

Article

Development and Evaluation of an Investigator Bias Mitigation Tool for Construction Industry Incident Evaluations

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Abstract

Learning from incidents is central to construction occupational safety management, yet information collected during incident investigation interviews may be influenced by cognitive bias. This study introduces Check Yourself, a web-based reflective tool designed to support construction incident investigators in recognizing and managing cognitive biases during interviews. The tool was developed with industry input and evaluated through an exploratory within-subjects simulated role-play experiment involving 20 construction safety professionals with an average experience of approximately 12 years conducting or participating in incident investigations. Participants completed two rounds of incident investigation interviews, with the Check Yourself tool introduced between rounds. Changes in observable bias indicators were assessed through transcript-based analysis, supported by participant reflections and post-study feedback. The results showed that 70% of participants exhibited fewer observable bias indicators during post-intervention interviews, according to the study's coding framework. Participants also reported that the tool supported greater awareness of bias, encouraged more structured questioning, and was relevant to real-world investigation practice. Although participant responses varied, findings suggest that Check Yourself may provide a practical reflective resource for improving interview quality and supporting more balanced incident investigations in construction. Findings from this study should be interpreted cautiously given the exploratory within-subjects design and the absence of a control group.

Keywords: cognitive bias; incident investigation; construction safety; debiasing; safety management; investigator interviews; organizational learning



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1. Introduction

Learning from incidents is a cornerstone of occupational safety management in all industries [1] including construction. Investigations aim to uncover the causal factors behind an incident to inform any changes needed to prevent reoccurrence [2–4]. A wide variety of tools have been developed to support the analytical aspects of incident investigations and help identify causal factors [5]. These tools seek to better understand incident causation and support effective corrective action. In contrast, relatively little attention has been paid towards factors that may affect it further upstream.

A critical early step in the investigative process is the collection of the information to be analyzed, which can include both objective and subjective data, such as photographs,

training records, video evidence, witness statements and interviews with relevant parties [6,7]. The quality of this collected information is critical to the overall success of the investigation, as poor-quality information will likely underpin poor quality analysis, and thus ultimately lead to poor quality conclusions and recommendations for change [8].

One of the more subjective ways in which information is collected is through interviews, which are inherently vulnerable to the influence of cognitive biases. Bias is innate to human cognition [9] and therefore affects construction industry incident investigators as much as any other professional group. Recent research [10] has revealed the presence and influence of various cognitive biases amongst construction industry incident investigators as they undertook post-incident interviews, including how and when different biases were most likely to emerge and influence the interview process.

Recent developments in occupational safety assessment have increasingly incorporated technology-supported approaches such as computer vision-based ergonomic risk assessment tools [11], markerless motion capture combined with machine learning for task classification [12], and vision-language models for occupational exposure assessment [13]. These approaches support more objective assessment of worker activities and safety-related exposures and reflect a broader trend toward reducing subjectivity in safety-related analyses. However, incident investigations continue to rely heavily on human judgment and interviews when establishing context, understanding decision-making, and interpreting contributory factors. Consequently, improving the quality of investigative interviewing remains an important challenge within contemporary safety management, as decisions made during interview processes can still influence what information is collected and how incidents are ultimately understood.

This paper presents the translation of prior research findings into a practical educational tool, *Check Yourself*, designed for use by construction industry incident investigators to support awareness and management of cognitive bias during interview processes. The tool was evaluated through a simulated incident investigation interview experiment involving experienced field investigators, enabling quantitative pre-post analysis supplemented by post-experiment interviews generating richer qualitative insights. By supporting reflective awareness of potential bias, improvements in investigative practice have the potential to enhance the quality of safety-critical information collected through interviews and, in turn, strengthen organizational learning from incidents.

While prior research has empirically demonstrated the presence and influence of cognitive bias in construction incident investigation interviews [14], this study advances literature in three important ways. First, it translates empirical findings into a domain-specific, practitioner-facing reflective tool designed for use during the investigative process. Second, it empirically evaluates this tool as a structured debiasing intervention embedded within investigative interviews, rather than focusing solely on retrospective training or general awareness-raising approaches. Third, it provides an applied assessment of the tool using simulated interviews conducted by experienced safety professionals, offering initial insights into its practical potential and limitations rather than claiming definitive effectiveness. Accordingly, the primary contribution of this paper lies not in the identification of cognitive biases, but in the development, structuring, and empirical evaluation of a practitioner-facing reflective tool derived from prior empirical findings.

2. Background

2.1. Bias in Incident Investigations

People are inevitably susceptible to bias, and often make judgements under uncertainty which only enhances the influence of bias on their thinking [9]. Psychological literature contains considerable research on biases, including a specialism that focuses on how

bias can affect the decision-making abilities of experts in fields where decision-making can be critical, such as medical practice [15], aviation maintenance [16], and criminal investigations [17].

Decision making, in the form of which questions to ask and which to not ask, and how to ask them, is critical in the field of incident investigation. It is the goal of the incident investigator to ensure the ‘best’ possible information, in terms of quality, comprehensiveness, depth and detail, is collected to enable rigorous analysis able to deliver accurate conclusions and effective subsequent actions [1]. In the construction industry information often comes from interviews, in which the investigators seek to ask questions of injured parties, witnesses, managers, and others, to determine what happened and why. Although research of incident investigation interviews has been undertaken from various perspectives seeking to optimize the process [18], research has only just begun to explore the effect of inevitable cognitive biases on the process.

Despite the inevitability of bias [19], few studies have set out to empirically explore which biases are most influential and what can be done to mitigate them in this specific context. One example is the work that identified the most common biases to emerge during the interview process as confirmation bias, anchoring bias, experience bias, conservatism in belief revision, hindsight bias and fundamental attribution error [14]. Biases were found to impact the lines of questioning investigators took during an interview, how and what decisions they made regarding the contributing factors of an incident and subsequently, the corrective or preventive actions suggested. The influence of bias was revealed to have potentially negative impacts on the investigative process overall, ultimately limiting learning from such investigations [10,14].

2.2. Mitigating Bias in Decision Making

Given the potentially negative consequences of biases in decision-making, strategies to counteract their effects have been studied extensively across many different domains [20,21]. Often collectively termed ‘debiasing strategies’, such approaches are intended to enhance decision-making skills in people by heightening their internal objectivity. Some of the most common debiasing strategies are set out in Table 1.

Table 1. Debiasing Strategies.

Debiasing Strategy	Definition	Example Sources
Consider the unknown	This approach asks individuals to evaluate the uncertainty associated with an outcome	[22]
Consider the opposite	This approach asks individuals to consider some reasons that an initial judgment might be incorrect	[23,24]
Consider the alternative	This approach asks individuals to simulate multiple alternatives regarding the outcome of an event	[25,26]
Nudges	Nudges refer to the way in which information is presented through which decisions and judgements are elicited	[27–29]
Third party interventions	In this approach, a third party is brought in during the decision-making process to resolve any disputes	[30]
Incentives	In this approach, optimal behavior is rewarded and is useful in motivating people to use cognitive resources effectively	[31,32]
Training	Training helps in identifying biases and heuristics, and reduces overconfidence by improving calibration	[33,34]
Cognitive diversity	This approach involves including a group of people with diverse thought patterns and mental perspectives when making decisions	[31,35]
Cognitive mapping	This approach involves creating a visual representation of an individual’s mental model for a decision-making process	[36,37]
Scenario planning	This approach aids decision-makers to make assumptions on the impacts caused by different outcomes	[38]

However, no debiasing strategy is perfect and each brings different advantages and limitations. For example, nudges are helpful in the elicitation of targeted decisions, are low-cost interventions and have been shown to be effective in certain contexts, particularly as they do not rely on changes in individual capability [39]. However, nudges can also be ineffective because they can lead to participant confusion, the effects are short-term, they can result in compensating behavior leading to no effect, and are based on inaccurate understanding of the choice architect [40]. Techniques such as ‘consider the unknown’, ‘consider the opposite’ and ‘scenario planning’ have been shown to encourage more comprehensive and deliberate contemplation of information [41], but often have to be used in tandem with other debiasing strategies as they are neither targeted nor structured. For example, ‘consider the unknown’ asks individuals to evaluate the uncertainty in all the possible alternatives considered, thereby leading to more credibility in the decision-making process. However, such considerations can also create nonsensical scenarios and implausible situations which then provide a misplaced confidence in the original, albeit potentially bias-affected and thus erroneous, decision. It should be noted here that these cognitive strategies are all beneficial in encouraging individuals to reflect on their own perceptions and approaches towards different decision-making problems [31], however their effectiveness in focused de-biasing is less evident.

Within debiasing research there has been considerable speculation of the most effective interventions, an obvious consideration being that experience plays a huge part in people making better decisions, and when people are experienced within their domains, they make more rational judgements [42]. However, this statement itself is not unproblematic, as people tend to evaluate decisions based on the outcome rather than how they were made, which can be quite misleading [43]. When a choice results in a positive outcome, individuals might become overly confident in their decision-making skills, potentially causing them to neglect crucial factors that played a role in the decision making that led to that outcome. On the contrary, if a decision yields a negative result, individuals may develop a reluctance to take similar risks in the future, even if those decisions were initially sound.

It is widely suggested that education and bias awareness play an important role in supporting individuals to recognize and manage cognitive biases [44,45]. Creating awareness by providing training on different biases has been shown to improve reasoning in people in situations where other debiasing strategies like incentives and nudges are ineffective [33]. For example, training on Tunnel Vision was provided to undergraduates and professional investigators and tested the efficacy of this debiasing protocol by providing the participants with information on Tunnel Vision and how it can impact information collection, analysis, and decision-making in industrial incident investigations [46]. After educating them on Tunnel Vision, participants were asked to evaluate the causes of an incident and completed a survey to rate their level of confidence, supportiveness of supplementary information, safety reports influence and investigative conclusions. They found that tunnel vision education was effective in reducing the effect of that specific bias, and that education had a positive impact on participants seeking more information and guidance in allocating causes of the incident.

Debiasing is therefore both a science and an art—and there is no straightforward solution. Some debiasing interventions such as scenario planning, nudges and incentives have been found to be effective in certain domains, but only when used in tandem with other debiasing strategies as they are not targeted making the effects relatively short-term. On the other hand, training can be a successful debiasing strategy as it covers a wide array of biases but is only effective only when it is domain specific because of the decision-making skills required that are unique to each domain.

A comprehensive systematic literature review examining cognitive bias within safety and accident investigation contexts has been previously conducted and published by the authors [8]. That review synthesized evidence concerning the prevalence, forms, and consequences of cognitive bias in incident investigations. The present study builds upon that work by shifting focus from identification and synthesis toward the development and evaluation of a practical intervention, rather than reproducing a systematic review of existing literature. Within the broader debiasing literature, the Check Yourself tool is best characterized as a reflective, education-based intervention intended to support metacognitive awareness during incident investigation interviews, rather than as a behavioral nudge or incentive-based approach.

2.3. Cognitive Bias Within Complex Organizational Systems

Although cognitive biases are often discussed as individual psychological phenomena, incident investigations do not occur in isolation from the broader organizational and sociotechnical system. Contemporary safety science argues that failures and the investigations that follow are shaped by complex interactions between people, organizational processes, production pressures, expectations, and institutional practices. From this perspective, investigator cognition may be influenced not only by individual reasoning processes, but also by wider contextual factors that shape how evidence is collected, interpreted, and acted upon. Dekker et al. argue that accident investigations often seek simplified cause-and-effect explanations despite failures emerging from complex system interactions, emphasizing the need to consider the broader context in which investigative judgements are made [47].

Organizational influences have similarly been identified as important contributors to safety outcomes and investigative practice. Komljenovic et al. [48] highlight the importance of considering organizational factors alongside immediate workplace factors when analyzing events and seeking opportunities for safety improvement. In addition, organizational complacency can arise when complexity is underestimated, resulting in excessive confidence in existing explanations, assumptions, and risk management practices [49].

Investigative bias may therefore arise through both cognitive and motivational influences. While cognitive biases are commonly understood as distortions arising from heuristic reasoning and information-processing limitations, motivational biases may arise through reputational concerns, conflict avoidance, organizational loyalty, social pressures, or desires for rapid closure. Motivational biases can shape judgment and analysis through self-interest and organizational context, even when decision-makers are aware of the risks associated with cognitive bias [50].

Accordingly, Check Yourself should be viewed as an individual-level reflective intervention intended to support awareness of bias during investigative interviewing. By encouraging reflection, consideration of alternative explanations, and deliberate questioning practices, the tool seeks to support more balanced information collection. However, it is not designed to remove broader organizational, cultural, or systemic influences on investigative practice. Consequently, the tool should be considered as one component within a wider organizational learning system rather than as a comprehensive solution to investigative bias.

3. Materials and Methods

The study of biases within psychology adheres to the natural-science model of knowledge that underpins the field [51], and that position was also adopted for this study. This results in a realist ontological and positivistic epistemological position through which biases are considered to be identifiable, and therefore can be identified and labelled through objective methods of analysis. This foundation is able to support an empirical evaluation of

the Check Yourself tool and its ability to help construction industry incident investigators mitigate cognitive bias when eliciting information from interviews.

This study adopts an exploratory approach focused on the development and evaluation of a practical, practitioner-oriented intervention intended to support construction incident investigation practice. The approach is informed by principles commonly associated with design science research. This includes the development of a problem-focused artifact and its evaluation within a simulated applied context.

3.1. Development of the Check Yourself Tool

3.1.1. Approach

Overall, training (either alone or in combination with other strategies) and education are widely reported as promising debiasing approaches [44,45], able to target multiple biases at once whilst also motivating higher levels of reflection in individuals [52]. Through reflection, investigators are able to apply their knowledge of biases to the decisions they take and the justifications behind them. In incident investigations, investigators often work in a dynamic and complex work environment, and therefore, the cognitive capacity of the investigator plays a crucial role in directing the investigation process [53]. Incorporating and encouraging reflection through an educational tool was therefore considered a good fit with the investigative process, supporting investigators as they develop their understanding of cognitive bias and its influence on decision-making.

A within-subjects pre–post design was adopted to allow participants to act as their own comparators when engaging with the reflective tool. While this approach supports exploratory examination of changes in interview practice, the absence of a control condition limits causal inference. Accordingly, findings are interpreted as indicative of potential influence rather than definitive evidence of effectiveness.

3.1.2. Tool Development

The Check Yourself tool is grounded in prior empirical work [14]. Check Yourself comprises a suite of reflective questions, the answers to which provide knowledge and insights to educate and inform the investigator using the tool. The questions were developed by the research team to address each of the most commonly identified biases previously identified in an empirical quasi-field experiment study that simulated incident investigation interviews, specifically within the construction industry [14]. Additional questions were also developed to address more general conditions for increased vulnerability to bias. The full suite of questions, the headline biases they seek to address, and the rationale for inclusion can be found in Table 2.

The reflective questions, educational response, and method of delivery were finalized through a focus group held with academic and professional members of the Construction Safety Research Alliance (CSRA), who made recommendations for both content and format which resulted in an online multi-media tool incorporating both text and video as opposed to a pocket book or similar tangible product. The use of an online platform enables users to interact and actively facilitate their learning as they ‘click through’ from each question to its answer which addresses why and how a yes or no answer to the question matters for bias in this context. Each answer also provides suggested actions for both interviewers and their management to help address potential impact, and many also contain further links to other relevant content on the host site, such as short training videos and example interview questions.

The full *Check Yourself* tool can be accessed here: <https://www.csra.colorado.edu/incident-learning-resource> (accessed on 25 July 2026) and an example of a question and follow-up educational insight can be seen in Figure 1.

Am I tired?

If we're not at our best as investigators, we may miss things or fail to collect valid data. Being tired makes us much more susceptible to bias – our brain starts to take shortcuts and rely more on heuristics, which adds more bias into the mix. This can also happen if we're distracted, burnt out or simply not feeling like ourselves for whatever reason.

Suggested actions:

1. Am I biasing the person being interviewed?
2. Have I stereotyped the person I am talking to?
3. Am I rushing the interview?
4. Am I hearing the same story?

For Interviewers

- Acknowledge that you are tired and be mindful that it matters and can make you more vulnerable to bias.
- Ask a colleague to take over the interview for you if possible.
- If not, be mindful that you are tired, and so go slowly and methodically.
- Have a checklist available to back up your memory, to make sure you don't miss any interview question topics and keep the interview on course.
- Run your plan past a colleague before you start to check you've not missed anything obvious.
- If possible, have a note-taker present to ensure everything is captured. This also means you have someone to discuss the outcome with after the interview, and can check yourself further.

For Managers

- Make sure your interviewing team are not overworked or fatigued by normal day to day operations.
- Be flexible in your resourcing and ensure enough headroom in scheduling to allow colleagues to support each other as necessary.
- Develop a bespoke standard interview checklist for your organization to support interviewers through the process.

Find out more about the different biases that can affect you when you're tired here.

Figure 1. Educational insight behind the Check Yourself question “Am I tired?”.

Table 2. The Check Yourself Question Framework.

Question	Headline Biases	Rationale	References	Category
Am I tired?	n/a	People are more vulnerable to bias when tired, as the brain starts to take shortcuts and rely more on heuristics.	[9]	Before
Am I feeling emotional?	n/a	Being emotional can cloud judgment and makes people more susceptible to bias, as distractions mean the brain is distracted and shortcuts and heuristics become more frequent.	[9]	
Do I like or not like this person for some reason?	Fundamental Attribution Error	This bias means people place more emphasis and value on personality than on situational or environmental factors when evaluating behavior or what is said. If we like someone we often value their input/information more than that of those we don't like.	[54,55]	
Am I actively trying to blame or not blame?	Confirmation bias & Anchoring bias	Ambitions to either blame or to ensure 'no blame' can enable bias. If we are looking to blame, confirmation bias can lead to rushing to do so and asking questions that reinforce the case against the worker singled out for blame. If we are keen to ensure a 'no blame' culture, this can result in an interviewer declining to explore areas where responsibility might lie through fear of blame. In either case, anchoring bias can shape the questions asked and the lines of enquiry followed by fixating us to this fundamental premise.	[10,46]	

Table 2. *Cont.*

Question	Headline Biases	Rationale	References	Category
Am I biasing the person being interviewed?	Fundamental Attribution Error	Hostile environments can create stress, which increases vulnerability to bias. In this case, the interview can become vulnerable to fundamental attribution error, where they blame someone else involved in the incident for their actions based on their personality traits, rather than on other reasons such as production pressures or scheduling conflicts.	[54,55]	During
Have I stereotyped the person I am talking to?	Representativeness bias	Stereotypes result from representativeness bias, which is the tendency to match things, including people, to our previous experiences and can lead to perceived similarities between people that aren't necessarily there. This can be problematic in construction, where workers can be stereotyped as poorly educated or less knowledgeable than more senior site management and leadership.	[56]	
Am I relying on informal information in my thinking?	n/a	Some information overheard at the food truck or on the jobsite may be useful, but hearsay should be treated very carefully. For example, someone commenting that the injured worker 'always breaks the rules' could simply be stereotyping them, as this doesn't mean that they 'broke the rules' in this particular instance.	[56]	
Am I hearing the same story?	Confirmation bias	Often when people hear information that broadly fits with previous ideas, thinking or experiences, it's quickly taken on board and added to prior convictions. This is a consequence of confirmation bias through which we seek out information that supports our existing ideas—and reject information that doesn't fit quite so easily.	[17,57]	
Am I not letting go of something?	Conservatism in Belief Revision	People can become fixed on certain pieces of information if, for example, they fit with preconceptions about what happened or we have become anchored to them. This is the result of conservatism in belief revision which means people will stick to ideas even in the face of contradictory evidence.	[58]	
Did I take the first solution I heard?	Anchoring bias	People can anchor to certain pieces of information, and the timing of when we receive it can mean it's given more credence than anything else, whether it's the first or last thing heard. This anchors people to a fact or insight, which can then lead to vulnerabilities to confirmation bias as they seek to validate it.	[9]	After
Do I think I know what happened?	Experience bias	People make judgments by relying on and interpreting their past experiences however overreliance can result in past experience bias. This can be compounded by other biases, such as anchoring or confirmation bias, which then reinforce this belief.	[59]	
Am I considering prior incidents as evidence?	Representativeness bias & Confirmation bias	Thinking back to prior incidents and assumptions that this 'always happens' or, worse, this 'always happens like this' or 'because of this' can be a consequence of bias. Assumptions from stereotyping, hindsight or confirmation bias can lead to the familiar investigation criticism that 'What You Look For Is What You Find'.	[56,57]	
Am I trying to rush to an answer?	n/a	Getting to a quick resolution can be an unwritten (or even written) goal of an investigative process; however, this adds time pressures which can lead to mistakes and poor data collection. Working under pressure and to strict deadlines enhances vulnerability to biases.	[9]	
Have I considered unlikely outcomes?	Confirmation bias	This question draws on mitigation strategies that ask people to 'consider the opposite'. This broad question provides a direct counter to confirmation bias, as well as potentially reducing the impact of many other biases.	[23–26,54]	
Have I evaluated all outcomes equally?	Representativeness bias	All evidence in an investigation should be evaluated with equal care and attention. This question nudges the investigator to reflect on aspects such as stereotypes, which can have considerable influence here and can be very hard to overcome, even when the individual is aware of it.	[27,56]	

In addition, questions were grouped into 3 Categories to avoid overwhelming the participants and provide some structure to the learning, aligned with different stages in the investigative process. The tool can therefore be used before, during and after an investigation, as well as holistically for full reflection by the interviewer before reaching any final conclusions. These Categories are also shown in Table 2.

3.2. Evaluation of the Check Yourself Tool

3.2.1. Research Questions

In order to evaluate the use of *Check Yourself* in practice, two research questions were set:

Does the use of *Check Yourself* result in fewer identifiable instances of biases during a simulated incident investigation interview?

Do practitioners feel *Check Yourself* is a useful tool in mitigating bias in incident investigation interviews within the construction industry?

3.2.2. Research Design

There is currently no universally accepted assessment method for cognitive bias that is without limitations. Some studies have developed quantitative self-reported measures to assess specific biases [60,61], whilst others set out hypothetical scenarios, followed by a self-reporting process adopting a Likert scale with coded responses [62,63]. In studies where training interventions are used as debiasing strategies, Likert scale surveys are often used to assess either initial or resultant bias among the participants [33,34,45]. However, such surveys can generate self-report bias, which can produce unreliable results [64], and furthermore suffer from a lack of ecological validity due to the nature of self-assessment [33].

In order to mitigate this as much as possible within this study, an empirical quasi-field experiment approach was taken that used role play to simulate incident investigation interviews. This replicated the previous study [14]. The role-play simulation method, when conducted with industry practitioners enhances the ecological validity of the experiment, with experienced investigators using the tool in the closest available approximation to a real-life setting. It also allows researchers to follow along both in real time and through the interview transcripts, and thus better understand the approach taken by investigators during incident interviews. Researchers can track and analyze decision-making and question-asking patterns, relative to the contributory factors of the incident. Responsibility for the identification of cognitive biases within the process is assigned to the research team, rather than the participants themselves, enabling a more consistent evaluation while reducing reliance on participant self-report and the associated risks of self-report bias.

The experimental protocol can be seen in Figure 2.

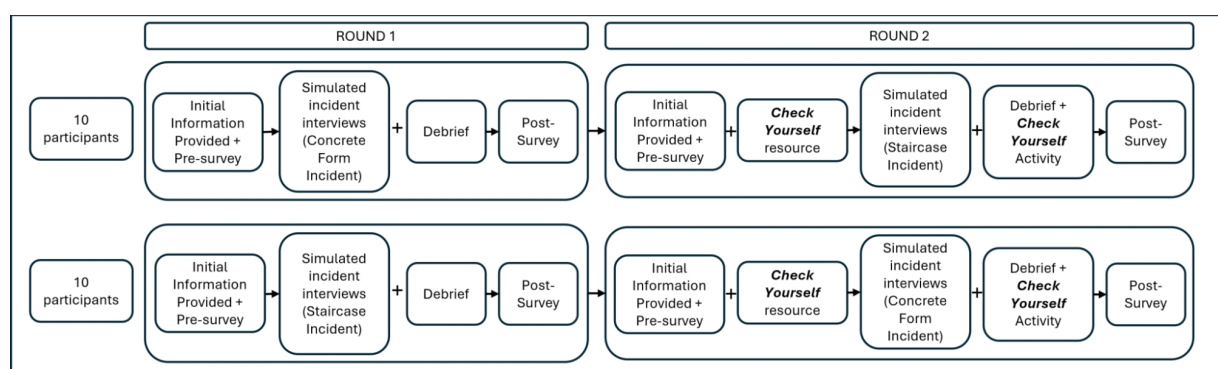


Figure 2. Experimental protocol showing the two-round study design, Check Yourself exposure between rounds, and counterbalanced incident order.

Two incidents—the ‘staircase incident’ and the ‘concrete form incident’—formed the simulated interview scenarios, details of which are outlined in prior work [14]. Two researchers played the roles of the injured person and the witness in each scenario. To ensure a systematic and rigorous simulation, the same two actors role-played the injured

person and the witness in all the simulated incidents, drawing on pre-established character and story line profiles to ensure consistency throughout the interviews.

As shown in Figure 2, the protocol involved two rounds of incident investigation interviews. Participants were randomly assigned to either of the two incidents in Round 1, in such a way that 10 participants investigated the staircase incident in Round 1 followed by the concrete form incident in Round 2 and vice versa for the other 10 participants. This approach was undertaken to avoid potential ordering effects that could introduce bias into the experimental process.

Due to the geographical distribution of the participants across North America, the experiment was conducted via zoom. Prior to the simulated interviews, a fact sheet about the incident was emailed to them, designed to replicate the limited information that would arrive in a notification phone call. This was supplemented by a short pre-survey which asked for the participant's initial thoughts about the incident based on the information provided in the fact sheet. The participant was then asked to independently interview each party—the 'injured person' and the 'witness'—to determine what happened as they usually would in any investigation, with permission to ask follow-up questions as necessary of either party until they had reached a decision about what had happened to their satisfaction. At that point, the lead researcher asked a short set of debrief questions about the decision-making process of the participants and any conclusions drawn about the incident.

Immediately after the experiment, participants were emailed a post-interview survey to add any final comments. This process repeated both the rounds of the experimental protocol with the difference being that on completion of Round 1, the participants were provided with the *Check Yourself* resource for self-study along with the fact sheet, before they undertook Round 2. It should also be acknowledged that observed differences between the two rounds may reflect not only exposure to Check Yourself, but also familiarity with the interview format, increased comfort with the simulation process, and general learning effects associated with repeated participation. Although scenario order was counterbalanced, the within-subjects design does not eliminate these influences.

In Round 2 of the simulation, a short activity based on the self-reflective questions contained in the *Check Yourself* tool was included in the debrief session as shown in Table 3. For this activity, participants were asked to reflect on their interview with both the injured party and the witness of the incident they were investigating and respond either yes or no to the set of questions posed to them. It should be noted that the structured reflective activity formed part of the intervention being evaluated and was therefore only conducted following Round 2. Consequently, the cumulative coding framework should be interpreted as assessing changes in both observable interview behaviors and post-interview reflective awareness following exposure to Check Yourself, rather than as a direct comparison of identical scoring opportunities across both rounds. The framework was intended to capture not only interview conduct but also the reflective processes encouraged by the intervention itself.

Table 3. The Check Yourself Debrief Questions.

Check Yourself Questions: Debrief	Yes	No
Was I tired/emotional during the interview?		
Did I like or not like the person being interviewed for some reason?		
Did I try to blame or not blame either the injured party or the witness?		
Did I bias the person being interviewed?		
Did I stereotype the person I was talking to?		

Table 3. *Cont.*

Check Yourself Questions: Debrief	Yes	No
Did I hear the same story from the interviewees?		
Did I take the first (or last) solution I heard?		
Do I think I know what happened?		
Did I consider prior incidents as evidence?		
Did I try to rush to an answer?		
Have I considered unlikely outcomes?		

3.2.3. Sample

This study recruited a total of 20 participants representing various construction industry domains including oil and gas, service and utility work and heavy civil construction. Participants were recruited through purposive sampling to ensure representation of experienced construction safety professionals actively involved in incident investigation processes. Due to resource constraints and the time-intensive nature of the experiment requiring two rounds of individuals, this was considered an appropriate sample size for this exploratory study without excessively impeding on professionals' time. On average, participants had around 12 years' experience working as a safety professional, which included undertaking incident investigations on a regular basis. The use of experienced practitioners was intentional, as the tool is designed for application within real-world construction incident investigations, where such levels of experience are typical.

The ultimate sample composition further enhanced the ecological validity of this study by enabling the direct participation of the relevant population. In turn, this also supports cautious transferability of the findings as the experienced sample of participants perform many incident investigations annually, and thus can be considered exemplary of the population the tool is intended to support.

3.2.4. Method of Analysis

All the simulated interviews were recorded and, along with the responses to all surveys and questions, were transcribed verbatim for analysis.

In order to answer the first research question, analysis focused on identifying differences in investigators' questioning and reasoning approaches. This process involved assessing each transcript consistently against descriptors of the specific biases previously determined to be prevalent in incident investigation interviews [14]. In an approach developed from similar coding methods used by [62,63], bias statements were developed to establish descriptors of each bias so they could be used as 'assessment elements' of analysis. For instance, anchoring bias refers to people's tendency to rely heavily on a specific piece of information, and thus this was translated into "The interviewer fixated on a specific aspect of the incident" to suit the incident investigation domain. Each of the bias statements was coded as Yes = 0; No = 1 as outlined in Table 4. This dichotomous coding approach was adopted to prioritize analytical clarity and reduce interpretive ambiguity across transcripts, which was considered appropriate given the exploratory aims of the study.

To support analysis of changes between interview rounds, an expectation was defined that a higher cumulative score in Round 2, relative to Round 1, would indicate fewer observable instances of cognitive bias within the interview transcript. Within this scoring framework, lower cumulative scores corresponded to a greater number of identifiable bias indicators, while higher scores reflected fewer observable indicators across the assessed bias elements.

Table 4. Bias Evaluation Framework.

Assessment Element	Bias	Rating Rationale
The interviewer structured the interview based on their initial assumptions	Confirmation bias	A participant was rated ‘0’ for confirmation bias only when the majority of the interview or the entire interview was centered around their initial assumptions mentioned in the pre-survey and in turn, confirmed these to be the contributory factors of the incident during discussion in the debrief session.
The interviewer relied on character/personality to base their judgment	Fundamental Attribution Error	A participant was rated ‘0’ for Fundamental Attribution Error if they made decision based on the personality traits of either the injured party or the witness, i.e., believed that the IP or the witness’s personality or demeanor led to the incident.
The interviewer made decision based on their experience	Past Experience Bias	A participant was rated ‘0’ for experience bias if they made decision based on incidents they investigated in the past of similar nature, i.e., they believed the contributing factors to the current incident to be the same as the ones they had investigated before.
The interviewer fixated on a specific aspect of the incident	Anchoring Bias	A participant was rated ‘0’ for anchoring bias if the majority of the interview or the entire interview revolved around a single aspect of the incident and if the incident root cause was also determined to be this specific factor.
The interviewer believes they have all the information they need to make decision	Confirmation Bias	The rating to this assessment element was based on the survey response to “On a scale of 1–5, do you agree that the evidence provided paints a complete picture” where answers 3–5 were considered as bias and rated ‘0’, and responses 1–2 were rated ‘1’.
The interviewer favored either the witness or the injured party	Conservatism in Belief Revision	A participant was rated ‘0’ for conservatism in belief revision if they made their decision based on the statements of the first person, either the injured party or the witnesses, interviewed, and disregarding the other’s narrative when it was subsequently introduced.

The scoring approach was used to enable comparative analysis of interview transcripts between rounds, rather than to demonstrate definitive bias reduction. Observed differences were therefore interpreted as indicative of potential changes in investigators’ engagement with bias, including increased reflective awareness, rather than as evidence of bias elimination. To support consistency in application, a bias evaluation framework comprising predefined assessment rules was applied systematically when coding each bias element, as detailed in Table 4.

In analysis of the Round 2 simulations, an instance of bias was recorded only when a bias indicator was observed within the interview transcript and the participant did not demonstrate reflective recognition of that bias during the subsequent debrief discussion. This approach reflects the acknowledgement that cognitive bias is an inherent aspect of human decision-making, including in incident investigation contexts. The purpose of the

Check Yourself tool is not to eliminate bias, but to support investigators in recognizing how bias may influence information collection and decision-making during interviews.

Accordingly, where participants explicitly identified potential biases, reflected on how these may have influenced their interview approach, and articulated actions they might take to manage such influences in future investigations, these instances were treated as indicative of reflective awareness rather than as evidence of bias absence. This distinction was applied as an analytic convention to support comparison between interview rounds and does not imply that bias was removed or no longer present. Responses to the *Check Yourself* reflective activity in the Round 2 debrief session (Table 3) were also examined to identify instances where participants did not recognize potential biases, even following exposure to the tool. This analytical approach should be understood as an exploratory scoring convention developed for this study. Observable interview behaviors and reflective recognition of potential biases are conceptually distinct constructs. The purpose of incorporating reflective recognition within Round 2 was not to imply absence of bias, but rather to identify instances where participants demonstrated awareness of potential bias influences after engagement with Check Yourself. Consequently, findings are interpreted as indicative of changes in bias-related interview practices and reflective awareness rather than definitive evidence of bias reduction.

To assess the reliability of the coding framework, a second researcher independently coded a purposively selected subset of five participants, comprising both interview rounds for each participant. The subset therefore included ten participant-round assessments and 60 individual assessment-element ratings. The selected cases represented a range of outcomes, including positive, negative, and unchanged cumulative scores between rounds. Comparison of the two coders' item-level ratings demonstrated 90.0% agreement. Cohen's kappa was 0.78, indicating substantial agreement after accounting for agreement expected by chance. These findings provide additional support for the consistency with which the predefined coding framework was applied.

To address the second research question, responses to the debrief and post-study survey were analyzed to explore participants' perceptions of the usefulness of *Check Yourself*. The post-survey, completed after Round 2, invited participants to reflect on their experiences of using the tool within the simulated investigation context. A thematic analysis of the qualitative responses was undertaken, with frequencies reported where appropriate to provide an overview of practitioner perceptions.

3.2.5. Limitations

As with all research, this study has limitations. Firstly, generalizability of the findings is limited owing to the small sample size, however, purposive sampling of the participants and the use of a simulated experiment enhanced the ecological validity of the study. This in turn supports cautious transferability of the findings to similar contexts, and potentially to other relevant industries conducting incident investigations. Secondly, as noted previously [14], adopting simulations as a research methodology can introduce additional constraints, including the Hawthorne effect, the artificial nature of the setting, and the absence of real-world consequences for participants, all of which may influence participant behavior and responses during the study and potentially shape how they approach the interview process. However, this was an unavoidable limitation due to ethical constraints that would arise if real-life investigations were used as the empirical context. Thirdly, bias may have been introduced by the researchers as they searched for participants' biases within the data; the irony is duly noted that incident investigation itself can suffer from 'what you look for is what you find' [57]. Whilst this possibility cannot be fully designed out of the analytical process, it was mitigated as much as possible through the use of a robust and

fully explicated experimental protocol and the creation of a clear and unambiguous set of rules for the analysis, supporting consistency throughout the research process. Although inter-rater reliability was assessed through independent coding of five participants across both interview rounds, the reliability assessment was limited to a subset of the complete dataset. The results therefore support coding consistency within the selected cases but should not be interpreted as confirmation of agreement across all participant interviews. Future studies should extend independent coding and assessment of coder agreement to a larger proportion of the dataset.

An additional limitation relates to the inclusion of reflective recognition within the Round 2 scoring framework. Because the structured Check Yourself debrief formed part of the intervention being evaluated, participants were provided with an opportunity to explicitly reflect on potential bias following Round 2. This created an asymmetry between rounds and therefore limits direct equivalence of scoring opportunities across the study. Findings should therefore be interpreted as exploratory indicators of changes in interview behavior and reflective awareness following exposure to the intervention.

4. Results and Discussion

Overall, the findings of this study revealed that a positive change in observed bias indicators was seen in a majority of the participants (70% $n = 14$) between the two rounds of the simulation as reflected in fewer observable instances of bias within their incident interviews.

4.1. Example Analysis

Due to constraints of space, only one example of the detailed analysis for one participant 'O', where a change in observed bias indicators was identified, has been unpacked here, to demonstrate the analytical process. The final evaluation for this participant can be seen in Table 5.

Table 5. Participant O's pre-post Check Yourself evaluation results.

Assessment Element	Round 1	Round 2
The interviewer structured the interview based on their initial assumptions	0	1
The interviewer relied on character/personality to base their judgment	0	1
The interviewer made decision based on their experience	1	1
The interviewer fixated on a specific aspect of the incident	0	1
The interviewer believes they have all the information they need to make decision	0	1
The interviewer favored either the witness or the injured party	0	1
Sum of all the elements	1	6

As shown in Table 5, in the first round, Participant O was prone to several biases with the exception of past experience bias; however, after engagement with Check Yourself in the second round, Participant O demonstrated greater reflective awareness of their own biases and, based on the applied analytical criteria, fewer observable bias indicators were identified within the transcript of their post-*Check Yourself* round 2 interview.

These evaluations were the result of careful analysis of the pre-survey and transcripts, through which observable indicators of bias on the part of the interviewer could be identified. In the case of Participant O, the pre-survey revealed that their first impressions were that poor communication due to change in the work process and time pressure were the contributing factors to the incident. Participant O was subsequently rated '0' for both

confirmation and anchoring bias (i.e., they were present), as the vast majority of questions throughout the interview subsequently also centered around these two factors. For example, when interviewing the injured party (the laborer in the 'concrete form incident') Participant O's questions included:

".....prior to beginning this method, did the superintendent train you in this process?..."

"You were comfortable with what your expectations were. And then when you were, approached, by the superintendent, and you were asked to change the method. Did you feel confident in that method?"

"And do you feel like the task once, once the superintendent was involved? Was it, was it rushed? Was there any sense of urgency above and beyond what you've normally experienced in your tasks?"

"...Underlying tone, kind of like aggravation or annoyance? How did that make you feel?"

"So there were some nerves. And pressure to perform, not to put words in your mouth. But would that be accurate? The pressure to perform and make, make the boss happy?"

When interviewing the witness (the superintendent in the same incident), Participant O asked:

"Ok. And as the laborer got started, with the operation, you felt comfortable like they were understanding this process."

"And you mentioned there's a, a concrete pour at four o'clock. How did that affect staying on schedule for the concrete pour.?"

"So obviously you said you had identified that, that the laborer was falling behind schedule and maybe not real comfortable. Were there any other obstructions or.?"

"Did, do you remember threatening the laborer that they would be fired if they didn't get the job done?"

When asked their opinions of what led to the incident in the debrief session, Participant O reconfirmed their initial assumptions by stating *"I think a contributing factor could be the perception of the approach of the, the, the superintendent and feeling pressured to perform. I think a distraction is ultimately, what led to, well, you could combine distraction and poor communication, would be the, the most immediate at the, at the time of incident, what, what caused the actual injury."*

This is perhaps a surprising finding given that most research of anchoring bias suggests it heavily relies on numerical anchors [65], however, this study suggests that non-numerical anchors (i.e., common contributing factors or 'root causes' of incidents) are also prevalent in incident investigations. These 'common' contributing factor(s) also seem to serve as anchors influencing the line of questioning taken by investigators wherein they choose to dig deeper into a specific aspect and, particularly when they believe this to be the main causal factor of the incident.

When asked whether the superintendent or the laborer should be held accountable for the poor communication that led to the incident, they stated that responsibility lay with the superintendent to maintain a safe work site as well as supporting the laborer's perspective that the superintendent's "intimidating behavior and demeanor" ultimately led to this incident occurring. Participant O was therefore also rated '0' for both Fundamental Attribution Error and Conservatism in Belief Revision based on the applied coding criteria.

In Round 2, Participant O stated in their pre-survey that they felt the structural integrity of the stairs had been compromised and resulted in the incident. However, in

the interview they touched upon a variety of different aspects surrounding the incident, and came to the conclusion that several factors contributed to the incident including the foreman working alone due to the crew being fired, time pressure, animosity between the superintendent and the foreman.

When asked about their perceptions of the *Check Yourself* tool, they indicated that using the tool had made them think about how different lines of questioning can lead to biases and so instead of coming in to do the interview with preconceived notions, they had consciously tried to remain open to uncovering new facts, and in the simulation they described consciously attempting to manage potential bias by adhering to a neutral line of questioning. The participant expressed, *“I think it was really good. even how I opened the conversation this time was a little different and tried to get a little bit more background. . . And, I also really liked, like the biases thing. It’s a, it was good to hear and it’s always good to hear when, you know, when people say the word that there’s going to be bias. Like, well, no, there’s not, I can be completely neutral. You’re like, no, it’s gonna happen and it’s kind of like, like that acceptable flaw, but it’s being aware of it and working around. I thought that was really enlightening.”*

Within the post-interview Check Yourself activity, Participant O mentioned that they might have been biased towards the superintendent at one point in their line of questioning because of a misunderstanding with a question that left them frustrated and further suggested that they would want to seek a follow-up interview with the superintendent to make sure they actually captured everything. They also stated that they would need more evidence related to how the stairs had broken before they can recommend potential corrective actions. Accordingly, this participant was ultimately rated ‘1’ after round 2 for all bias elements, indicating that no observable bias indicators were identified based on the applied analytical criteria.

4.2. Experimental Findings

To evaluate if there was a statistically significant change within the interviewers’ approach, a paired *t*-test was used to determine the change in bias measure [66]. This test was considered appropriate for comparing the same participants across the two interview rounds, and its assumptions were deemed suitable for this exploratory analysis. Participants achieved a mean cumulative score of 3.45 (SD = 1.43) during Round 1 and 4.85 (SD = 1.23) during Round 2, representing an average increase of 1.40 points following exposure to Check Yourself. A paired *t*-test revealed a statistically significant difference between the pre- and post-intervention cumulative scores among investigators exposed to Check Yourself, $t(19) = -3.62$, $p = 0.0018$, Cohen’s $d = 0.76$. A Wilcoxon signed-rank test produced a consistent result ($W = 13.0$, $p = 0.0040$), providing additional support for the observed difference.

When provided with the Check Yourself tool, participants demonstrated an average increase of 1.4 points in the cumulative coded score between rounds. These findings suggest that Check Yourself was associated with positive changes in the cumulative bias related coding framework adopted for this study, indicating its potential value as a reflective resource to support incident investigation practice. Table 6 shows participant level changes in cumulative coded scores between interview rounds.

Overall, a positive change in the cumulative scores was seen in $n = 14$ (70%) participants following engagement with the *Check Yourself* tool, i.e., the participant was prone to fewer biases in Round 2 than Round 1. Four of the participants had no change in the approach between the two experimental rounds, whilst two actually had a negative change in approach, i.e., participants were prone to increased bias after they had used the tool. This observation highlights variability in participant responses across the two rounds and underscores the complexity of influencing cognitive bias within applied investigative settings.

Table 6. Changes in cumulative codes scores between study rounds.

Participant	Round 1 Cumulative Score	Round 2 Cumulative Score	Point Difference	% Change in Cumulative Scores
A	3	5	2	67%
B	3	3	0	0%
C	3	5	2	67%
D	2	3	1	50%
E	2	5	3	150%
F	4	2	−2	−50%
G	4	6	2	50%
H	4	4	0	0%
I	4	5	1	25%
J	5	4	−1	−20%
K	3	3	0	0%
L	4	6	2	50%
M	4	6	2	50%
N	1	5	4	400%
O	1	6	5	500%
P	6	6	0	0%
Q	4	5	1	25%
R	2	6	4	200%
S	5	6	1	20%
T	5	6	1	20%
Mean	3.5	4.85	1.35	77.2%

Note: Reported values represent cumulative coded scores derived from the study's bias evaluation framework. Higher scores indicate fewer observable bias indicators according to the applied coding criteria.

This finding highlights variability in participant responses and suggests that reflective interventions may not influence all investigators in the same way. The reasons behind these differences were not examined directly within this study and therefore should not be inferred from the available data.

Surprisingly, there were no noticeable differences in the interviewing approach based on the order of investigating the incidents, i.e., participants who investigated the staircase incident followed by the concrete form incident and vice versa were all prone to the same types of biases. This reinforces the findings of earlier work [14] that revealed these to be the most common biases that emerge within the specific context of construction industry incident investigations.

These findings should also be interpreted within the broader organizational context in which investigations occur. Previous safety research has highlighted how organizational expectations, established causal narratives, production pressures, and routine investigative practices can shape how evidence is sought and interpreted. While Check Yourself was designed to support reflection at the level of the individual investigator, organizational influences may continue to contribute to investigative bias regardless of an individual's awareness of such influences. Consequently, the tool should be considered as a comple-

mentary aid within broader organizational learning and investigation systems rather than a standalone solution.

4.3. Practitioner Evaluation of Check Yourself

Following the experiment, participants were asked to evaluate the use of *Check Yourself* as a useful tool for supporting bias awareness and reflective practice in incident investigation interviews within the construction industry. 70% (n = 14) of participants stated that the tool helped them become more aware of their biases and reflect on their mental state, which is important for supporting reflective and balanced investigative practice. One of the participants stated, “Yeah, so for me, it was just kind of eye opening to see some biases that I don’t feel like we view about ourselves. So there were a few there like, oh, okay, yeah, that’s good.” 75% (n = 15) of the participants appreciated the structured questioning of the tool, helping them stay focused on the facts and avoid jumping to conclusions. As one participant noted, “What I do like about it is the step wise approach to questioning yourself to make sure that you’re, I guess you’re doing the best job that you possibly could. It’s comprehensive in the questioning; it really helps you understand the basis for your questions, from your own internal perspective.” Furthermore, 80% (n = 16) of participants found the tool to be relevant to real-life situations. One of the participants mentioned, “It’s just an in-your-face reminder of how important what we’re doing... we can’t afford to let anything get in the way of getting to the bottom line... make sure we clear our mind and see it for what it is and get the desired results out of it.”

Overall, n = 3 participants found the Check Yourself tool to be an extremely useful tool in promoting their understanding of biases, n = 14 of them found the tool to be very useful and n = 3 of them found it moderately useful. Moreover, n = 2 participants found the Check Yourself tool to be extremely useful in helping them collect better information during investigations, n = 15 of them found the tool to be very useful and the remaining n = 3 participants found the Check Yourself tool to be moderately useful. In summary, while the tool was widely regarded as useful for fostering bias awareness and supporting investigation practice, participants also highlighted a need for it to be more accessible, concise and integrated into regular training and investigation workflows.

5. Conclusions

This study presents the evaluation of a novel practical application to supporting bias awareness in construction industry incident investigations, examining its use through a simulated experiment. The web-based tool *Check Yourself* was designed to specifically address the different biases previously determined to commonly affect construction industry incident investigation interviews and creates awareness among investigators of cognitive biases and how they may influence interview practice.

Empirical findings indicate that use of Check Yourself was associated with positive changes in the cumulative bias-related coding framework in simulated incident investigation interviews. Although participant responses varied, a majority (70%) exhibited fewer observable bias indicators after being exposed to the tool, suggesting its potential value as a reflective resource for supporting bias awareness in construction industry investigation interviews. However, two participants achieved lower cumulative coded scores in Round 2 than in Round 1. While the current study was not designed to identify the reasons for these outcomes, the finding suggests that reflective interventions may not benefit all investigators equally and that individual, contextual, or organizational factors may influence engagement with bias mitigation strategies. Statistical analysis indicated that participants demonstrated an average increase of 1.4 points in cumulative coded scores following exposure to the tool. These findings should be interpreted cautiously given the exploratory

within-subjects design, absence of a control group, simulated setting, small sample size, and scoring approach adopted for the evaluation.

From an academic perspective, this study contributes to the literature on bias mitigation strategies in incident investigation within the construction industry. From a practical standpoint, *Check Yourself* may offer value as an educational resource to support investigators' understanding of common cognitive biases that affect incident investigations, specifically within the construction industry. Further research is needed to confirm this first finding, ideally through longitudinal studies that can not only evaluate potential effectiveness using stronger controlled designs over multiple incidents and interviews but can also seek to evaluate user retention of the knowledge shared through the *Check Yourself* tool. *Check Yourself* appears to support incident investigators in reflecting on the potential influence of cognitive bias in their work, which may in turn contribute to more considered decision-making and more robust interview information.

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