Unraveling the Sources of Confidence in Value-Based Choices

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Introduction

Importance of Confidence

Confidence plays a vital role in decision-making, affecting learning from mistakes and influencing future actions, especially in economic contexts where choices have significant consequences for individuals and groups.

Significance in Decision-Making

Confidence serves as a subjective evaluation of decision quality, allowing individuals to revise choices and guide future behavior based on past experiences and perceived certainty in their decisions.

Guiding Future Behavior

The cognitive process of confidence is essential for reflecting on past decisions, learning from errors, and making informed choices to optimize outcomes in future scenarios.

Research Gap

Limited knowledge about the mechanisms of confidence in value-based decisions

Importance of developing a detailed understanding of confidence mechanisms in economic choices

Distinguishing characteristics of confidence in value-based decisions compared to perceptual decision-making

Study Objective

Dissecting components of decision-making in value-based choices

Investigating the connection between decision processes and confidence

Utilizing a blend of behavioral tasks and computational modeling for in-depth analysis

Experimental Design

Significance of Two-Phase Rating

The two-phase rating task allowed for the capture of true subjective value estimates by preventing participants from memorizing ratings and ensuring unbiased value assessments for subsequent choices.

Incentive-Compatible Choices

Participants engaged in a series of choices where they selected preferred food items, ensuring decisions aligned with true subjective values established in the rating task.

Unbiased Value Assessments

The design aimed to minimize biases by presenting food items without prior knowledge of the subsequent rating phase, enhancing the accuracy of subjective value estimations.

Eye-Tracking and Attention

1

Utilized eye-tracking to observe participants' eye movements during decision-making tasks

2

Examined the role of visual fixation dynamics in influencing decision-making processes

3

Studied the impact of attentional effort on both confidence reports and choice behavior

Model-Free Analysis

Key Decision Variables

Analysis reveals the impact of key decision variables, such as value difference (VD) and total value (TV) of input alternatives, on choice consistency and confidence reports. Higher VD leads to more consistent choices and confidence, while TV influences confidence but not choice consistency.

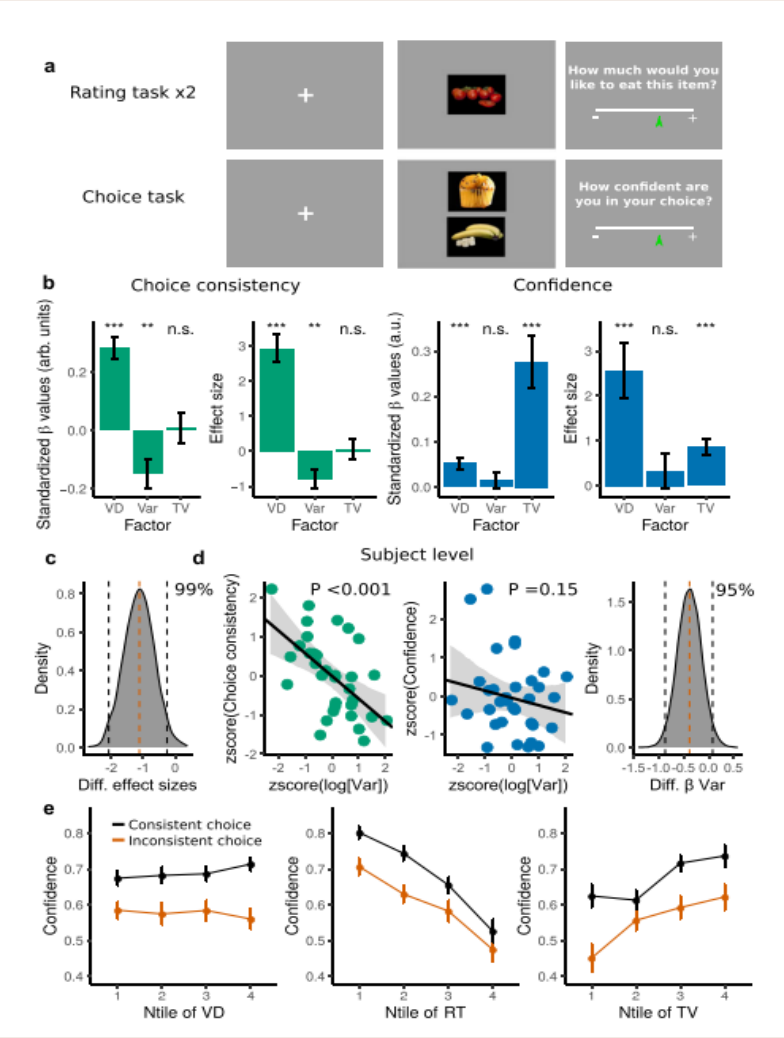
Influence on Choice Consistency

Higher VD results in more consistent choices, whereas increased variability in the value ratings of the alternatives leads to less consistent decisions. TV of the alternatives does not influence choice consistency significantly.

Impact on Confidence Reports

Higher VD positively influences confidence reports, while variability in the rating of the alternatives has no reliable effect on confidence. However, higher TV increases confidence significantly.

A. Display of Rating and Choice Task.
B. Regression Analysis on Choice Consistency.
C. Difference in Effect Size on Choice Consistency and Confidence.
D. Influence of Participant Variability on Choice Consistency and Confidence.
E. Behavior of Confidence in Different Situations.



Generative dynamical models of confidence

- ❏ Understand the underlying mechanics behind their previous findings.
- ❏ Modeling approach to dissect different aspects of the decision-making process and how they relate to confidence.

Gaze-weighted Linear Accumulator Model (GLAM)

GLAM considers attentional effort, which is how much focus a person puts on each choice option during decision-making.

Unlike typical applications, they're exploring if attentional effort fluctuates from trial to trial and how this affects confidence.

Generative Models of Confidence

Heuristic and Normative Models

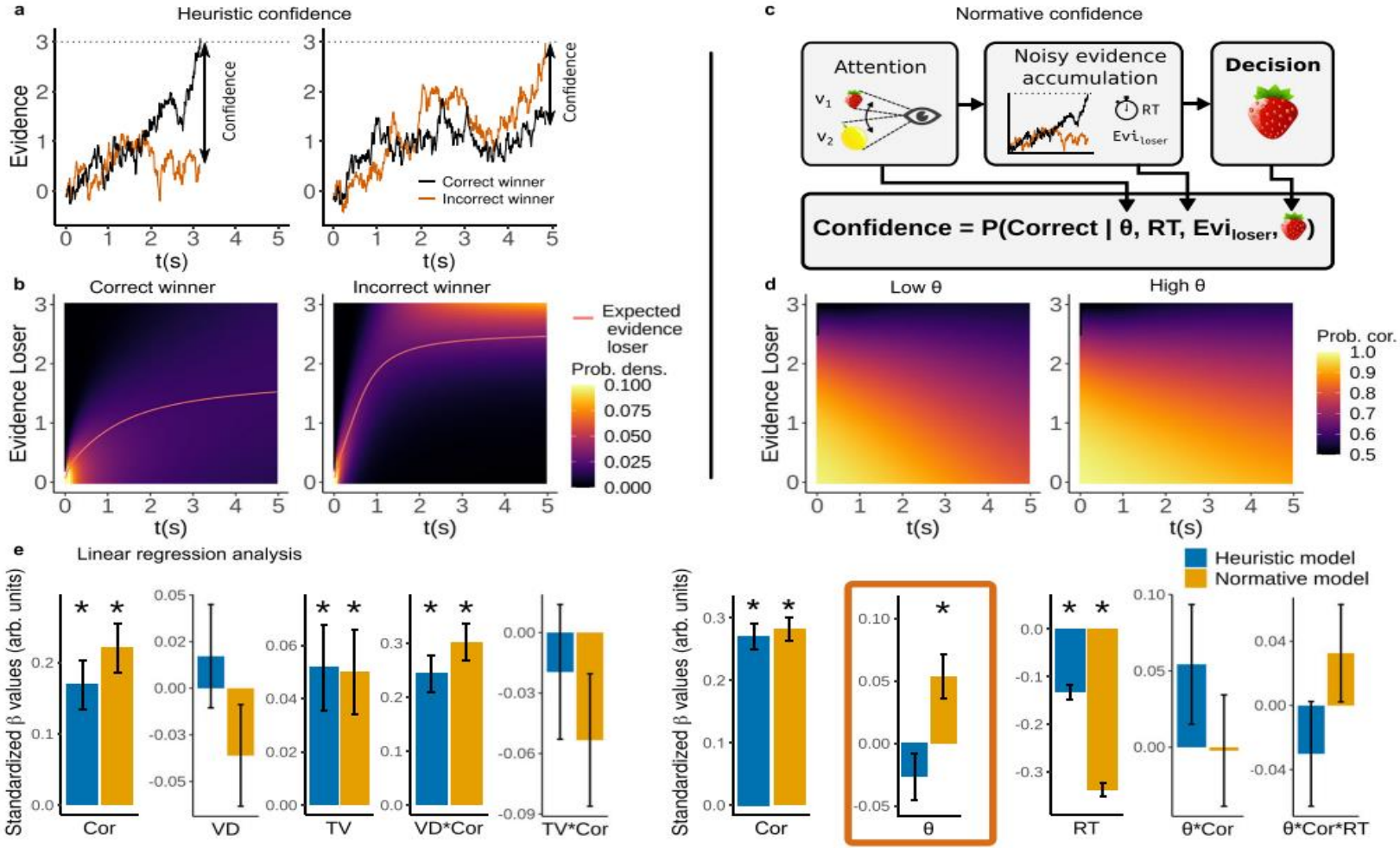
Introduces two families of generative models, heuristic and normative, to explore dynamic aspects of the decision process and their impact on confidence reports in value-based choices.

Model Comparison

Contrasts the heuristic and normative models to understand their predictive power and reliability in explaining confidence reports.

Statistical Inference

Utilizes the models to infer the relationship between decision variables, attentional factors, and confidence, shedding light on the underlying mechanisms of confidence in value-based decisions.


a
Heuristic confidence
Evidence
Confidence
Correct winner
Incorrect winner
t(s)
b
Correct winner
Incorrect winner
Evidence Loser
Expected evidence loser
Prob. dens.
0.100
0.075
0.050
0.025
0.000
c
Normative confidence
Attention
Noisy evidence accumulation
Decision
RT
Evi loser
Confidence = P(Correct | θ, RT, Evi loser,)
d
Low θ
High θ
Evidence Loser
Prob. cor.
1.0
0.9
0.8
0.7
0.6
0.5
e
Linear regression analysis
Heuristic model
Normative model
Standardized β values (arb. units)
Cor
VD
TV
VD*Cor
TV*Cor
θ
RT
θ*Cor
θ*Cor*RT

Joint Modeling Approach

Methodology Overview

Describes how the joint modeling approach correlates confidence reports with decision model parameters. It allows for a comprehensive analysis of the relationship between confidence and key decision variables.

Advantages

Highlights the benefits of the joint modeling approach in capturing trial-to-trial fluctuations in decision-making processes. It provides insights into the dynamic nature of attentional effort and its impact on confidence.

Statistical Analysis

Utilizes statistical methods to analyze the interplay between confidence reports and decision model parameters. It offers a systematic way to understand how attentional factors influence confidence in value-based choices.

Normative Model Predictions

Higher Confidence with Increased Attentional Effort

The normative model predicts that as attentional effort increases during the decision process, confidence levels also rise. This finding aligns with the statistical definition of confidence, where higher attentional effort correlates with higher confidence judgments.

Statistical Definition of Confidence

Confidence reflects an optimal estimate that the decision was correct and is directly influenced by the level of attentional effort exerted during the decision-making process.

Implications for Decision-Making

Understanding the role of attentional effort in confidence can lead to improved decision-making strategies and metacognitive awareness in value-based choices.

Random Utility Model (RUM) Analysis

Incorporating Attentional Factors

Integrating attentional factors into the Random Utility Model (RUM) to examine how confidence impacts trial-to-trial variations in attentional effort and evidence gain during decision-making.

Understanding Confidence Dynamics

Exploring the interplay between confidence levels and attentional effort within the RUM framework to analyze the influence on decision processes and metacognitive awareness.

Model Validation

Validating the RUM model with attentional factors to assess its ability to capture the dynamic nature of attentional effort and its impact on confidence reports in value-based choices.

Efficient Coding Model

Mechanistic Understanding

Incorporates a probabilistic inference process to capture encoding and decoding operations in value-based decisions. Considers the environment's prior distribution, encoding noise, and downstream comparison noise.

Relationship to Confidence

Reveals that confidence reports are strongly related to downstream comparison noise, but unrelated to trial-to-trial fluctuations in encoding precision of reward values. Shows attentional effort significantly influences confidence judgments.

Model Predictions

Predicts that confidence is influenced by attentional effort and downstream noise, highlighting the dynamic interplay between decision processes and metacognitive awareness.

Attentional Effort Dynamics

1

Attentional effort is not a static characteristic but fluctuates significantly from trial to trial.

2

These fluctuations in attentional effort have a notable impact on both decision-making processes and confidence reports.

3

Participants can introspect about their attentional states during decision-making, influencing their confidence judgments based on the level of attentional effort exerted.

Confidence and Encoding Noise

1. Trial-to-trial fluctuations in encoding precision of reward values do not impact confidence reports.

2. Downstream comparison noise has a significant influence on confidence evaluations, indicating a dissociation between encoding noise and comparison noise.

3. Confidence appears to be more sensitive to the noise that occurs after the decoding stage of the decision process, rather than the noise in encoding the input values.

Discussion: Attention and Confidence

Humans can introspect about their attentional states during decisions, impacting confidence reports.

The fluctuation of attentional effort from trial to trial suggests a dynamic nature of attention during decision-making.

The findings extend beyond value-based decisions, indicating implications for refining models of metacognitive distortions in psychiatric disorders.

Future Directions

1

Explore the role of confidence in perceptual decision-making tasks to understand how confidence mechanisms differ across decision domains.

2

Investigate the impact of confidence on decision-making processes in individuals with psychiatric disorders to enhance understanding of metacognitive distortions in these populations.

3

Consider cross-domain studies to compare confidence mechanisms in value-based choices and perceptual decisions for a comprehensive understanding of metacognitive processes.

Conclusion

1

Understanding confidence origins enhances decision-making models

2

Insights from value-based choices contribute to metacognitive awareness

3

Significance of unraveling confidence sources for cognitive processes