



Evaluating Point and Range Predictions Under Epistemic vs. Aleatory Uncertainty

Eitan D. Rude, Craig R. Fox, Hal E. Hershfield

UCLA Anderson



Motivation

Motivation



Photo Credit: Alex Brandon/AP

Motivation

The Washington Post

Winter is coming: What 5 experts are forecasting for D.C. – and why.

By [Dan Stillman](#) and [Ian Livingston](#)

October 31, 2023 at 11:45 a.m. EDT



Photo Credit: Alex Brandon/AP

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Snowfall forecasts

All five forecasts are for near or above-average snowfall. Washington's seasonal average is 13.7 inches.

- Judah Cohen, Verisk AER: 13.3 inches
- Todd Crawford, Atmospheric G2: 16 inches
- Paul Dorian, Arcfield Weather: 20 to 30 inches
- Paul Pastelok, AccuWeather: 14 to 18 inches
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Point Predictions

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Range Predictions

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Motivation

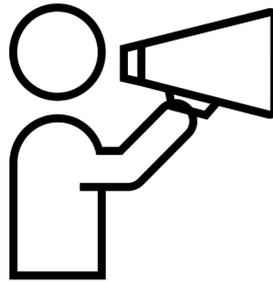


Financial Forecasts

Motivation



Financial Forecasts

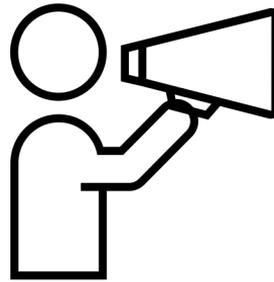


Advertising Claims

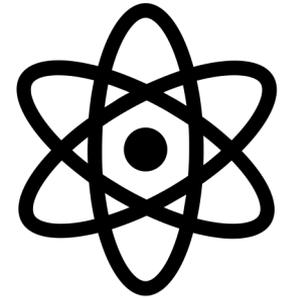
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Financial Forecasts



Advertising Claims



Scientific Communications

*Which types of expert forecasts are more credible:
point predictions or range predictions?*

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point predictions or range predictions?*



Expertise, trustworthiness,
competence, etc.
(e.g., Pornpitakpan, 2004)

Perspectives from Prior Research

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- **Overconfidence:** Over-precise point predictions may bolster experts' perceived credibility (Anderson et al., 2012; Price & Stone, 2004; Radzevick & Moore, 2011)

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vs.

- **Communication of Uncertainty:** Experts providing range predictions may appear to be more credible in certain contexts, or – at a minimum – they may not necessarily be deemed *less* credible (Du et al., 2011; Gaertig & Simmons, 2017, 2023; Gustafson & Rice, 2019; Howe et al., 2019; Joslyn & LeClerc, 2012, 2016; van der Bles et al., 2020)

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Can these findings be reconciled by considering the **perceived nature of uncertainty**?

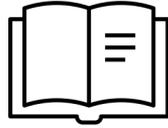
Considering the Perceived Nature of Uncertainty

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- People intuitively distinguish between two dimensions of subjective uncertainty (Fox & Ülkümen, 2011; Ülkümen et al., 2016):

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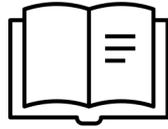


Epistemic (Knowable) Uncertainty

Missing knowledge, skill,
and/or information

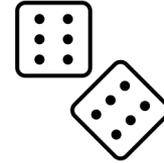
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Epistemic (Knowable) Uncertainty

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Aleatory (Random) Uncertainty

Chance or stochastic
processes

*Which types of expert forecasts are more credible:
point predictions or range predictions?*

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Our question:

When are experts' point predictions versus range predictions deemed more or less credible?

Key Predictions

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Credibility of experts providing point versus range predictions will depend on the perceived nature of uncertainty

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- 2 Point and range predictions communicate different things under different forms of perceived uncertainty

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Point and range predictions communicate different things under different forms of perceived uncertainty (**Study 4**)

Key Predictions

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Credibility of experts providing point versus range predictions will depend on the perceived nature of uncertainty (**Studies 1-3**)

- **Epistemic (Knowable) Uncertainty:** Narrower Points > Wider Ranges

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Point and range predictions communicate different things under different forms of perceived uncertainty (**Study 4**)

Key Predictions

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Credibility of experts providing point versus range predictions will depend on the perceived nature of uncertainty (**Studies 1-3**)

- **Epistemic (Knowable) Uncertainty:** Narrower Points > Wider Ranges
- **Aleatory (Random) Uncertainty:** Narrower Points < Wider Ranges

2

Point and range predictions communicate different things under different forms of perceived uncertainty (**Study 4**)

Study 1: Correlational Results ($N = 299$; MTurk)



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Preferences

Study 1: Correlational Results ($N = 299$; MTurk)

Preferences

You are looking to hire a financial advisor You talk to two advisors, and ask both of them how much of a return you can expect to realize in 10 years' time if you invest \$2,500 in NexusTech...

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Advisor P
(1)

Which advisor provided...

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...a more credible estimate?	<input type="radio"/>					

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...a more credible estimate?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...a more accurate estimate?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...an estimate reflecting more careful thought?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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...a more honest estimate?	<input type="radio"/>					

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...a more honest estimate?	<input type="radio"/>					
...a more realistic estimate?	<input type="radio"/>					

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Preferences

You are looking to hire a financial advisor to advise you on how to invest \$2,500 in NexusTech. You ask two different advisors, and ask both of them how much of a return you can expect to realize in 10 years' time. Advisor P tells you that "If you invest \$2,500 in NexusTech now, you should expect the value of your holdings to be \$6,000 in 10 years' time." Advisor R tells you that "If you invest \$2,500 in NexusTech now, you should expect the value of your holdings to be \$5,000 to \$7,000 in 10 years' time."

Preferences
($\alpha = 0.93$)

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...a more honest estimate?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...a more realistic estimate?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Epistemic-Aleatory Ratings Scale (EARS; Fox et al., 2021)

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The 10-year return from an investment in NexusTech...

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at all
(1)***

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The 10-year return from an investment in NexusTech...	<i>Not at all</i> (1)	<i>Very much</i> (7)
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E1 ...is knowable in advance, given enough information

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E1 ...is knowable in advance, given enough information

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E2	...is something that becomes predictable with additional knowledge or skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
E3	...is something that well-informed people would agree on	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Epistemicness
($\alpha = 0.85$)

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A1	...is determined by chance factors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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A1	...is determined by chance factors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A2	...could play out in different ways on similar occasions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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A2	...could play out in different ways on similar occasions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A3	...is something that has an element of randomness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Aleatoriness
($\alpha = 0.84$)

Study 1: Correlational Results ($N = 299$; MTurk)



Preferences

Study 1: Correlational Results ($N = 299$; MTurk)



Preferences ~ (Aleatoriness – Epistemicness)

Study 1: Correlational Results ($N = 299$; MTurk)

Preferences ~ ("Randomness" – "Knowableness")

Study 1: Correlational Results ($N = 299$; MTurk)

Preferences ~ (Aleatoriness – Epistemicness)

Scenarios

- 1 Investment Forecasts

Study 1: Correlational Results ($N = 299$; MTurk)

Preferences ~ (Aleatoriness – Epistemicness)

Scenarios

- 1 Investment Forecasts
- 2 Contractor Bids

Study 1: Correlational Results ($N = 299$; MTurk)

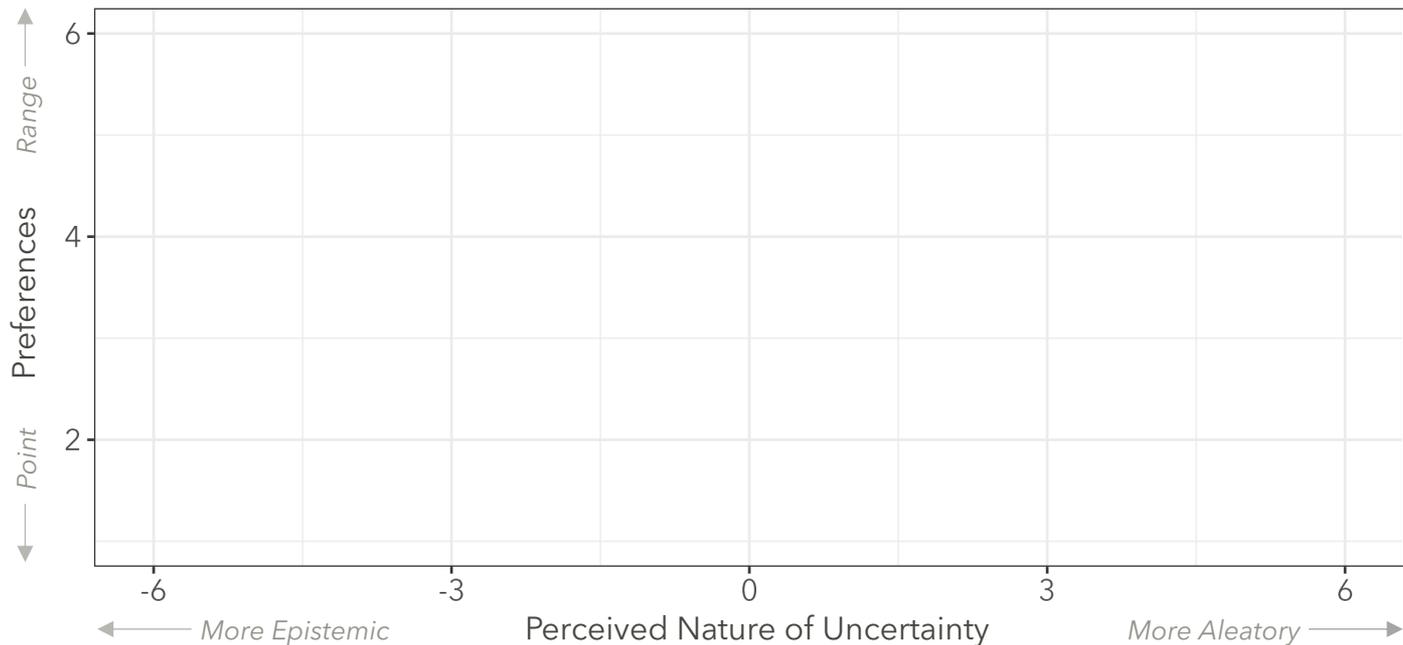
Preferences ~ (Aleatoriness – Epistemicness)

Scenarios

- 1 Investment Forecasts
- 2 Contractor Bids
- 3 Climate Projections

Study 1: Correlational Results ($N = 299$; MTurk)

Investment Forecasts

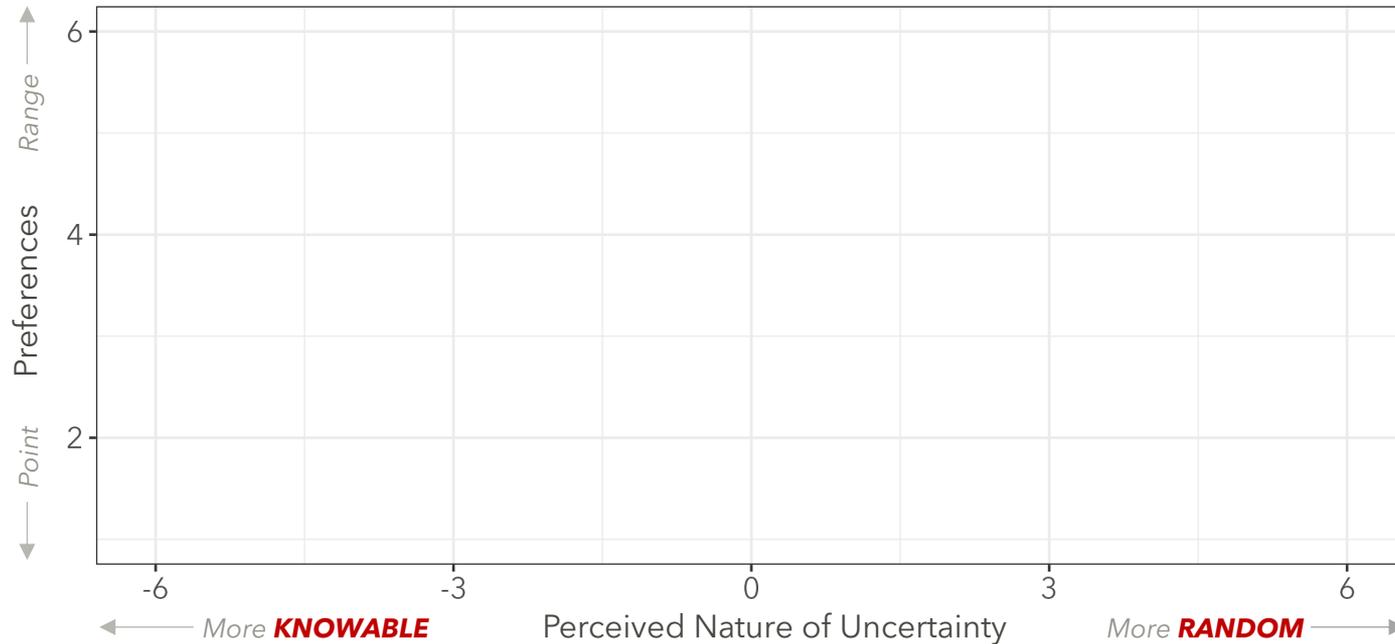


Contractor Bids

Climate Projections

Study 1: Correlational Results ($N = 299$; MTurk)

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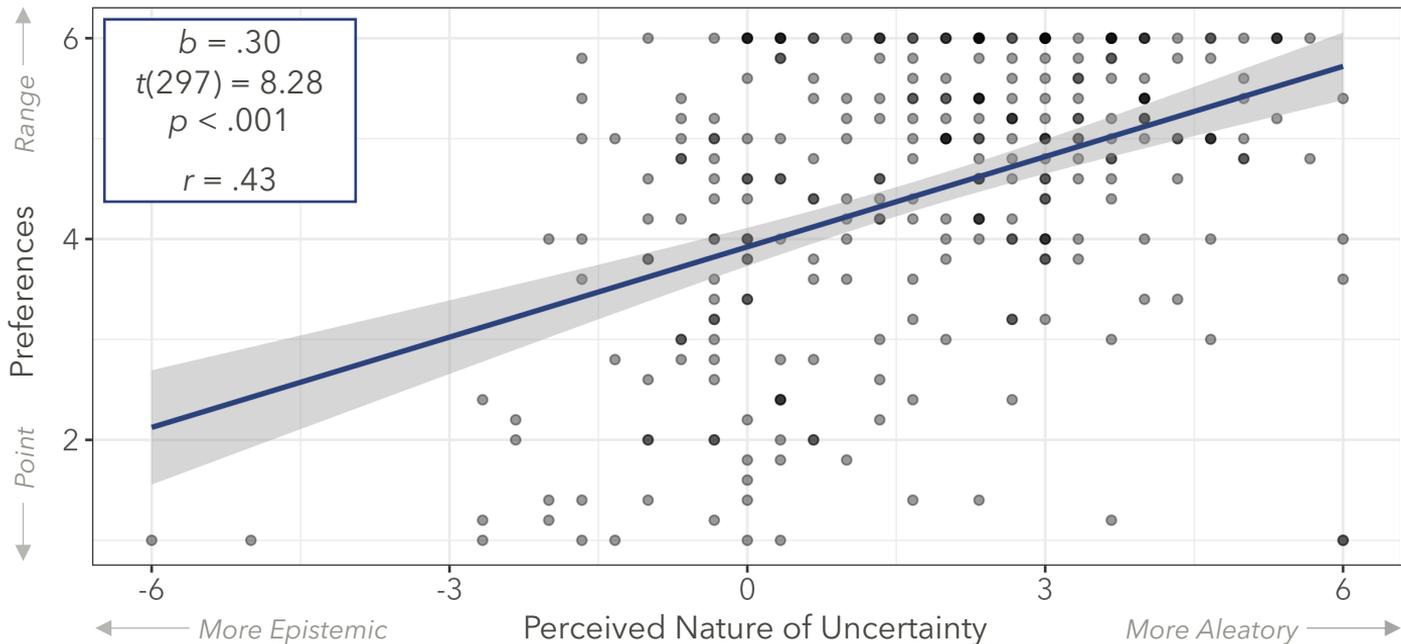


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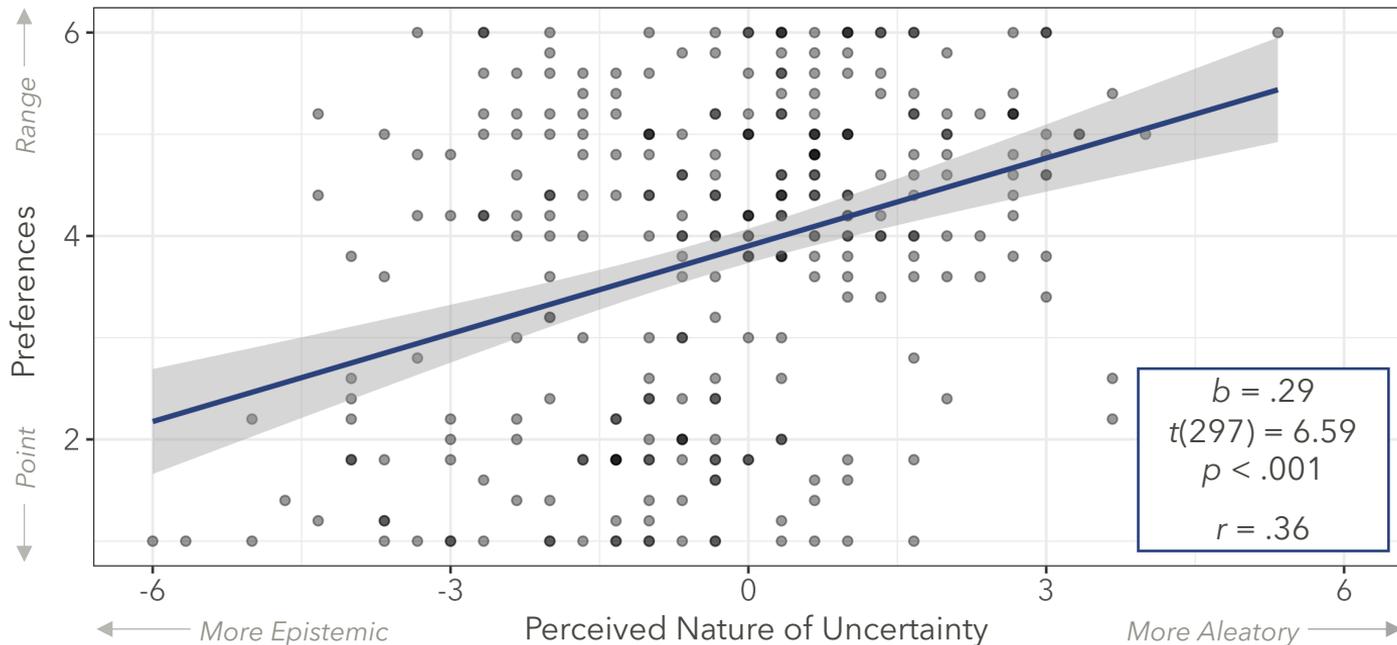
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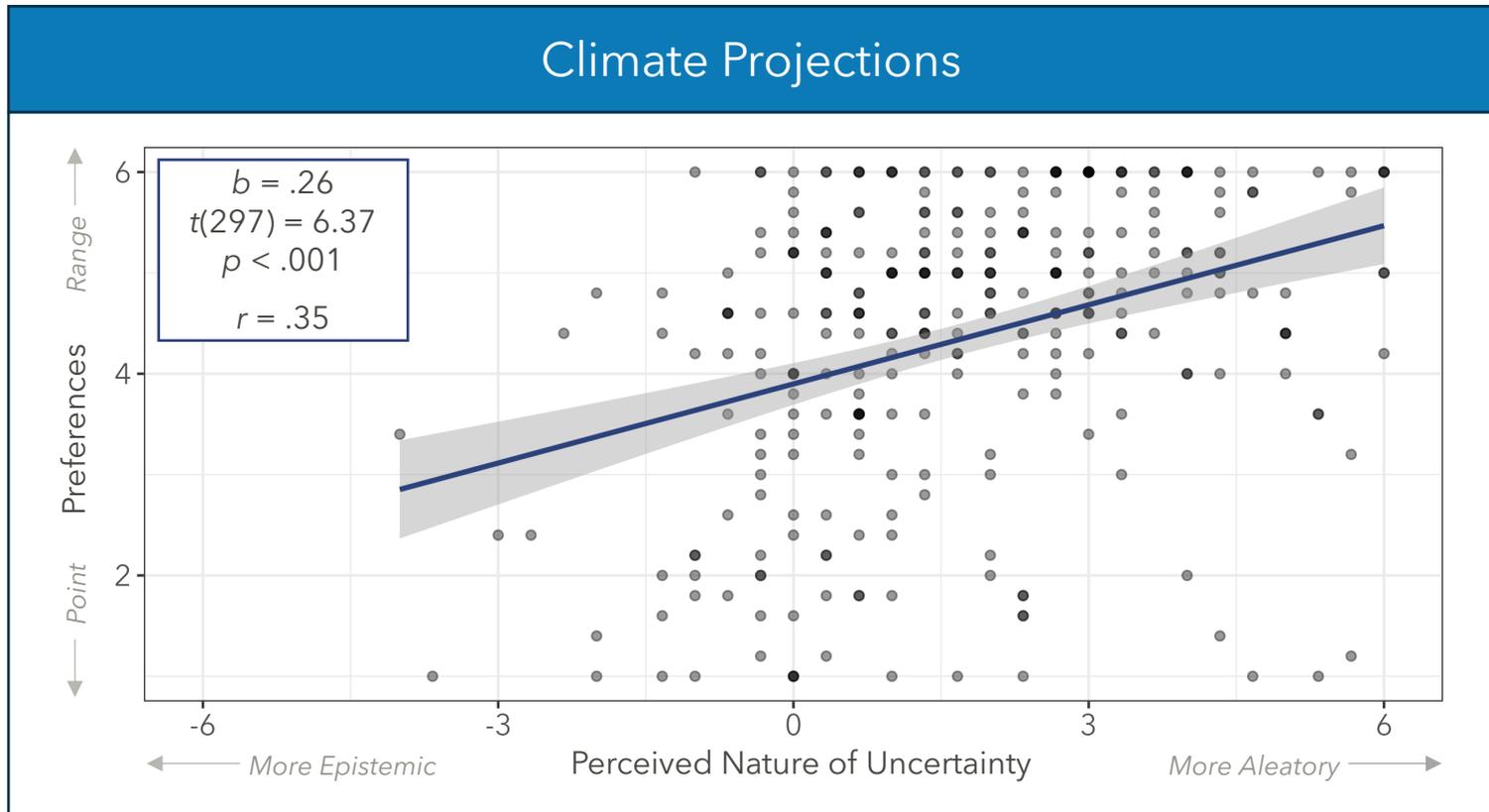


Climate Projections

Study 1: Correlational Results ($N = 299$; MTurk)

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Contractor Bids



Study 2: Visual Manipulation of E/A (N = 700; MTurk)



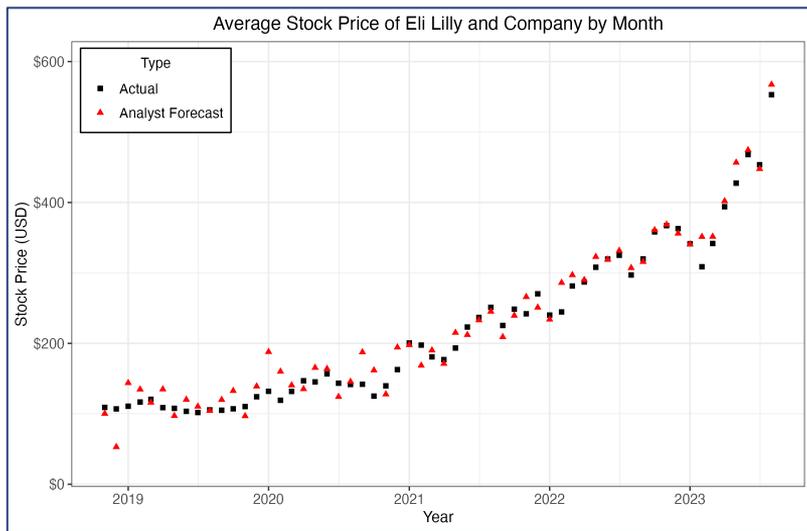
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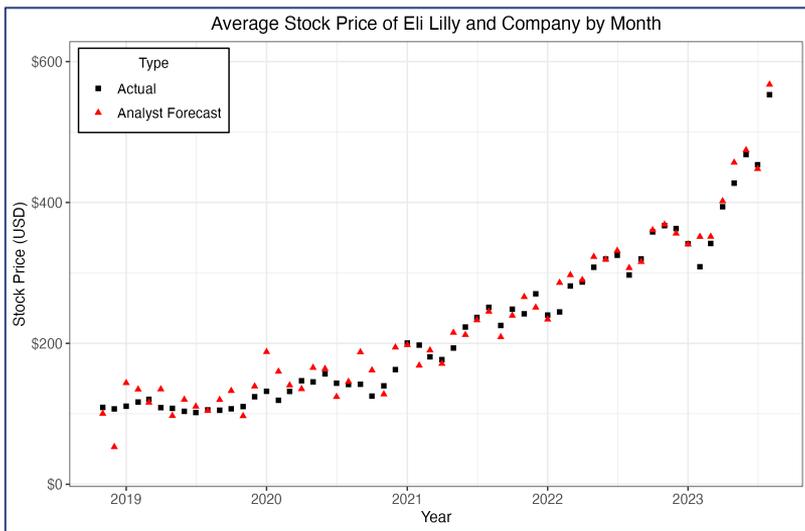
Absolute Change = Epistemic



Study 2: Visual Manipulation of E/A (N = 700; MTurk)

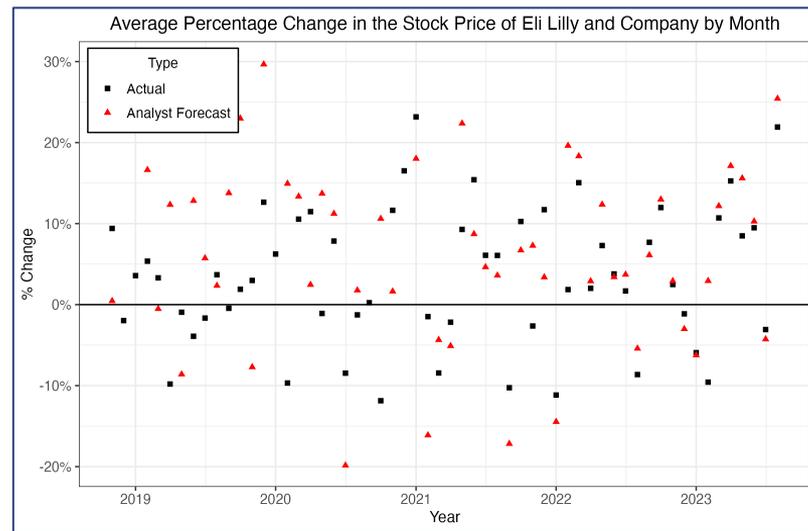
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Absolute Change = Epistemic



or

Relative Change = Aleatory





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Each candidate responded as follows:

- Candidate P: \$575

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- Candidate P: \$575
- Candidate R1: \$565 to \$585
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Preferences

Which candidate do you think is the most credible?

- Candidate P
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Which candidate do you think is the most credible?

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Which candidate do you think is the most credible?

Which candidate do you think is the most competent?

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Which candidate do you think is the most thoughtful?

Which candidate do you think is the most trustworthy?

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$\alpha = 0.95$

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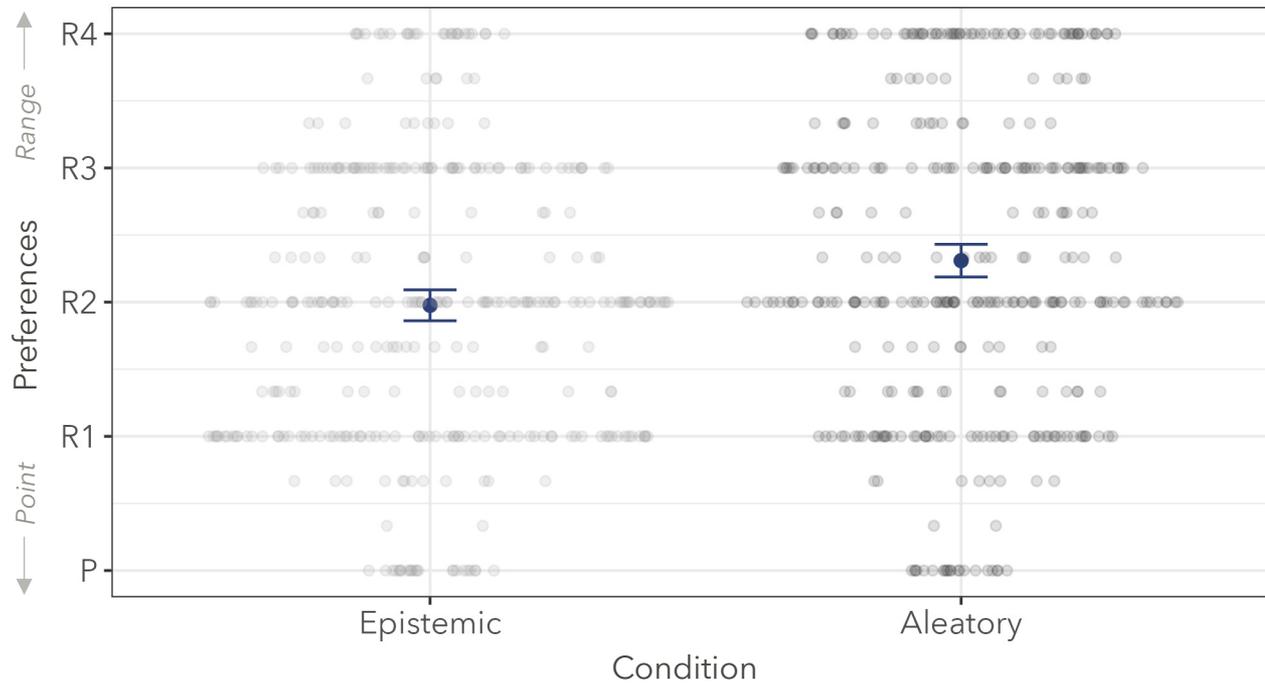
Choice

Which candidate do you think you would like to hire?

- Candidate P
- Candidate R1
- Candidate R2
- Candidate R3
- Candidate R4

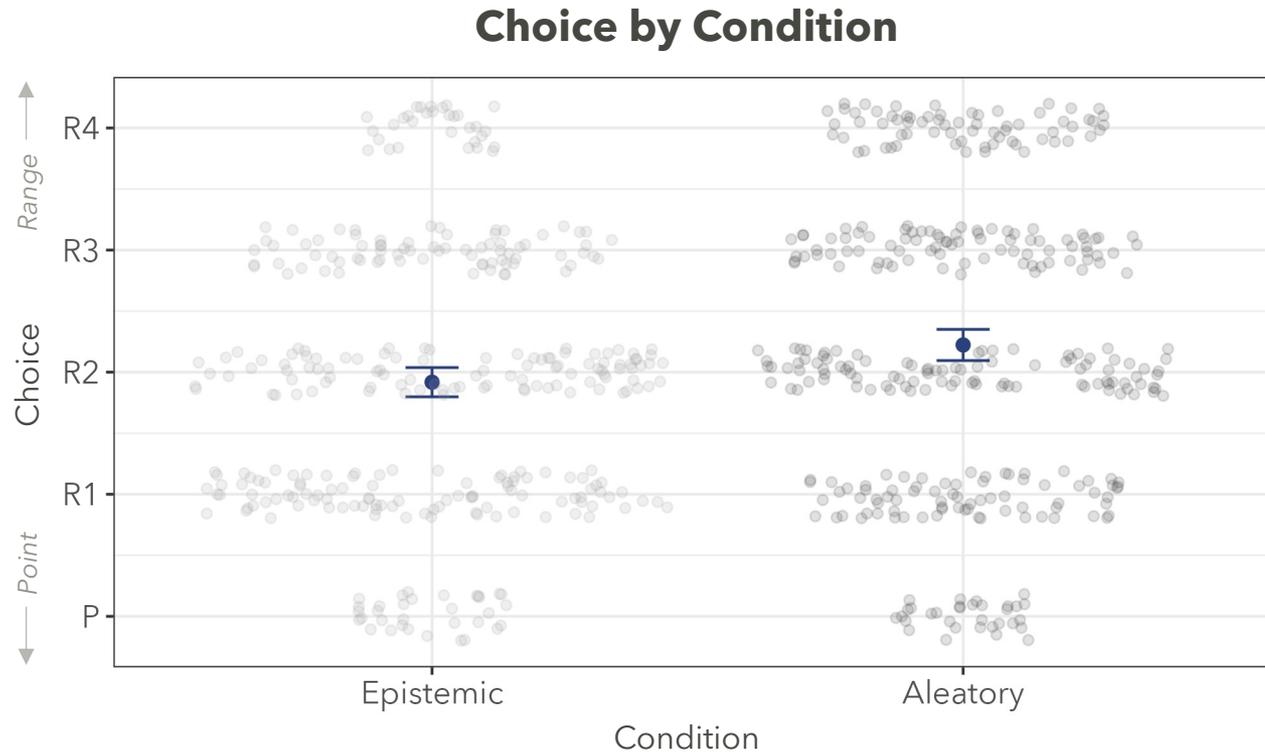
Study 2: Visual Manipulation of E/A (N = 700; MTurk)

Preferences by Condition



- Effect of Condition:
 $b = .33$, $t(698) = 3.89$,
 $p < .001$

Study 2: Visual Manipulation of E/A (N = 700; MTurk)



- Effect of Condition:
 $b = .30$, $t(698) = 3.42$,
 $p < .001$

Studies 3A/3B: Text Manipulation of E/A

($N_{3A} = 367$, MTurk; $N_{3B} = 592$, Prolific)

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Study 3A: Court Settlements

- **Event:** Forecasted size of an out-of-court settlement in a traffic accident case with the help of counsel
- **Predictions:**
 - Point: \$5,000
 - Range: \$4,000 to \$6,000

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- **Event:** Forecasted weight loss following the completion of a personal trainer's fitness program
- **Predictions:**
 - Point: 20lbs
 - Range: 16lbs to 24lbs

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 - Range: 16lbs to 24lbs

- Participants then responded to measures adapted from Study 1 (1 = Point; 6 = Range):
 - Preferences
 - Choice

Studies 3A/3B: Text Manipulation of E/A

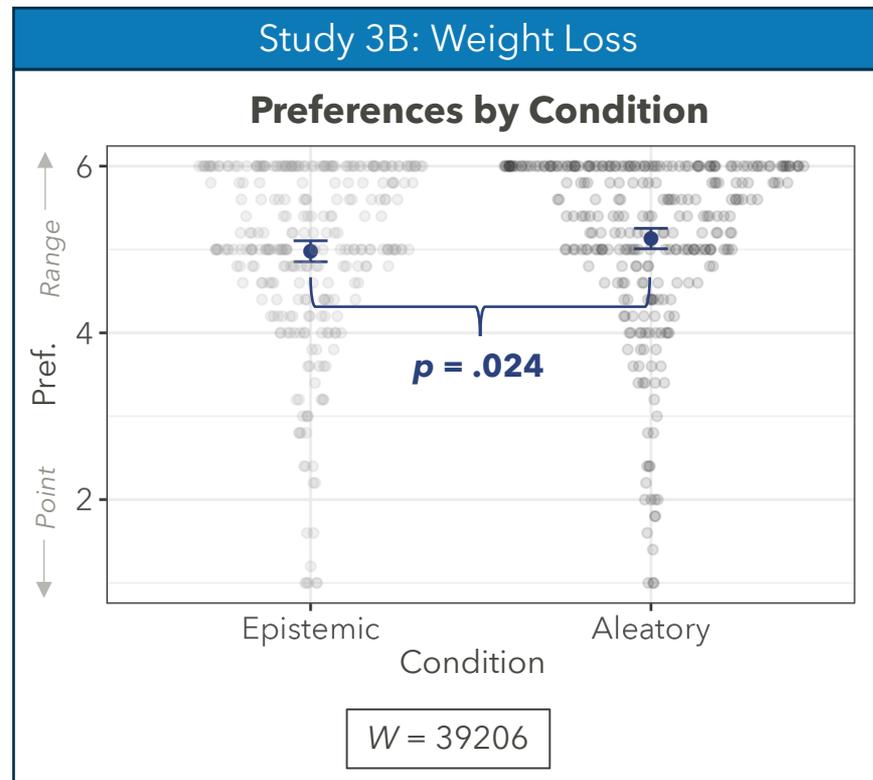
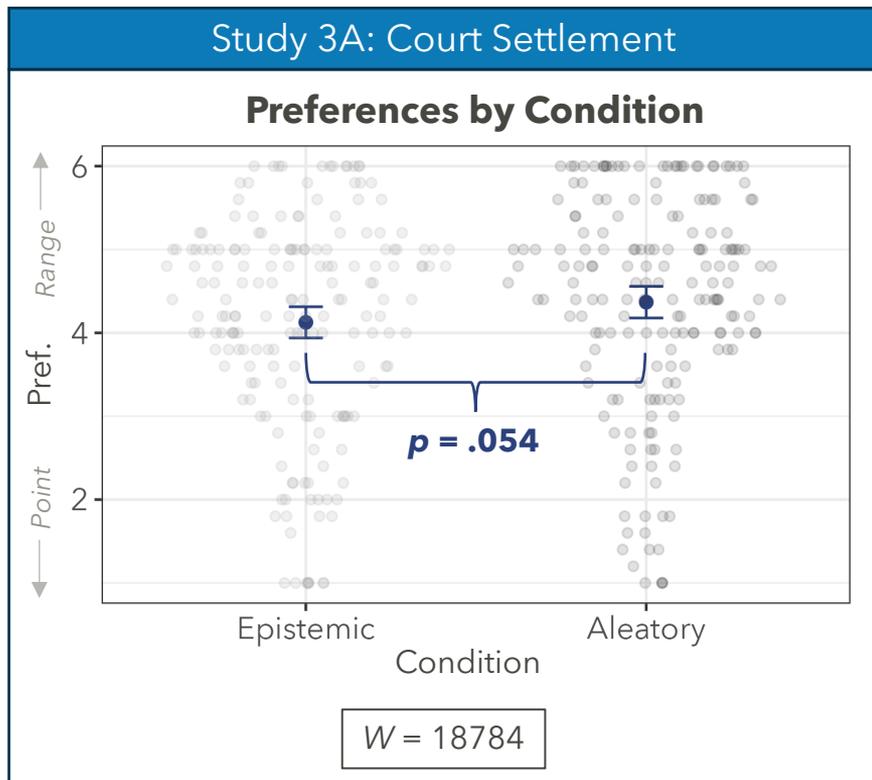
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Study 3A: Court Settlement

Study 3B: Weight Loss

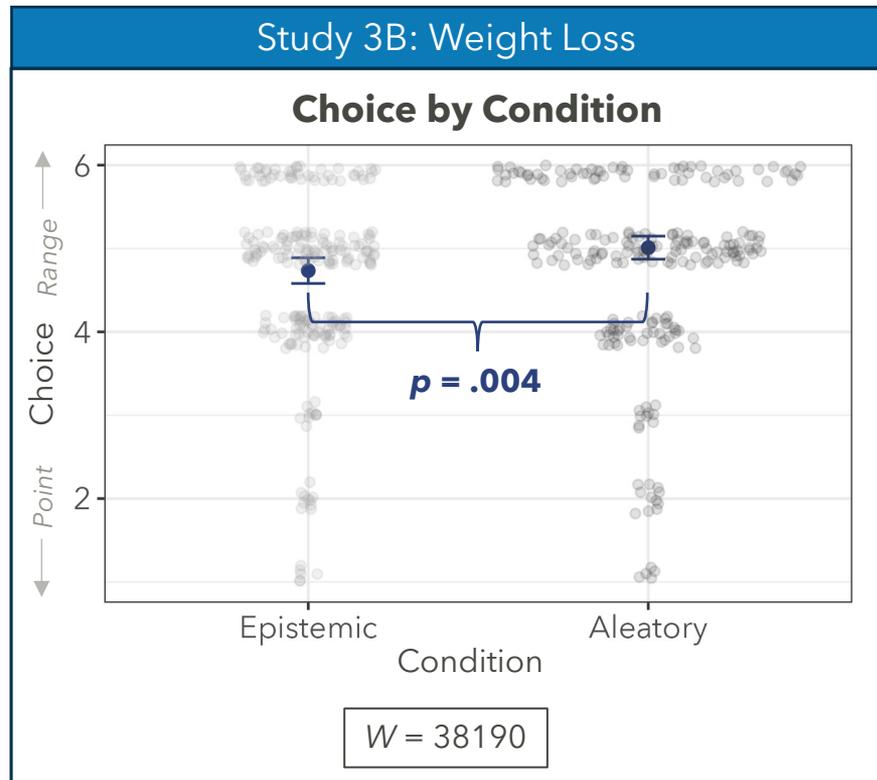
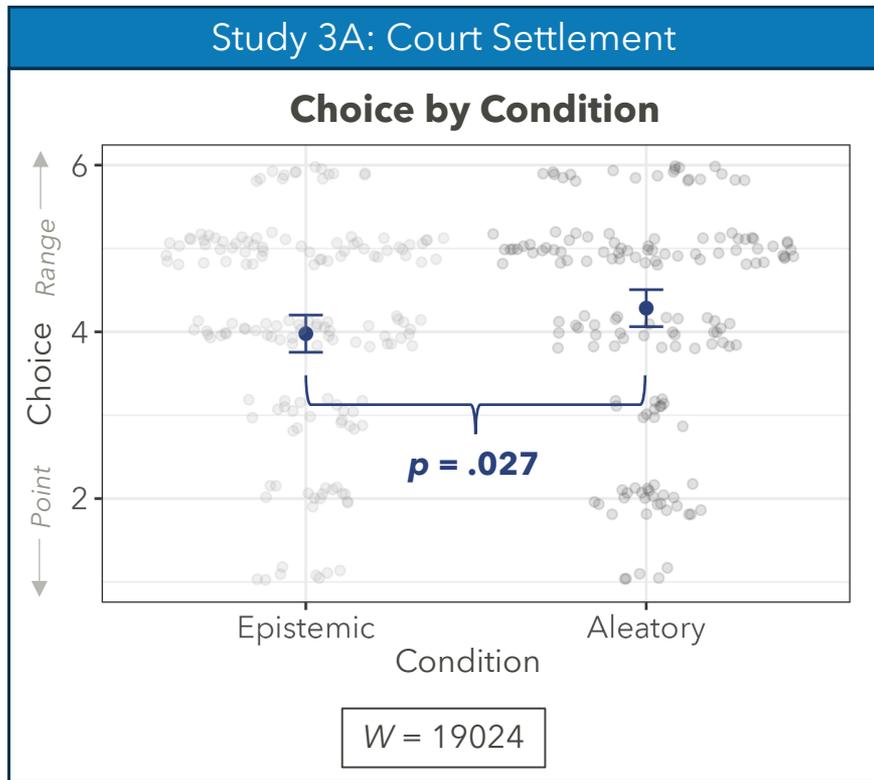
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Key Predictions

1

Credibility of experts providing point versus range predictions will depend on the perceived nature of uncertainty (**Studies 1-3**)

- **Epistemic (Knowable) Uncertainty:** Narrower Points > Wider Ranges
- **Aleatory (Random) Uncertainty:** Narrower Points < Wider Ranges

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Point and range predictions communicate different things under different forms of perceived uncertainty (**Study 4**)

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- **Epistemic (Knowable) Uncertainty:** Confidence

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Point and range predictions communicate different things under different forms of perceived uncertainty (**Study 4**)

- **Epistemic (Knowable) Uncertainty:** Confidence
- **Aleatory (Random) Uncertainty:** Confidence + Distributional Information

Study 4 ($N = 199$, MTurk)



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- Participants considered judgments about the total number of points scored in two NBA Finals games between the Denver Nuggets and the Miami Heat

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June 12th (Day)



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We asked five people who watched ***this past Friday's*** NBA finals game...to tell us how many points...were scored by [both teams, in total]:

- Person P: 203 points [**Actual Outcome**]
- Person R1: 200 to 205 points
- Person R2: 190 to 220 points
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We asked five people who plan to watch ***tonight's*** NBA finals game...to tell us how many points they think will be scored [by both teams, in total]:

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Evaluations

Please carefully evaluate this person on the following dimensions

Study 4 ($N = 199$, MTurk)

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Not at all
(1)

Extremely
(7)

How credible is this person?

Study 4 ($N = 199$, MTurk)

Evaluations

Please carefully evaluate this person on the following dimensions

	<i>Not at all</i> (1)					<i>Extremely</i> (7)	
How credible is this person?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How competent is this person?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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How competent is this person?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How knowledgeable is this person?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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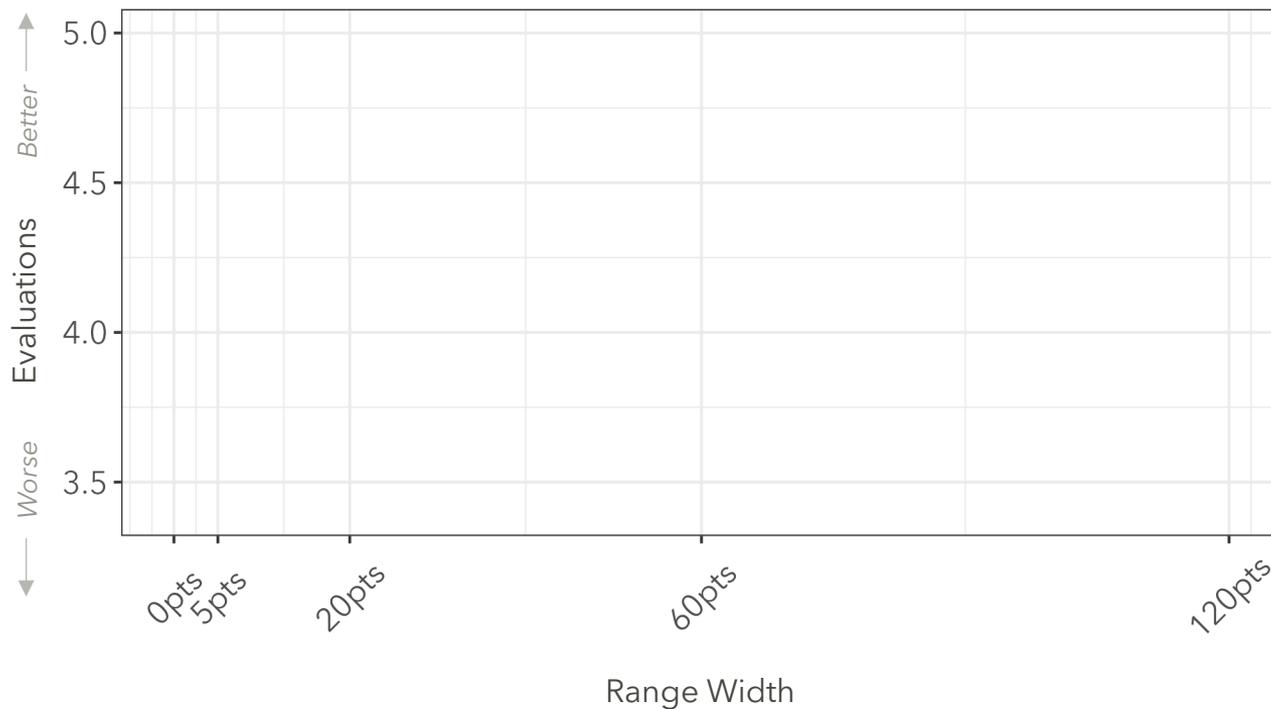
	Not at all			Extremely			
	(1)			(7)			
How credible is this person?	<input type="radio"/>						
How competent is this person?	<input type="radio"/>						
How knowledgeable is this person?	<input type="radio"/>						

Evaluation Score for each Judge
($\alpha = 0.95$)

Study 4 ($N = 199$, MTurk)

Evaluations by Condition

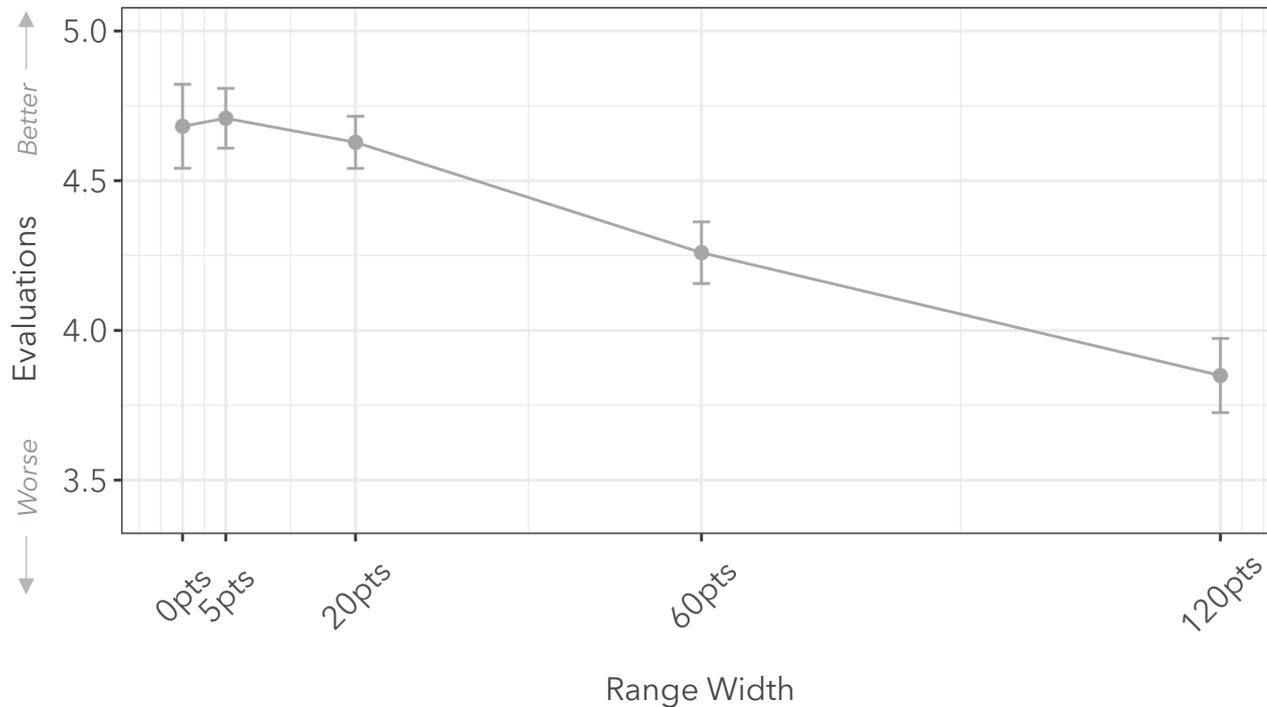
Grey = Epistemic, **Blue** = Aleatory



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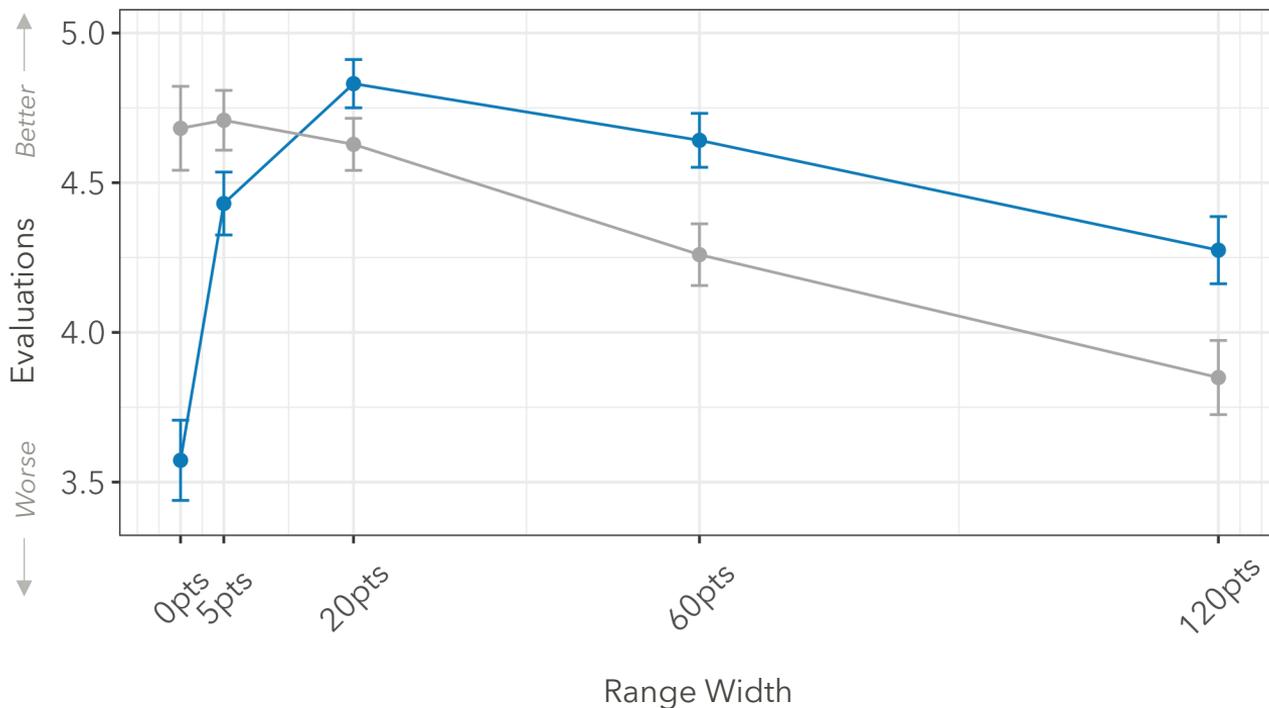


- Effect of Width:
 $b = -.007, p = .113$
- Model: OLS regression with participant fixed effects and standard errors clustered by participant

Study 4 (N = 199, MTurk)

Evaluations by Condition

Grey = Epistemic, **Blue** = Aleatory



- Effect of Width²:
 $b = -.0002, p < .001$
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 $b = -.007, p = .113$
- Condition x Width²:
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- Can help to explain inconsistent findings in the literature regarding evaluations of different numerical predictions
- Suggests that ranges are subject to different interpretations based on the perceived nature of uncertainty

- **Practical Implications**

- Experts should consider the perceived nature of uncertainty when offering judgments about various types of events

UCLA Anderson

Thank you!

Please direct any questions or feedback to:
eitan.rude.phd@anderson.ucla.edu