

REVIEWER'S REPORT

Manuscript No.: IJAR-59192

Title: Simulating Cognitive Bias in Interactive Environments: A Framework for Using Behavioural Simulation Games as Educational Tools.

Recommendation:

Accept as it is

Accept after minor revision.....

Accept after major revision

Do not accept (*Reasons below*)

Rating	Excel.	Good	Fair	Poor
Originality		X		
Techn. Quality		X		
Clarity		X		
Significance		X		

Reviewer's ID: JPR-212

Detailed Reviewer's Report

This is an excellent, original, and intellectually rigorous conceptual paper that makes a significant contribution to the fields of educational technology, cognitive science, and game-based learning. The paper addresses a genuinely unsolved problem: how to teach people to recognize and resist cognitive biases. The author correctly identifies that conventional instruction lectures and textbook examples produces weak and short-lived improvements because it engages the slow, deliberate system while biases operate automatically in the fast system, at a different moment and under different cognitive conditions. The proposed solution interactive simulation games that let users experience a cognitive bias operating on their own decisions in real time is both innovative and well-grounded in psychological and educational theory.

The paper is exceptionally well-structured. It moves logically from the theoretical foundation (dual-process theory, Kolb's experiential learning theory, game-based learning) to a concrete design framework mapping specific biases to specific game mechanics, to the technical architecture required for implementation, to a nuanced discussion of measurement limits, and finally to a thoughtful examination of ethical considerations. The writing is clear, precise, and engaging. The author demonstrates a sophisticated understanding of the relevant literature and is careful to make claims that are defensible and evidence-based, avoiding the temptation to oversell the intervention. The caution about the limits of any bias intervention the acknowledgment that even direct experience is not guaranteed to produce durable resistance is a mark of intellectual honesty that strengthens the paper considerably. The ethical analysis is particularly valuable, acknowledging the proximity between educational and exploitative uses of the same techniques. This manuscript is in excellent shape and requires only minor revisions before publication.

Minor Issues (to be addressed in revision):

1. Strengthening the Link Between Theory and Design:

- The paper does an excellent job of grounding the framework in Kolb's experiential learning theory. However, the connection between dual-process theory and the specific design choices could be made even more explicit. For example, in Section 3.1 (Anchoring Bias), the author could explain more clearly *why* showing the player their own anchoring effect after the decision is expected to be more effective than simply telling them about

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anchoring. The mechanism that the immediate, personalized feedback creates a "teachable moment" that engages the reflective system while the concrete experience is still fresh could be articulated more fully.

- In Section 2.3, the author cites Gee's argument that well-designed games situate knowledge inside meaningful action and immediate consequence. This is a crucial point that could be developed further. How exactly do the proposed mechanics (e.g., resource estimation, investigation, confidence intervals) embody this principle? A brief discussion of how the mechanics create "meaningful action" would strengthen the theoretical justification.

2. Expanding the Design Framework:

- The design framework in Section 3 is a significant contribution. However, it covers only four biases (anchoring, loss aversion/sunk cost, confirmation bias, and overconfidence). While these are well-chosen and illustrative, the author could briefly discuss how the framework might be extended to other important biases (e.g., availability heuristic, representativeness heuristic, framing effects, in-group bias). A sentence or two on the generalizability of the framework would be valuable.
- For each bias, the author could provide a slightly more detailed description of what the actual gameplay might look like. For example, in the confirmation bias section, what kind of investigation or diagnosis scenario would be used? What would the player actually be doing? While the paper is conceptual, not a design document, a bit more concreteness would help readers visualize the implementation.

3. Technical Architecture:

- Section 4 is well-conceived, but it could be slightly expanded. For example, the author mentions "decision telemetry" but does not discuss data storage, security, or privacy considerations. Given that the system would be collecting detailed data on users' decision-making (and potentially their biases), data privacy is a significant concern that deserves at least a brief mention.
- The "bias-detection and feedback layer" is described, but the author could briefly discuss the computational challenges involved in accurately measuring bias susceptibility from limited data points. How many decisions are needed to reliably estimate a player's anchoring susceptibility? What statistical techniques might be used? Some discussion of these practical challenges would strengthen the technical credibility of the proposal.

4. Measurement and Evaluation:

- Section 5 is excellent, particularly the caution about the limits of any bias intervention. However, the author could briefly discuss the practical challenges of conducting a rigorous evaluation. For example, what would be an appropriate control condition? How long should the follow-up period be? What outcome measures would be most appropriate (e.g., performance on a novel anchoring task, self-reported awareness, behavioral change in real-world decisions)? Some discussion of these methodological challenges would be valuable.

5. Ethical Considerations:

- The ethical discussion in Section 6 is a highlight of the paper. It could be further strengthened by a brief discussion of informed consent. Should players be told at the outset that they will be experiencing biases, or would that undermine the educational effect? If they are told afterward, is that sufficient for informed consent? The author could discuss the tension between full transparency and the goal of creating an authentic, immersive experience.

6. Minor Typographical and Formatting Issues:

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- There are a few minor typographical errors. For example, in the abstract, "humans-computer interaction" should be "human-computer interaction." In the keywords, "Keywords cognitive bias" is missing a space. The author should carefully proofread the manuscript.
- The reference list is comprehensive but could be slightly expanded to include key works on the specific biases discussed (e.g., Tversky & Kahneman's work on anchoring and availability). The author cites Kahneman (2011) and Tversky & Kahneman (1974), which are appropriate, but additional references to specific studies on confirmation bias, overconfidence, and loss aversion would strengthen the paper.

Specific Comments for the Authors (for a Minor Revision):

This is an outstanding conceptual paper that makes a valuable contribution to the fields of educational technology and cognitive science. The framework is well-grounded, the design proposals are concrete and thoughtful, and the ethical analysis is exemplary. To prepare the manuscript for final publication, the author should address the following minor points:

1. **Strengthen the Link Between Theory and Design:** More explicitly explain how the immediate, personalized feedback in the proposed mechanics is expected to engage the reflective system and create a "teachable moment."
2. **Expand the Design Framework:** Briefly discuss how the framework could be extended to other biases. Provide slightly more concrete descriptions of the gameplay for each bias.
3. **Expand the Technical Architecture:** Briefly discuss data privacy and the computational challenges of measuring bias from limited data points.
4. **Discuss Evaluation Challenges:** Briefly discuss the practical challenges of conducting a rigorous evaluation (control condition, follow-up period, outcome measures).
5. **Discuss Informed Consent:** Address the tension between full transparency and the goal of creating an authentic, immersive experience.
6. **Correct Minor Typographical and Formatting Errors:** Proofread carefully. Ensure consistency in formatting.
7. **Consider Expanding the References:** Include additional key works on the specific biases discussed.

Conclusion:

This manuscript presents an excellent, original, and rigorous conceptual framework for using interactive simulation games to teach cognitive biases. The paper is well-written, well-structured, and demonstrates a sophisticated understanding of the relevant psychological and educational literature. The design framework is concrete and actionable, the technical architecture is well-conceived, and the ethical analysis is exemplary. The author's intellectual honesty about the limits of the intervention is commendable and strengthens the paper considerably. With the minor revisions outlined above, this manuscript will be ready for publication and will be of great interest to researchers, educators, and game designers working in the fields of cognitive science, educational technology, and decision science. The recommendation is for acceptance after minor revision.