



Evaluating Point and Range Predictions Under Epistemic vs. Aleatory Uncertainty

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

UCLA Anderson



Motivation

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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



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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
- Matt Rogers, Commodity Weather Group: 15 inches

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Point Predictions

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Range Predictions

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Motivation

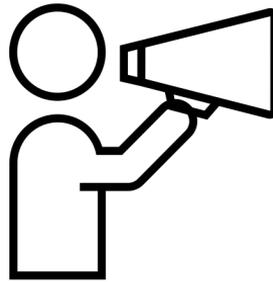


Financial Forecasts

Motivation



Financial Forecasts

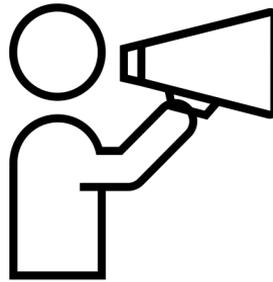


Advertising Claims

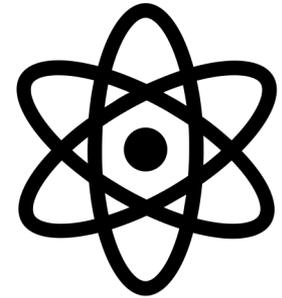
Motivation



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**?

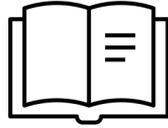
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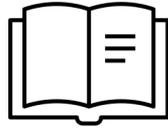


Epistemic (Knowable) Uncertainty

Missing knowledge, skill,
and/or information

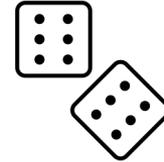
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Epistemic (Knowable) Uncertainty

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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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point predictions or range predictions?~~

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

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

2

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

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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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Which advisor provided...	Advisor P (1)			Advisor R (6)		
...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 financial 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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...an estimate reflecting more careful thought?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...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...

***Not
at all
(1)***

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	<i>Not at all</i>	<i>Very much</i>
The 10-year return from an investment in NexusTech...	(1)	(7)

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(1)

***Very
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(7)

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

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

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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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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"/>
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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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"/>
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"/>
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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E2	...is something that becomes predictable as you gain more 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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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

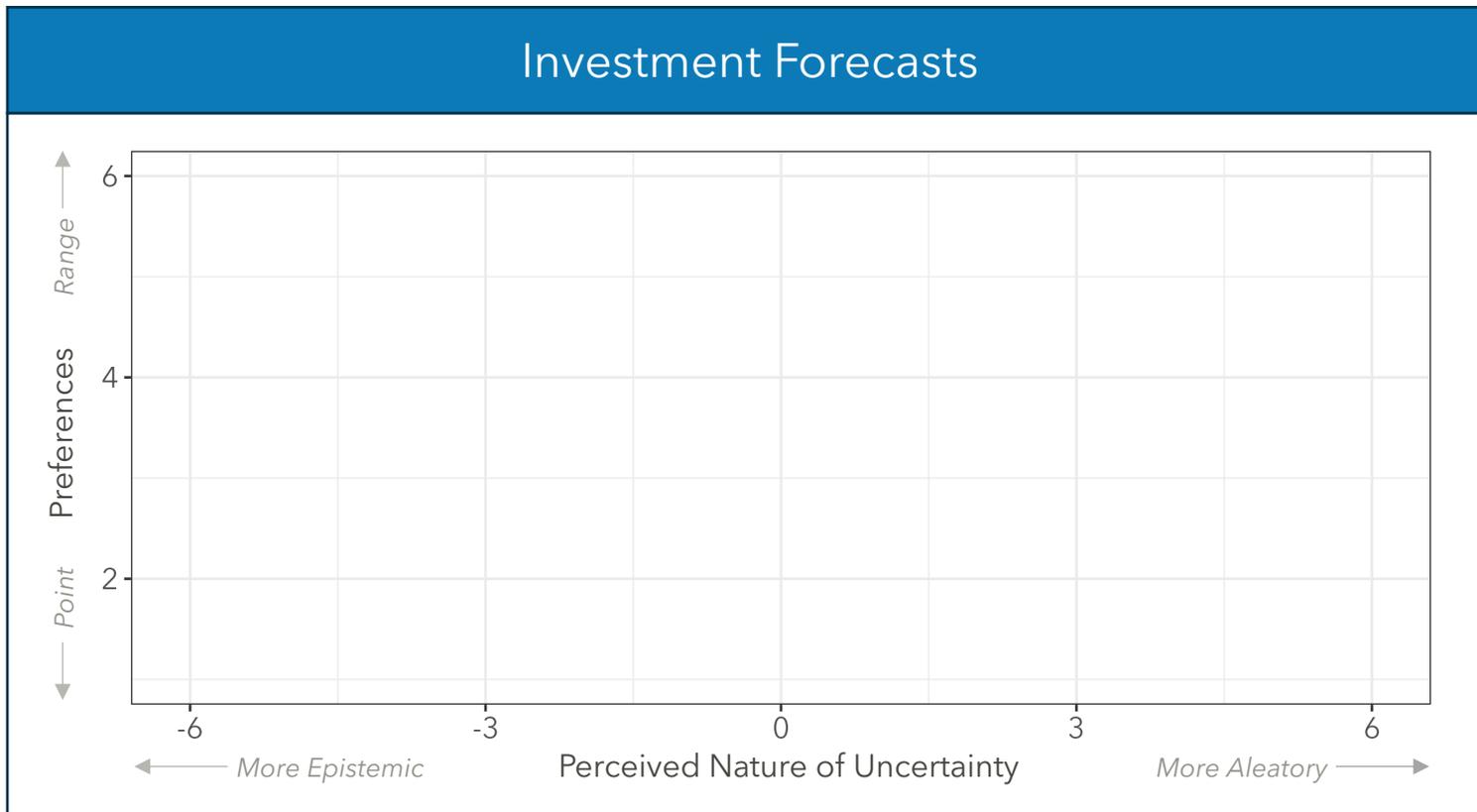
Study 1: Correlational Results ($N = 299$; MTurk)

Preferences ~ (Aleatoriness – Epistemicness)

Scenarios

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

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



Contractor Bids

Climate Projections

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

Investment Forecasts

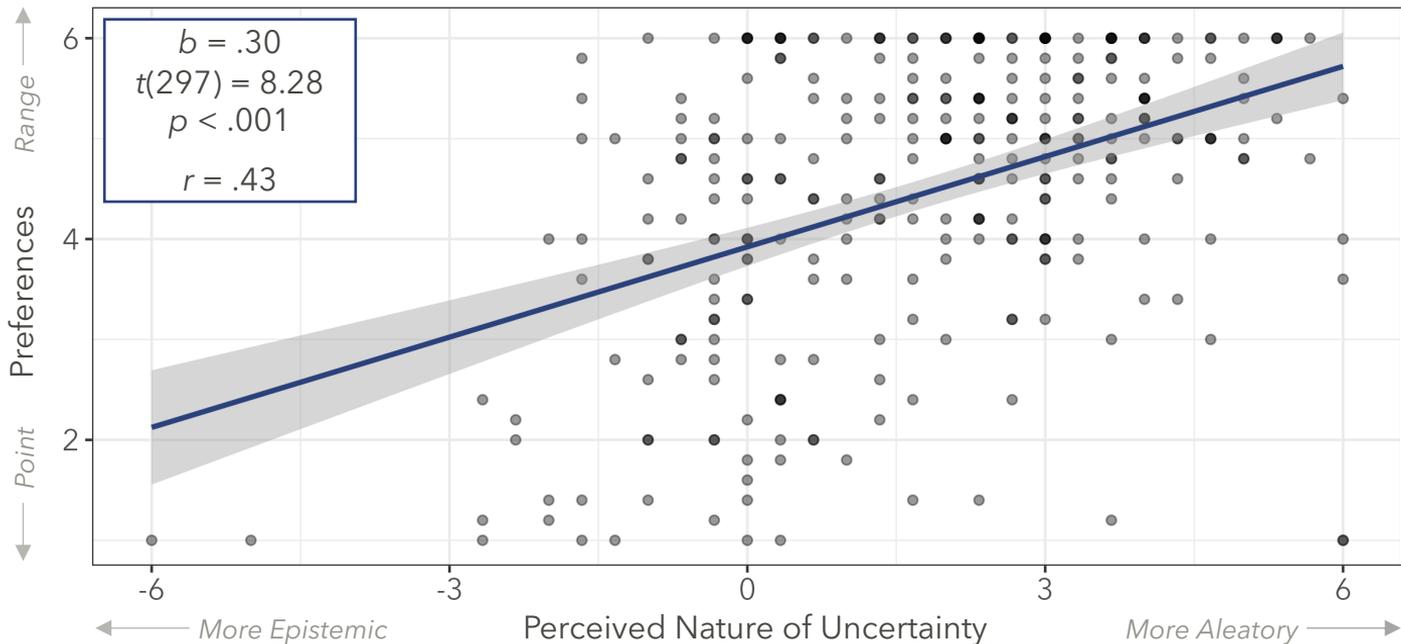


Contractor Bids

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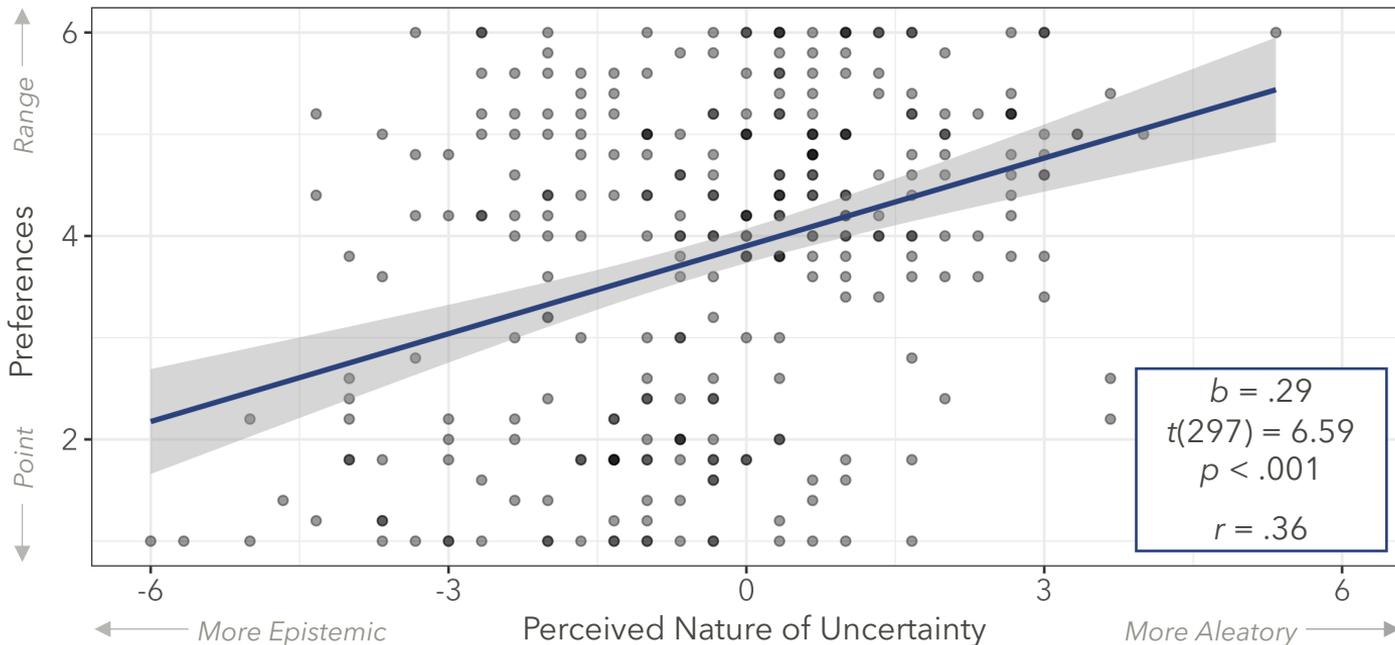


Contractor Bids

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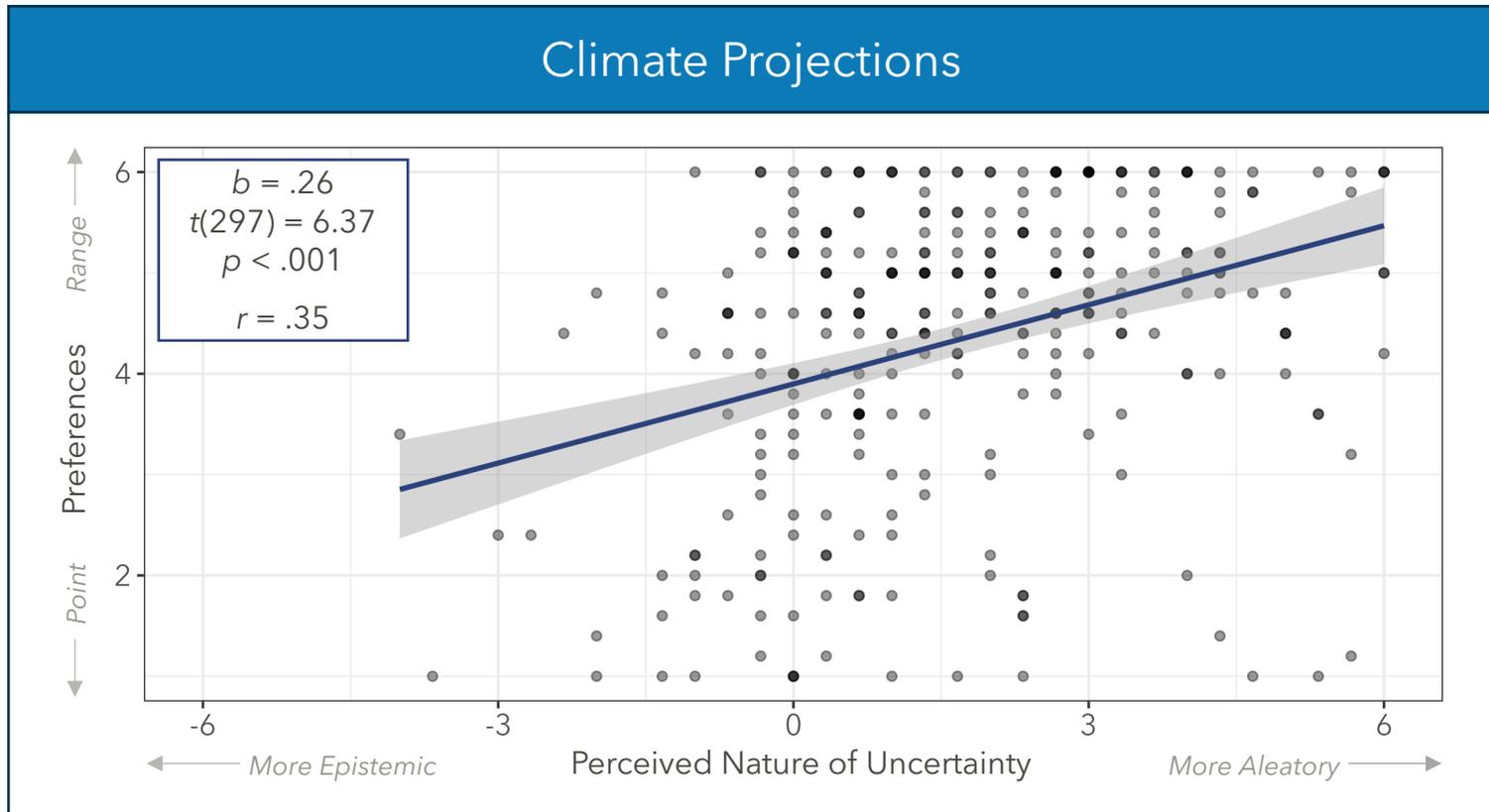
Contractor Bids



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

Investment Forecasts

Contractor Bids



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



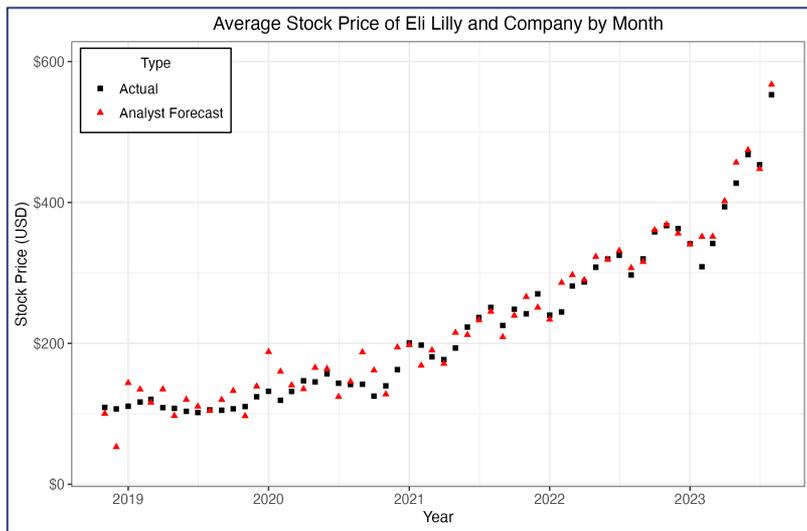
Study 2: Visual Manipulation of E/A (N = 700; MTurk)

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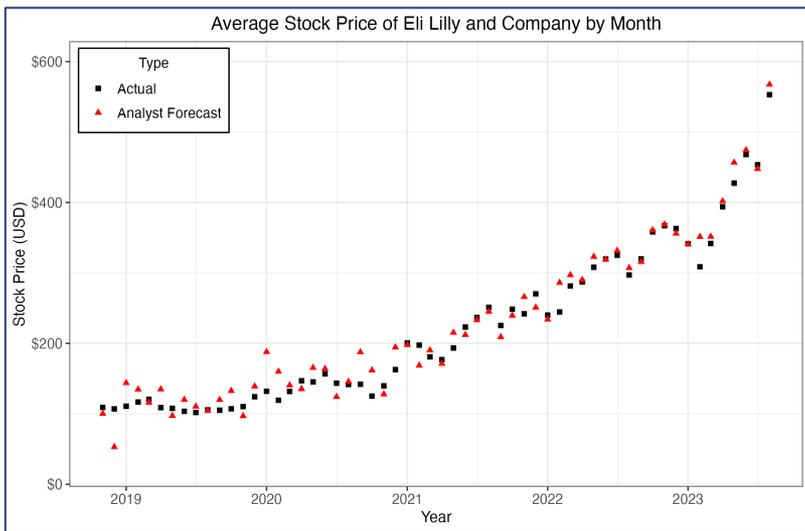
Absolute Change = Epistemic



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

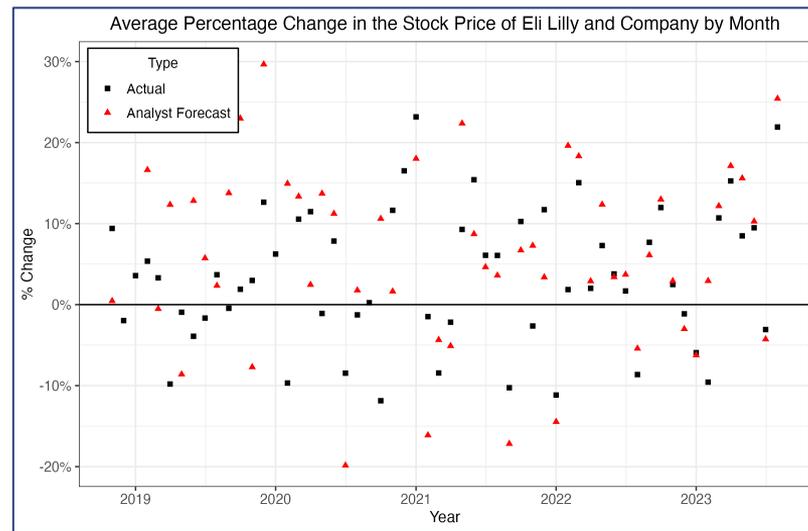
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Absolute Change = Epistemic



or

Relative Change = Aleatory



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- 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
- Candidate R1
- Candidate R2
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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 credible?

Which candidate do you think is the most competent?

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Which candidate do you think is the most credible?

Which candidate do you think is the most competent?

Which candidate do you think is the most thoughtful?

Which candidate do you think is the most trustworthy?

- Candidate P
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$\alpha = 0.95$

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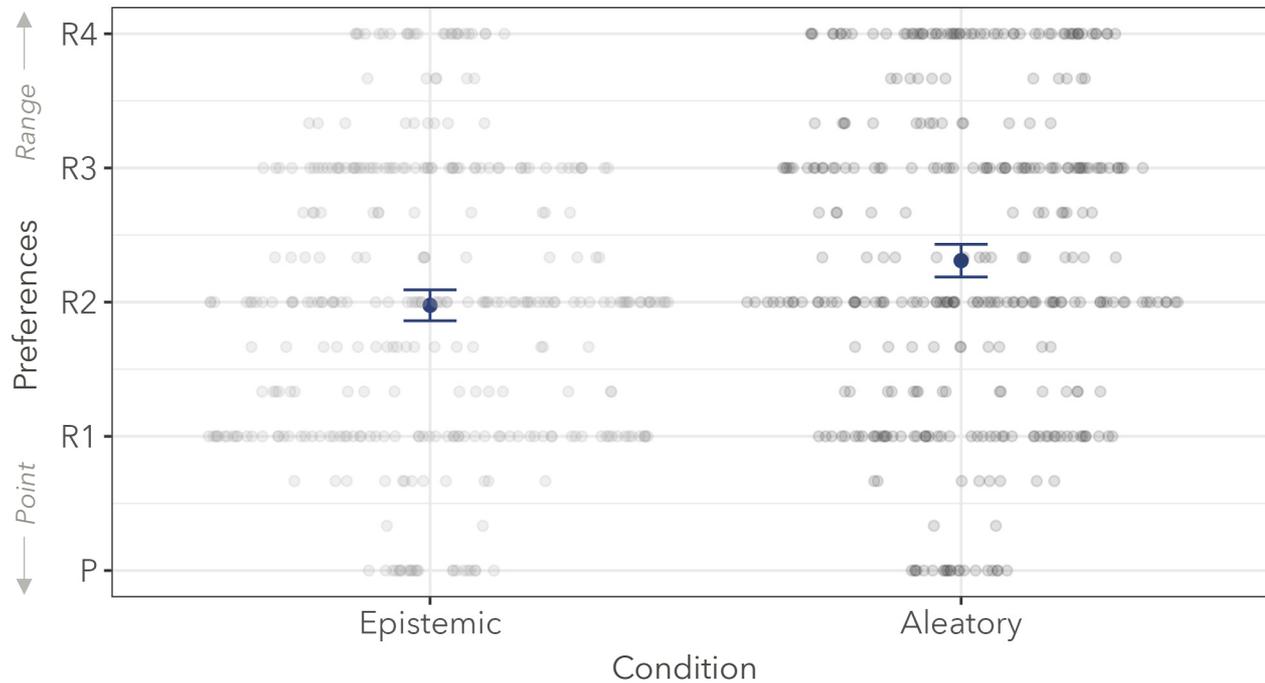
Choice

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)

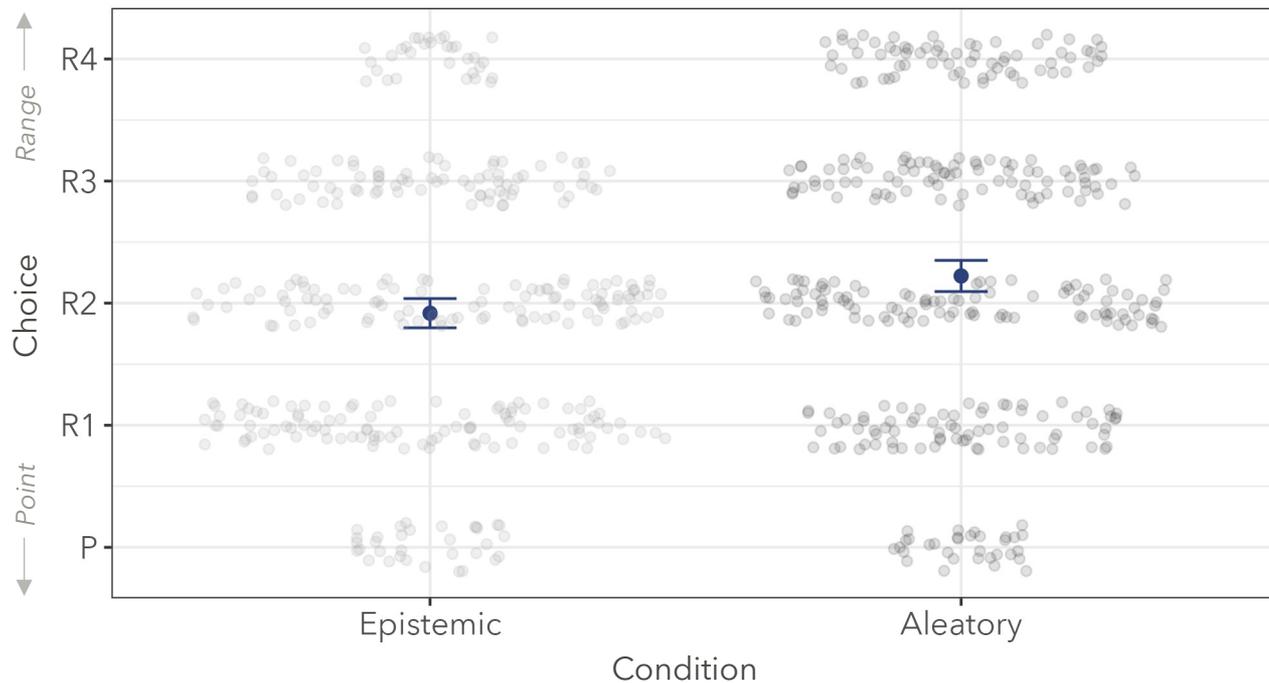
Preferences by Condition



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

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

Choice by Condition



- 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
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 - 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

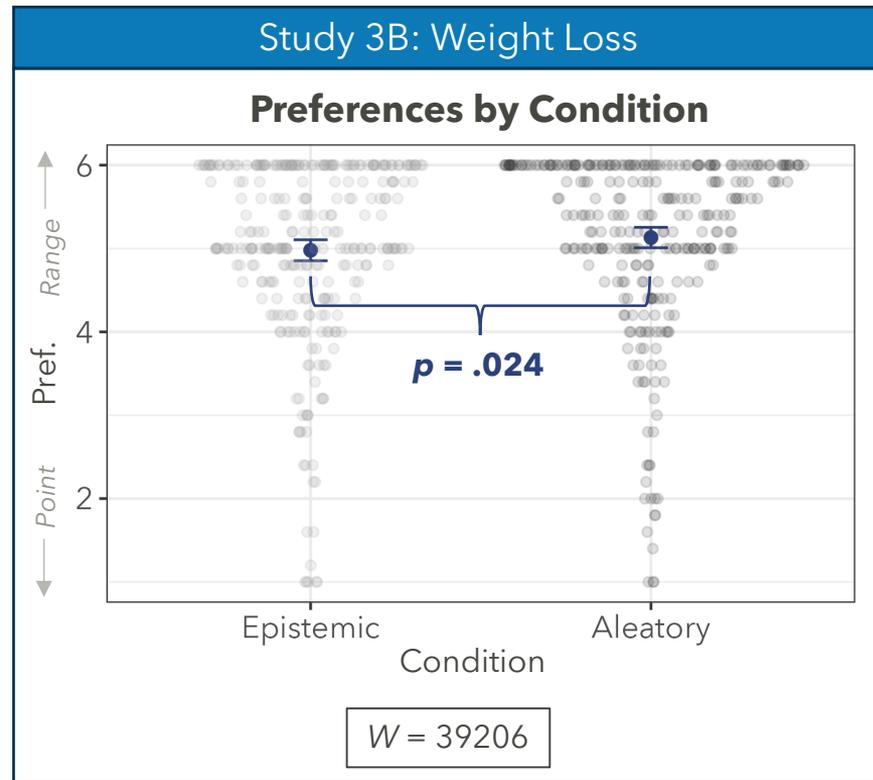
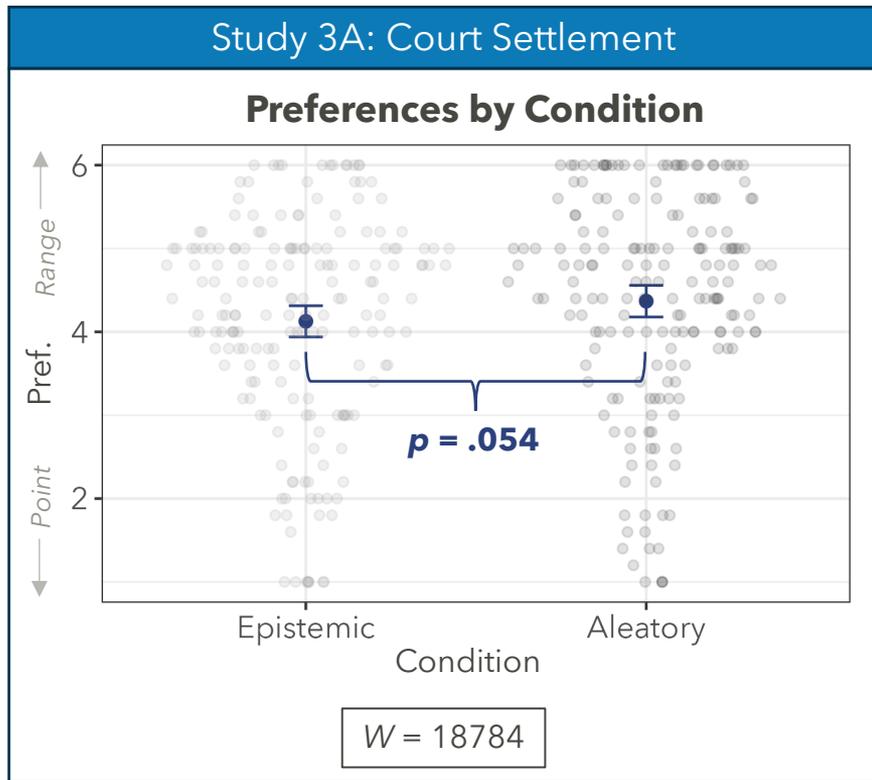
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Study 3A: Court Settlement

Study 3B: Weight Loss

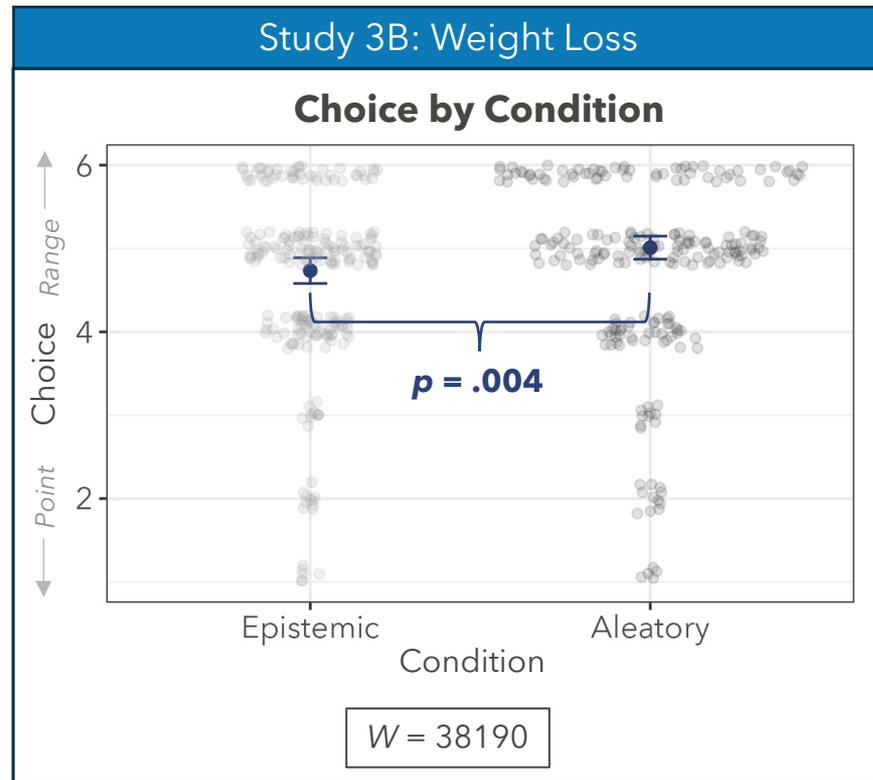
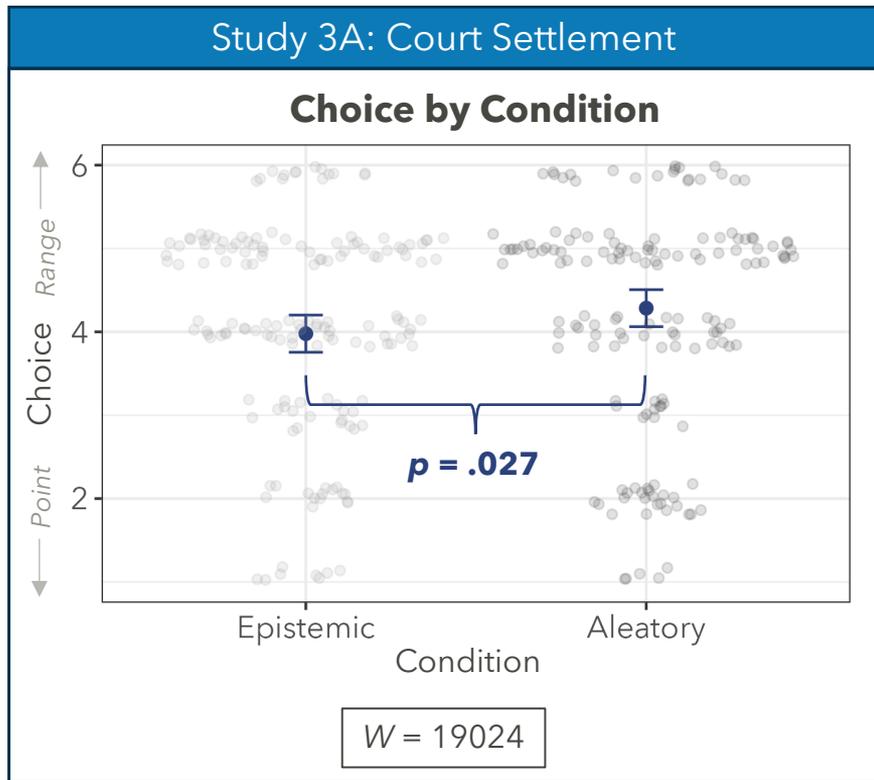
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Key Predictions

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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

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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
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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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Study 4 ($N = 199$, MTurk)

Evaluations

Please carefully evaluate this person on the following dimensions

Study 4 ($N = 199$, MTurk)

Evaluations

Please carefully evaluate this person on the following dimensions

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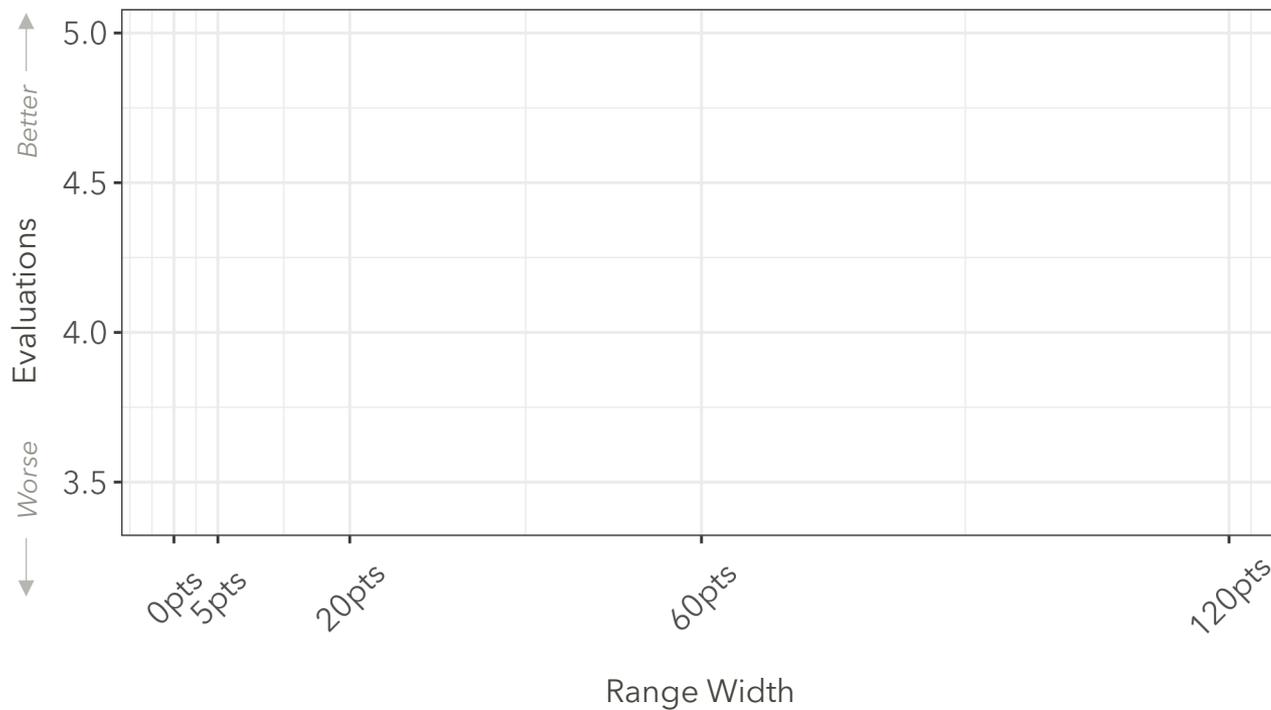
	Not at all			Extremely			
	(1)			(7)			
How credible is this person?	<input type="radio"/>						
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How knowledgeable is this person?	<input type="radio"/>						

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

Study 4 ($N = 199$, MTurk)

Evaluations by Condition

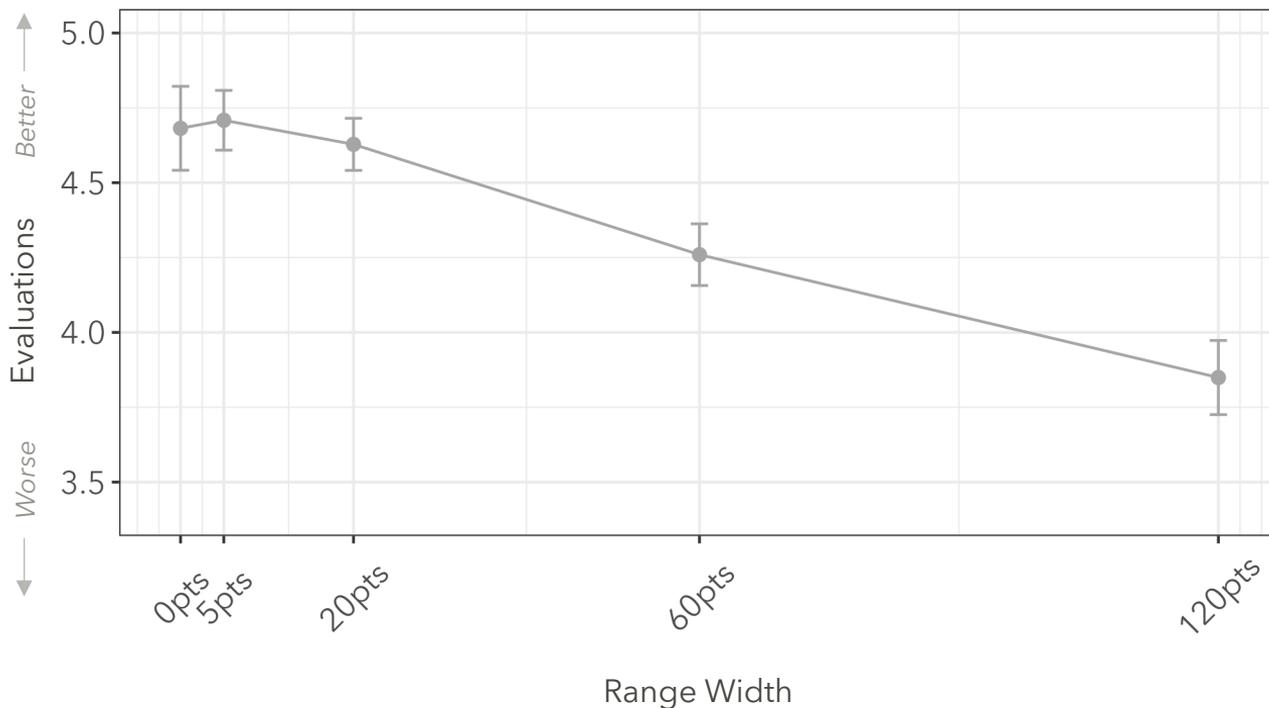
Grey = Epistemic, **Blue** = Aleatory



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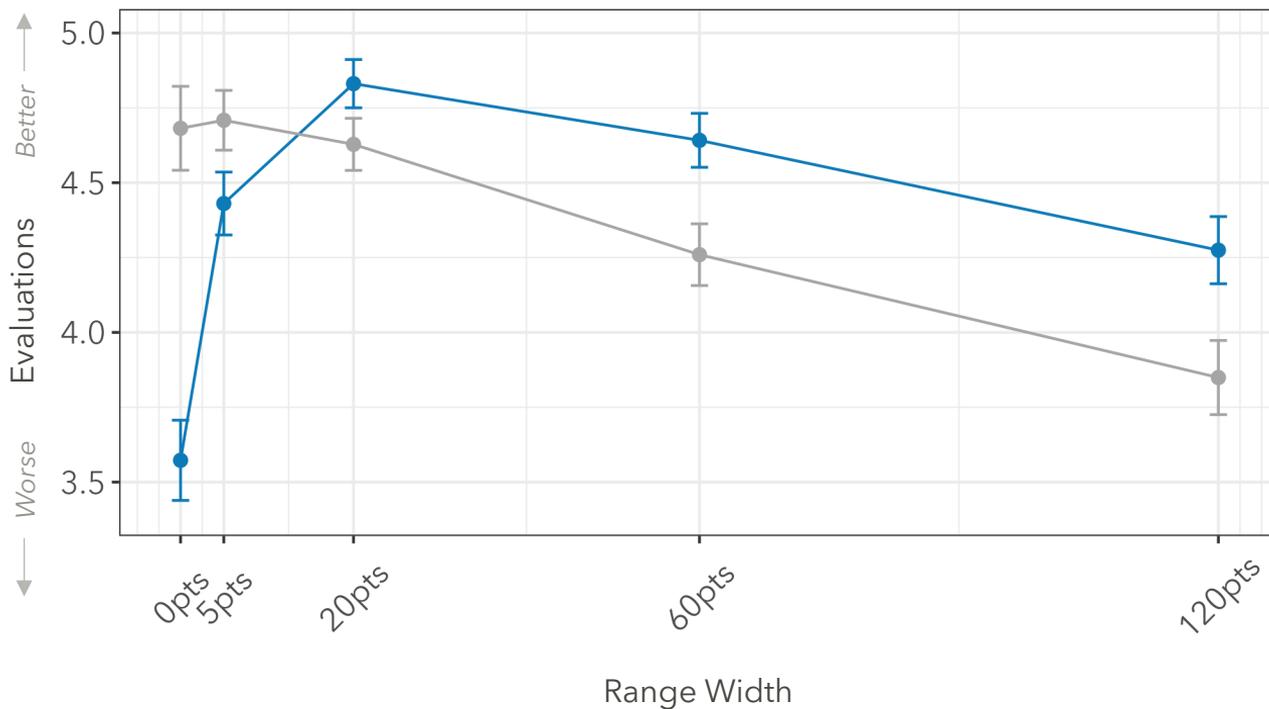


- Effect of Width:
 $b = -.007, p = .113$
- Model: OLS regression with participant fixed effects and standard errors clustered by participant

Study 4 (N = 199, MTurk)

Evaluations by Condition

Grey = Epistemic, **Blue** = Aleatory



- Effect of Width²:
 $b = -.0002, p < .001$
- Effect of Width:
 $b = -.007, p = .113$
- 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