments. Learning interventions are particularly effective when they activate self-awareness, provide structured reflection opportunities, and support the transfer of insights into action (Bell et al. 2017; DeRue et al. 2012; Kirkpatrick and Kirkpatrick 2006). Building on the theoretical (Winkler et al. 2023) and empirical (Fahrbach et al. 2025) premises that SREL is a competence that can be fostered through structured learning experiences, we reexamine whether participation in an SREL intervention leads to measurable improvements in entrepreneurs' self-regulated learning capabilities.

Hypothesis 1. *Participation in a SREL intervention enhances entrepreneurs' SREL capabilities.*

SREL capabilities are relevant for entrepreneurs as they often face emotional stress, cognitive overload and high uncertainty where cognitive biases frequently arise (Zhang and Cueto 2017). Under such conditions, inflated self-beliefs such as overprecision may initially drive entrepreneurial action, for example, by reducing fear of failure during uncertainty and providing a sense of assertiveness (Kurdoglu et al. 2022; Zhang and Cueto 2017). However, there is a downside: overprecision distorts information processing, causing entrepreneurs to avoid the search for new information, prematurely terminate the information search process, or evaluate new information in a biased manner that reinforces their existing beliefs (Kraft et al. 2022; Robinson and Marino 2015).

SREL interventions can address overprecision by fostering cognitive, metacognitive, and motivational abilities across three structured phases: forefront, performance, and self-reflection (Fahrbach et al. 2025). Each phase plays a distinct role in mitigating overprecision. In the forefront phase, entrepreneurs define specific learning objectives, analyze tasks, and proactively identify information gaps. Research in

metacognition shows that critically evaluating one's existing knowledge can help identify such gaps (Bastian et al. 2025). Additionally, the explicit articulation of goals and challenges increases awareness of uncertainty, which reduces the likelihood of developing overprecision early in the decision-making process (Winkler et al. 2023). The performance phase involves metacognitive monitoring, including self-monitoring and adaptive adjustment. These strategies support the critical reassessment of initial assumptions and facilitate the integration of new information, enabling entrepreneurs to evaluate whether their actions align with learning goals and adjust strategies accordingly. SREL also strengthens volitional control, helping entrepreneurs manage emotional responses to setbacks and remain open to new or discomforting information (Fust et al. 2018; Winkler et al. 2023). In the self-reflection phase, entrepreneurs assess the outcomes of their learning efforts and the effectiveness of their strategies. This includes identifying whether incorrect beliefs led to suboptimal decisions and engaging in structured updating of beliefs, assumptions, and heuristics (Winkler et al. 2023). Through this iterative process, entrepreneurs can reveal and close information gaps, thereby correcting misalignments between perceived and actual knowledge. SREL thus serves as a structured countermeasure to overprecision: it supports both the acquisition of new knowledge, and the metacognitive evaluation of what is known, and, more importantly, what is not known.

Hypothesis 2. *Participation in an SREL intervention will lead to improved knowledge calibration among entrepreneurs.*

4 | Methods

4.1 | Intervention

To test the hypotheses, we employed a pre–post quasi-experimental design. The intervention consisted of a 1-day workshop conducted with a treatment group and a control group. The treatment group participated in a workshop specifically designed to enhance their SREL capabilities. This involved targeted SREL training, where participants engaged in structured exercises aimed at improving their ability to plan, execute, and reflect on entrepreneurial tasks under conditions of uncertainty. In contrast, the control group participated in a workshop focused on Design Thinking and Time Management and was thus devoid of explicit SREL components. Despite the difference in focus, both workshops were comparable in terms of structure and content, centering on individual development and entrepreneurial advancement. Both groups worked on their own real business cases, applying the workshop learnings directly to the challenges faced within their respective ventures. Both workshops addressed decision-making under uncertainty. The treatment group was trained in self-regulatory strategies to manage uncertainty and make well-informed decisions, while the control group focused on alternative decision-making frameworks. To measure the effects of the intervention, participants in both groups completed a pretest immediately before the workshop and a posttest immediately after. The tests assessed participants' SREL capabilities and their levels of over- or underprecision, providing a direct measure of the impact of the SREL intervention. Figure 1 shows the SREL intervention.

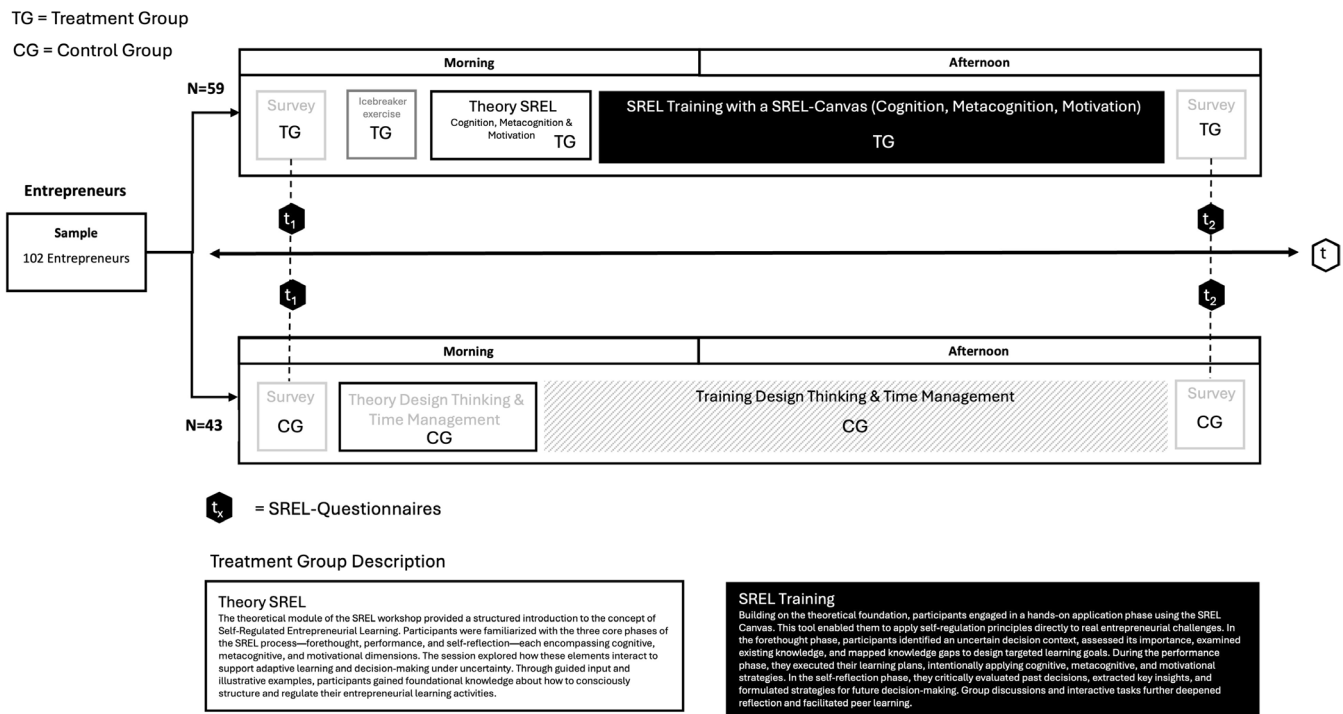


FIGURE 1 | Intervention design.

4.2 | Sample

The experiment involved five distinct samples. The first sample, a treatment group, consisted of Master students enrolled in an Entrepreneurship program at a leading European university. As part of their academic curriculum, these students developed start-up ventures. The second sample, serving as a control group, participated in the same program but was recruited from a different cohort. These two European samples participated in in-person workshops held on the university campus. The third sample included entrepreneurs from South America who took part in an in-person workshop as part of an accelerator program. The fourth (treatment group) and fifth (control group) samples consisted of African entrepreneurs. These participants were recruited in collaboration with the Right for education R:Ed foundation. The two African groups participated in online workshops. Due to organizational constraints within the structure of the accelerator program, it was not possible to recruit a comparable non-treated control group for the South American sample. Overall, the study encompassed three in-person workshop samples and two online workshop samples. Comprehensive demographic data for all five samples are presented in Table 1.

4.3 | Measurements

4.3.1 | Self-Regulated Entrepreneurial Learning

To assess SREL capabilities, we employed three validated questionnaires developed by Bellwald et al. (2023). These instruments are specifically designed to measure SREL across the three phases of the self-regulation process: forethought, performance, and self-reflection. Each phase is assessed through a distinct questionnaire, ensuring comprehensive coverage of the

learning process. Within each phase, the questionnaires measure the cognitive, metacognitive, and motivational dimensions. By integrating these dimensions, the total score provides a holistic measure of the participants' SREL capabilities. In total, the combined set of questionnaires includes 27 items, allowing for a nuanced and multidimensional evaluation of entrepreneurial self-regulation.

4.3.2 | Overprecision

The overprecision measurement procedure was similar to the one described by Forbes (2005). The measurement compares an individual's mean confidence in general knowledge questions (of medium to high difficulty) to the relative frequency of correct responses (overprecision = mean confidence – % correct answers) (Fischhoff et al. 1977; Forbes 2005). This method has been frequently used in studies examining overprecision among entrepreneurs (Busenitz and Barney 1997; Forbes 2005; Ilieva et al. 2018, 2022; Thomas and Wulf 2019; Zhang et al. 2020). As Brenner et al. (1996) emphasize, the procedure is a valid diagnostic tool for overprecision that “does not depend on the mode of analysis” (214). Moreover, the task design mirrors situations that require individuals to act under uncertainty based on subjective knowledge confidence. Hence, beyond practical considerations, this method also connects conceptually to the cognitive mechanisms of interest in our study. The method reflects how individuals evaluate information, that is, they assess the reliability of their judgments. It is also aligned with the metacognitive component of SREL, which emphasizes monitoring one's knowledge limitations (Winkler et al. 2023).

To apply the method in a pretest and posttest design, we collected answers to four general knowledge questions in the pretest and four questions in the posttest. These items were previously

TABLE 1 | Overview of participant demographics and group characteristics.

Sample 1 (N = 27)	
Dimension	Value(s)
Name of the group	Europe treatment
Type of group	Treatment group
Type of workshop	In-person
Number of participants	27
Age	25.00 (mean), 2.18 (standard deviation)
Gender	55.56% male, 44.44% female
Average working hours per week	38.04 h (mean), 16.66 (standard deviation)
Years as an entrepreneur (self-employed)	1.26 (mean), 2.38 (standard deviation)
Country	Germany (37.04%), Austria (29.62%), Switzerland (25.93%), Liechtenstein (7.41%)
Level of education	Bachelor's degree (100%)
Sample 2 (N = 16)	
Dimension	Value(s)
Name of the group	Europe control
Type of group	Control group
Type of workshop	In-person
Number of participants	16
Age	24.94 (mean), 4.55 (standard deviation)
Gender	56.25% male, 43.75% female
Average working hours per week	35.38 h (mean), 14.83 (standard deviation)
Years as an entrepreneur (self-employed)	0.88 (mean), 2.63 (standard deviation)
Country	Germany (43.75%), Switzerland (25.00%), Austria (25.00%), Czech Republic (6.25%)
Level of education	Master's degree (6.25%), bachelor's degree (93.75%)
Sample 3 (N = 11)	
Dimension	Value(s)
Name of the group	South America treatment
Type of group	Treatment group
Type of workshop	In-person
Number of participants	11
Age	22.27 (mean), 0.90 (standard deviation)
Gender	36.36% male, 63.64% female
Average working hours per week	49.36 h (mean), 14.58 (standard deviation)
Years as an entrepreneur (self-employed)	1.44 (mean), 1.03 (standard deviation)
Country	Colombia (36.37%), Peru (27.27%), Mexico (9.09%), South Africa (9.09%), Brazil (9.09%), Argentina (9.09%)
Level of education	Bachelor's degree (54.55%), some time at college (36.36%), professional degree (9.09%)

TABLE 1 | (Continued)

Sample 4 (N=21)	
Dimension	Value(s)
Name of the group	Africa treatment
Type of group	Treatment group
Type of workshop	Online
Number of participants	21
Age	29.48 (mean), 6.45 (standard deviation)
Gender	61.90% male, 38.10% female
Average working hours per week	28.81 h (mean), 15.73 (standard deviation)
Years as an entrepreneur (self-employed)	2.69 (mean), 2.76 (standard deviation)
Country	Congo (23.82%), Zimbabwe (19.05%), Ghana (19.05%), Burkina (4.76%), South Sudan (4.76%), Togo (4.76%), Mali (4.76%), Cameroon (4.76%), Niger (4.76%), Uganda (4.76%), Ethiopia (4.76%)
Level of education	Master's degree (52.38%), bachelor's degree (42.86%), professional degree (4.76%)
Sample 5 (N=27)	
Dimension	Value(s)
Name of the group	Africa control
Type of group	Control group
Type of workshop	Online
Number of participants	27
Age	28.70 (mean), 5.84 (standard deviation)
Gender	70.37% male, 29.63% female
Average working hours per week	35.85 h (mean), 21.42 (standard deviation)
Years as an entrepreneur (self-employed)	3.41 (mean), 2.87 (standard deviation)
Country	Namibia (25.93%), Uganda (11.11%), Mozambique (11.11%), Burundi (7.41%), South Africa (7.41%), Ethiopia (7.41%), Cameroon (3.70%), Mali (3.70%), Sierra Leone (3.70%), Nigeria (3.70%), Sudan (3.70%), Ghana (3.70%), Angola (3.70%), Zimbabwe (3.70%)
Level of education	Master's degree (18.52%), bachelor's degree (44.44%), some time at college (22.22%), professional degree (7.40%)

published and had been categorized into medium and high difficulty levels in the original studies (Ilieva et al. 2018, 2022). By asking general knowledge questions (as opposed to subject-specific questions), the impact of underlying knowledge participants might possess was limited (Forbes 2005). Although the item difficulty had been previously established, we conducted a pilot study to ensure comparability of the two item sets. During the pilot ($N=74$), subjects answered the eight knowledge questions in a single session. This procedure allowed us to statistically test if the two item sets produced comparable overprecision scores. The statistical analysis revealed a moderate and statistically significant correlation between the first and second set of questions ($r=0.263$, $p=0.024$), indicating consistency. A paired sample t -test compared the difference between overprecision scores for the first four questions ($M=0.222$, $SD=0.260$) and the second four questions ($M=0.177$, $SD=0.276$). The results

showed that the difference was not statistically significant, $t(73)=1.190$, $p=0.238$, which further confirmed that the two sets of questions provided similar results, strengthening the robustness of our measurement design.

4.3.3 | Statistical Analysis

To test Hypothesis 1, which posits that the SREL intervention improves SREL capabilities, we conducted both paired samples t -tests and independent samples t -tests (Field 2024). Paired samples t -tests were used to assess within-group changes by comparing pretest and posttest SREL scores for each group independently. These analyses were applied to both treatment and control groups, covering participants from both in-person and online workshops. Additionally, we conducted independent

samples *t*-tests to compare the mean changes in SREL capabilities between the treatment and control groups. This approach enabled us to determine whether the SREL intervention resulted in significantly greater improvements in SREL capabilities compared to the control group.

For Hypothesis 2, which examines whether improvements in SREL capabilities lead to better knowledge calibration, we first calculated the overprecision scores as described above (Forbes 2005). We then computed change scores for calibration (the difference between pretest and posttest scores) to assess how much each participant moved closer to a well-calibrated self-assessment (i.e., a confidence score closer to zero). Paired samples *t*-tests were used to evaluate within-group changes in calibration for both overprecise and underprecise participants. Additionally, independent samples *t*-tests were applied to compare the change scores between treatment and control groups, testing whether the SREL intervention led to a significantly greater reduction in calibration bias compared to the control condition. We used IBM SPSS Statistics Version 29.0.2.0 (20) for the statistical analyses.

5 | Results

To determine the appropriateness of parametric testing, we conducted Shapiro–Wilk tests to assess the normality of the distributions for both the SREL capabilities and overprecision scores across the five samples (Razali and Wah 2011). For the pretest of the SREL capabilities, the African Control group, the European Treatment group, and the South American Treatment group exhibited no significant deviations from normality ($p > 0.05$), indicating normal distributions (Ghasemi and Zahediasl 2012). The European Control group ($p = 0.005$) and the African Treatment group ($p = 0.115$) displayed deviations from normality, suggesting potential non-normal distributions. For the posttest of the SREL capabilities, the African Treatment group ($p = 0.010$) and the European Treatment group ($p = 0.040$) demonstrated significant deviations from normality. Regarding the pretest for overprecision, the African Treatment and European Treatment groups displayed no significant deviations from normality ($p > 0.05$), while the African Control group ($p = 0.031$) showed a slight deviation from normality. The posttest for overprecision indicated non-normal distributions in the African Control group ($p = 0.001$) and African Treatment group ($p = 0.010$), while all other groups displayed normal distributions ($p > 0.05$). Given these results, parametric tests (*t*-tests) were deemed appropriate for groups where normality was met ($p > 0.05$). For groups where normality was violated, non-parametric alternatives (Wilcoxon test, Mann–Whitney *U* test) were applied (Conover 1999).

To assess the homogeneity of variances between the treatment and control groups, we conducted Levene's test for equality of variances (Brown and Forsythe 1974). The results indicated that for the pretest of SREL capabilities, the assumption of homogeneity was met ($F[1,100] = 0.299$, $p = 0.586$), allowing for the application of the standard independent samples *t*-test. However, for the posttest of SREL capabilities, the Levene's test indicated that the assumption of homogeneity was not violated ($F[1,100] = 0.591$, $p = 0.444$), supporting the use of the standard *t*-test. When assessing the difference scores (Δ SREL

capabilities), Levene's test revealed a violation of the homogeneity assumption ($F[1,100] = 5.329$, $p = 0.023$). As a result, we applied the *t*-test for unequal variances with adjusted degrees of freedom to account for this violation, ensuring the robustness of our statistical comparison between groups. In summary, we employed the standard independent samples *t*-test for comparisons of the pretest and posttest SREL scores, while for the difference scores, we used the adjusted *t*-test due to unequal variances.

To evaluate the effectiveness of the SREL intervention (Hypothesis 1), paired samples *t*-tests were conducted within each group to examine changes in SREL capabilities from pretest to posttest. In the African treatment group, a paired samples *t*-test revealed a significant improvement in SREL capabilities, with posttest scores ($M = 4.384$, $SD = 0.505$) significantly higher than pretest scores ($M = 3.939$, $SD = 0.588$), $t(20) = -5.174$, $p < 0.001$. This result suggests that the SREL intervention had a strong positive effect on the development of SREL capabilities in this group, with a medium effect size ($d = 0.394$, 95% CI $[-1.672, -0.569]$). In the European treatment group, a similar pattern was observed. Participants' posttest scores ($M = 4.058$, $SD = 0.356$) were significantly higher than their pretest scores ($M = 3.836$, $SD = 0.306$), $t(26) = -3.429$, $p = 0.002$, demonstrating a moderate improvement in SREL capabilities following the intervention ($d = 0.337$, 95% CI $[-1.072, -0.237]$). In the South American treatment group, the SREL capabilities also improved significantly, with posttest scores ($M = 4.306$, $SD = 0.393$) higher than pretest scores ($M = 3.597$, $SD = 0.459$), $t(10) = -4.542$, $p = 0.001$. This improvement was associated with a large effect size ($d = 0.517$, 95% CI $[-2.189, -0.517]$). In contrast, the African control group did not exhibit a significant change in SREL capabilities. Pretest scores ($M = 4.050$, $SD = 0.524$) were not significantly different from posttest scores ($M = 4.136$, $SD = 0.2445$), $t(26) = -1.842$, $p = 0.077$, indicating no measurable improvement. Similarly, the European control group showed no significant changes in SREL capabilities between the pretest ($M = 3.778$, $SD = 0.311$) and posttest scores ($M = 3.823$, $SD = 0.379$), $t(15) = -0.671$, $p = 0.512$. Additionally, independent samples *t*-tests were conducted to compare the posttest SREL capabilities between the treatment and control groups. The results indicated a significant difference in posttest SREL scores between the treatment ($M = 4.220$, $SD = 0.441$) and control group ($M = 4.019$, $SD = 0.517$), $t(100) = -2.111$, $p = 0.037$, suggesting that the SREL intervention led to significantly greater improvements in SREL capabilities in the treatment group compared to the control group. The effect size for this comparison was medium, with a Cohen's $d = 0.475$ (95% CI $[-0.820, -0.025]$), indicating a moderate impact of the intervention. On the other hand, the pretest showed no significant differences, $t(100) = 1.291$, $p = 0.200$, between the control group ($M = 3.948$, $SD = 0.472$) and the treatment group ($M = 3.828$, $SD = 0.461$) before the intervention. This suggests that the groups were comparable before the intervention. These findings strongly support Hypothesis 1, demonstrating that the SREL intervention significantly enhances SREL capabilities across different treatment groups. The consistency of improvements across multiple samples further highlights the efficacy of the intervention, suggesting its potential applicability in diverse entrepreneurial contexts.

For Hypothesis 2, we examined whether improvements in SREL capabilities led to better calibration of self-assessment, with

overprecision scores approaching zero. In the African treatment group, the paired *t*-test revealed a significant improvement in bias scores from pretest ($M=0.290$, $SD=0.136$) to posttest ($M=0.153$, $SD=0.141$), $t(20)=3.215$, $p=0.004$. This suggests that the SREL intervention led to a meaningful improvement in the participants' knowledge calibration. The effect size was small (Cohen's $d=0.194$, 95% CI [0.215, 1.174]). For the European treatment group, there was also a significant improvement in the overprecision scores between the pretest ($M=0.372$, $SD=0.167$) and posttest ($M=0.281$, $SD=0.193$), $t(26)=2.089$, $p=0.047$. The effect size was small (Cohen's $d=0.227$, 95% CI [0.006, 0.791]), indicating a weak but significant improvement in calibration of knowledge. In the South American treatment group, the paired *t*-test revealed an improvement in overprecision scores. Pretest scores ($M=0.221$, $SD=0.125$) significantly improved compared to the posttest ($M=0.098$, $SD=0.082$), $t(10)=3.774$, $p=0.004$. The effect size was small (Cohen's $d=0.108$, 95% CI [0.353, 1.890]).

In contrast, the African control group did not exhibit a significant change in the overprecise scores from pretest ($M=0.227$, $SD=0.189$) to posttest ($M=0.192$, $SD=0.188$), $t(26)=0.668$, $p=0.510$, suggesting no meaningful improvement in knowledge calibration in the absence of the SREL intervention. Similarly, the European control group showed no significant change in overprecision scores between pretest ($M=0.279$, $SD=0.217$) and posttest ($M=0.281$, $SD=0.246$), $t(15)=-0.023$, $p=0.982$. Additionally, independent samples *t*-tests were conducted to compare the changes in overprecision scores between the treatment and control groups. The results indicated a significant difference in the change scores (Δ overprecision) between the treatment ($M=0.118$, $SD=0.193$) and control group ($M=0.021$, $SD=0.281$), $t(100)=-2.053$, $p=0.043$, suggesting that the SREL intervention led to significant improvements in knowledge calibrations in the treatment group compared to the control group. The effect size for this comparison was small to medium, with a Cohen's $d=0.234$ (95% CI [-0.808, -0.014]). These results collectively suggest that the SREL intervention significantly improves the accuracy of knowledge calibrations among participants in the treatment groups, while no significant changes were observed in the control groups, further supporting the positive impact of the intervention.

6 | Discussion

Our results show that the SREL intervention improved overprecise judgements across all treatment groups, although the effect sizes were modest. While most prior studies emphasize the robustness of overprecision (e.g., Gudmundsson and Lechner 2013), our findings provide empirical evidence that a one-time intervention can improve how entrepreneurs calibrate the accuracy in their knowledge.

Through metacognitive monitoring and reflective evaluation, participants learn to examine their own knowledge claims more carefully (Winkler et al. 2023). Additionally, exercising volitional control can motivate entrepreneurs to persist through uncertainty without defaulting to emotionally comforting but inaccurate self-assessments. However, SREL

processes may not effectively address emotionally protective reasoning patterns that underlie overprecision. The relatively weak findings may reflect a reliance on eristic reasoning, where judgments are shaped by irrationally motivated hedonic desires such as a desire to be certain in the provided answers (Kurdoglu et al. 2022). This could explain why the improvements observed were modest. An alternative explanation may be found in the inherent complexity of the investigated psychological constructs, as multidimensionality may make it difficult to capture their full essence through standard quantitative measures, which can potentially undermine statistical strength (Kickul et al. 2005). Despite the limited magnitude of the results, we show consistently that SREL can recalibrate certainty judgments and reveal knowledge limitations. Therefore, SREL offers a theoretically grounded and practically viable response to overprecision.

Under radical uncertainty, both analytical reasoning and heuristics become infeasible. While heuristics can drive action under uncertainty, they lose meaningful applicability under radical conditions because they require quantitative or qualitative cues and patterns from relevant prior experience, all of which are absent when there is no information (Kurdoglu et al. 2022). SREL remains effective in such extreme conditions, as it structures self-directed learning processes around uncertainty (Winkler et al. 2023). By promoting deliberate goal formulation, critical self-monitoring, and reflective reassessment, SREL enables entrepreneurs to stay engaged with their knowledge limitations and update their heuristics, even when clear answers are unavailable. Its motivational dimension supports persistence and task focus despite ambiguity or setbacks (Winkler et al. 2023). Hence, SREL equips entrepreneurs with cognitive, metacognitive, and motivational tools that are particularly valuable in radical decision contexts where neither logic nor intuition alone is sufficient.

These findings complement recent publications that highlight the importance of regulating the *rhythm* of decision-making under uncertainty. Entrepreneurs often alternate between scanning information, making intuitive judgments, and acting decisively. Their ability to shift between these modes, while managing cognitive load and effort, is key to effective decision-making (Sasseti et al. 2022). SREL provides a structured mechanism for managing this regulatory process: it supports flexible shifts in cognitive strategy, while maintaining awareness of uncertainty and confidence calibration. In this way, SREL may enhance decision adaptability even when other judgment tools fail. As more information continues to become available and uncertainty resolves, SREL encourages entrepreneurs to make more deliberate evaluations. Therefore, SREL can not only guide decision-making under radical uncertainty, but also moderate between intuitive and analytical reasoning (cf. Ostafin 2015).

6.1 | Theoretical Implications

Our study advances research on entrepreneurial cognition and learning in three ways. First, we contribute to research on cognitive biases by showing that overprecision, a highly consequential bias, can be mitigated through a structured learning intervention. While earlier work suggests that overprecision is

difficult to debias (e.g., Mannes and Moore 2013), our findings demonstrate that SREL training can improve the alignment between perceived and actual knowledge. This reinforces prior suggestions about the debiasing potential of self-monitoring (Pulford and Colman 1997) and extends it into the domain of entrepreneurship.

Second, we contribute to the literature on adaptive decision-making by introducing SREL as a metacognitive mechanism that enhances cognitive flexibility. Our results suggest that entrepreneurs trained in SREL become more calibrated in their confidence, allowing them to better adjust their decisions as the level of information evolves, thereby avoiding premature decisions based on inflated self-beliefs. This supports research on metacognitive awareness and its role in regulating information processing (Haynie et al. 2012; Stanovich and West 2000). Under this lens, SREL enables entrepreneurs to balance intuitive and analytical processes, and potentially improves the ability to “switch between cognitive gears” (Baldacchino et al. 2023, 1105).

Third, we complement theoretical perspectives on cognitive strategies in radically uncertain environments. Decision-making frameworks such as heuristics or intuitive judgments may fail when no prior patterns or meaningful informational cues are available. SREL fosters deliberate reflection, motivational persistence, and ongoing adjustment as information becomes available. In doing so, we contribute to the literature on entrepreneurial learning under uncertainty (e.g., Haynie et al. 2012; Winkler et al. 2023), on cognitive bias calibration (Haran et al. 2010; Moore et al. 2015), and on the emerging stream of eristic reasoning in entrepreneurship (Kurdoglu et al. 2023). By demonstrating that a structured learning intervention can recalibrate biased judgments, we join current conversations on how entrepreneurs can counteract maladaptive cognitive and motivational shortcuts in uncertain decision contexts.

6.2 | Practical Implications

From a practical standpoint, our findings highlight the value of integrating SREL into entrepreneurship training and education. In environments of radical uncertainty, the ability to learn and be aware of the limits of one's knowledge is essential, as entrepreneurs need to constantly stay alert and adapt to new circumstances or emerging information (Alvarez and Porac 2020). This is particularly relevant in novel and unforeseeable situations, where prior experience and existing knowledge provide little guidance. By offering a structured learning framework that addresses both (meta)cognitive and motivational processes, SREL equips entrepreneurs with tools to challenge and correct inflated self-beliefs, remain cognitively flexible, and adapt their learning strategies if the situation demands it.

The one-day SREL workshop was effective across culturally and geographically diverse groups (Europe, Africa, South America), which demonstrates that SREL is transferable to other contexts. Educators can adapt the SREL framework to foster greater knowledge calibration accuracy, helping entrepreneurs identify and respond to information gaps more effectively. Additionally, in volatile or unstructured environments where external validation is scarce, SREL offers a self-directed scaffolding mechanism

that can substitute or amend external feedback loops. As such, it is particularly useful in contexts of radical uncertainty, such as entry into unfamiliar markets, where overprecision may otherwise lead to costly premature decisions.

6.3 | Limitations and Future Research

Our study is not without limitations. We measured the effects of the intervention in a single session. Research could benefit by conducting longitudinal studies to provide further insights on the sustained effectiveness of SREL on knowledge calibration. Start-up accelerator programs or entrepreneurship courses at universities provide appropriate and realistic settings to repeatedly apply and measure the effects of SREL on overprecision.

Furthermore, our research measured the calibration of overprecision with a probability estimation task (e.g., Zhang et al. 2020). Scholars could repeat the SREL training intervention by using different measurement techniques such as the interval method (Moore et al. 2015) or the Subjective Probability Interval Estimate (SPIES) method, which combines elements of interval and probability measures (Haran et al. 2010). These approaches allow researchers to gain additional methodological insights and better address concerns regarding the probability estimation method, particularly its potential to confound overestimation with overprecision (Prims and Moore 2017). Additionally, the effects of SREL on overestimation, overplacement, and other related cognitive biases could be investigated. This could add further insight into the effectiveness of SREL in the realm of cognitive biases in entrepreneurship.

Although the treatment and control groups differed slightly in demographic composition (e.g., age, gender, education), these differences were within expected ranges for field-based quasi-experimental research, where perfect group balance is often not feasible (Anderson-Cook 2005). Post hoc sensitivity analyses were conducted using G*Power 3.1 (Faul et al. 2007) for each sample. These analyses revealed that, given our group sizes ($N = 11\text{--}27$), only medium to large effects ($d_z = 0.56\text{--}0.94$) could be reliably detected with 80% power at $\alpha = 0.05$. While several observed effects were below these thresholds, they still reached statistical significance. We therefore report these findings cautiously and emphasize the need for larger-scale replications in future research.

Finally, as SREL capabilities can be developed, it opens up a wide range of research opportunities. Intervention studies could be outlined to show different effects on entrepreneurial outcomes such as entrepreneurial performance or new venture survival. There might be differences in SREL capabilities among entrepreneurs, whereby differentiating the cognitive, metacognitive, and motivational dimensions can reveal interesting insights. Furthermore, the SREL intervention can advance research about the relationship between learning and entrepreneurial experience. For example, some entrepreneurs might be tempted to search for less information when they have experienced entrepreneurial success in the past. Lastly, SREL might explain why some experienced entrepreneurs are more successful than others and become serial founders even in different industries (cf. Winkler et al. 2023).

7 | Conclusion

This study investigated the impact of SREL on overprecision. The findings show that SREL training interventions enhanced SREL capabilities and improved knowledge calibration among entrepreneurs across all treatment groups. In contrast, no control groups showed changes, indicating that the observed improvements were directly attributable to the SREL intervention. Although the effect sizes of the SREL intervention on overprecision were small, they were consistent across all groups. In conclusion, our results reflect two important tales of uncertainty: first, entrepreneurs can strengthen their SREL capacities through targeted training. Second, these enhanced SREL capacities will allow them to better recognize the limits of their knowledge, which is valuable under radical uncertainty, where accurate information processing is not possible and neither heuristics nor intuition offer reliable guidance.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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