

# **A Sound Decision? The Impact of Audio Descriptions on Economic Rationality**

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2024 POMS International Conference in China

## Perception

- Costly or imprecise (Woodford, 2020; Frydman and Jin, 2022)
- Shapes economic behavior (Bordalo et al., 2016)

## Audio Descriptions

- Social judgements (Lavan, 2023; Aung et al., 2024)
- Financial markets outcomes (Gorodnichenko et al., 2023)
- Inferior auditory capacity (Cohen et al., 2009; Kaiser, 2015)

## Question

- Impact of audio descriptions on economic decision-making?

## Laboratory Experiments

Revealed preference setup with decision-making under risk

- 1 Audio vs. Visual treatments
  - Natural human speech

## Impacts of Audio Descriptions

- 1 Severe impairment in economic rationality across measures
  - Despite increased decision times

## Laboratory Experiments

Revealed preference setup with decision-making under risk

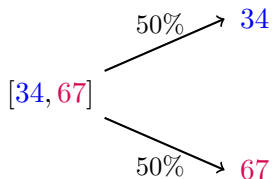
- ① Audio vs. Visual treatments
  - Natural human speech
- ② Calibrated Audio vs. Calibrated Visual treatments
  - Speed fine-tuned
  - Sequential nature controlled

## Impacts of Audio Descriptions

- ① Severe impairment in economic rationality across measures
  - Despite increased decision times
- ② Mechanisms
- ③ Behavioral implications

## Decision-Making under Risk

- Makes a choice from 11 options in 20 problems (Kim et al., 2018)
- All options and problems are randomly ordered



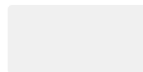
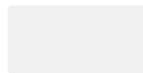
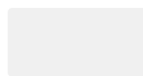
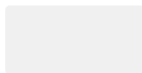
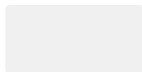
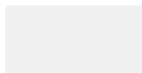
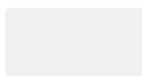
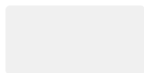
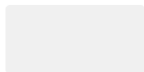
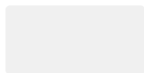
Example of Decision Problem

## Decision Problem Entry

# Audio Treatment

Natural speech respecting prosody and pauses:

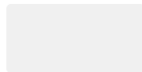
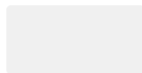
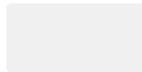
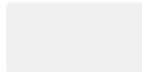
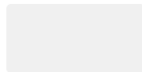
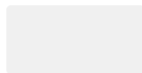
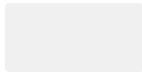
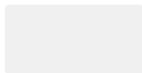
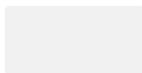
- Female Mandarin voice
- Moderate speed rate (120 words per minute)
- Audio played for one option at a time:
  - Mean audio duration: 4.2 seconds
  - Example: “34”-“or”-“67” (4.2s)



Display one option at a time:

- Duration: 4 seconds

[34, 67]





## Consistency with Preference Maximization

- Procedure developed by Nishimura et al. (2017)
  - Resembles the Generalized Axiom of Revealed Preference
  - (Weak) Monotonicity
- *Consistency*: A binary indicator of whether subjects pass the test or not

## Houtman–Maks Index (HMI)

- The minimal number of choice observations needed to be removed to achieve consistency (Houtman and Maks, 1985)
- Inferred as choice “mistakes”

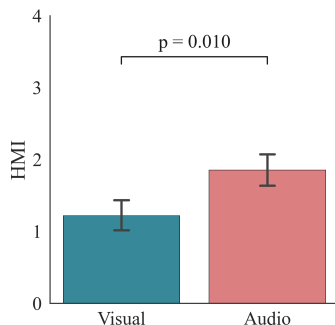
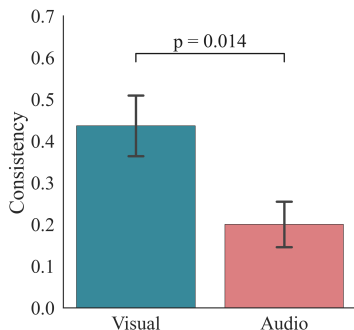
## Laboratory Experiment

- Adequate distance to minimize noise
- Comprehension tests
- Controls:
  - Cognitive ability
  - Demographics
  - Decision time

## Sample

- 110 in total
  - 50% in each treatment
  - Mean age  $\approx 22$ , female  $\approx 47\%$
  - All native in Mandarin

# Experiment 1: Economic Rationality



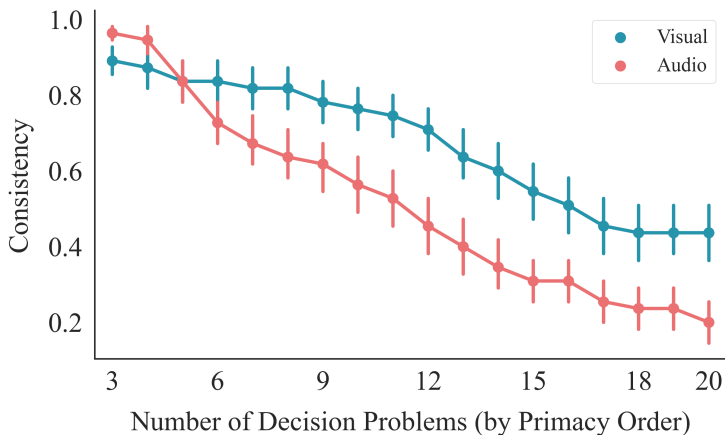
Audio (vs. Visual):

- Impairs Consistency by 54% (0.436 vs. 0.2)
- Exacerbates HMI by 52% (1.218 vs. 1.855)

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Note: Error bars indicate the standard error of means; P-values from the chi-square and the Mann-Whitney U-Test, respectively

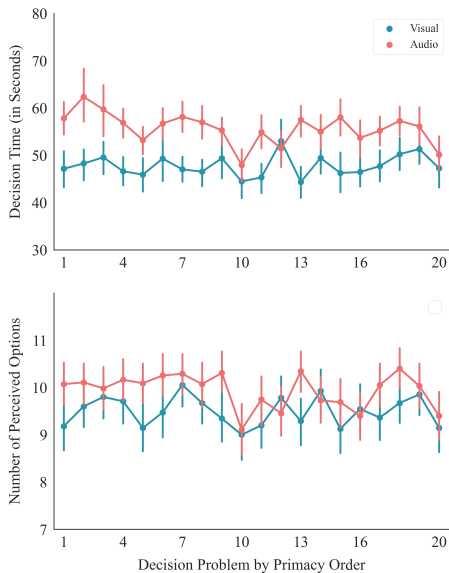
# Experiment 1: Economic Rationality Dynamics



- The gap emerges with a smaller number of choices

Note: Error bars indicate the standard error of means

# Experiment 1: Perceptual Behavior Dynamics



## Experiment 2

# Calibrated Audio Treatment

Slow speed rate: 60 words per minute (half of Audio treatment)

- Each number's audio duration calibrated around its digit count
- Mean audio duration: 5s
- Example: “34”—“67” (5.1s)

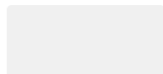
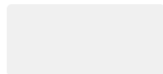
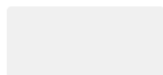
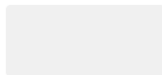
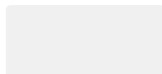
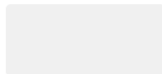
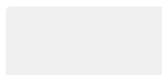
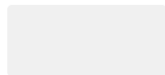
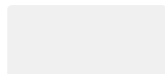
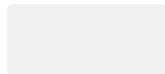


# Calibrated Visual Treatment

Sequential display of each digit:

- Duration of each digit: 1 seconds
- Mean option duration: 4.9s
- Example: “3”, “4”—“6”, “7” (4.5s)

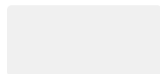
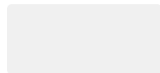
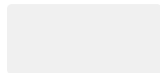
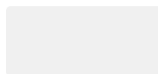
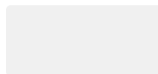
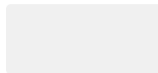
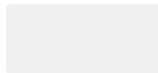
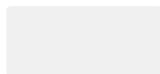
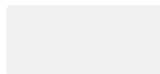
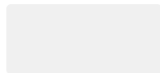
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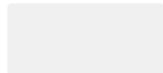
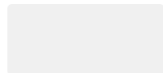
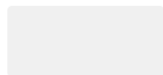
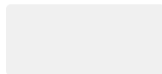
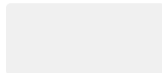
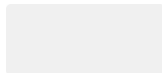
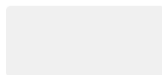
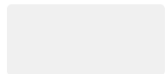
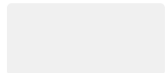
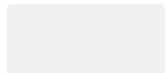




# Calibrated Visual Treatment

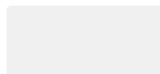
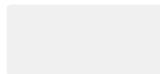
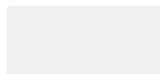
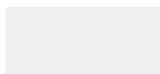
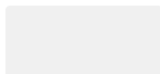
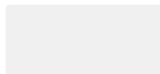
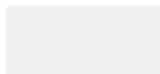
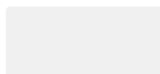
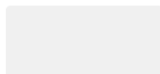
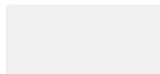
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# Calibrated Visual Treatment

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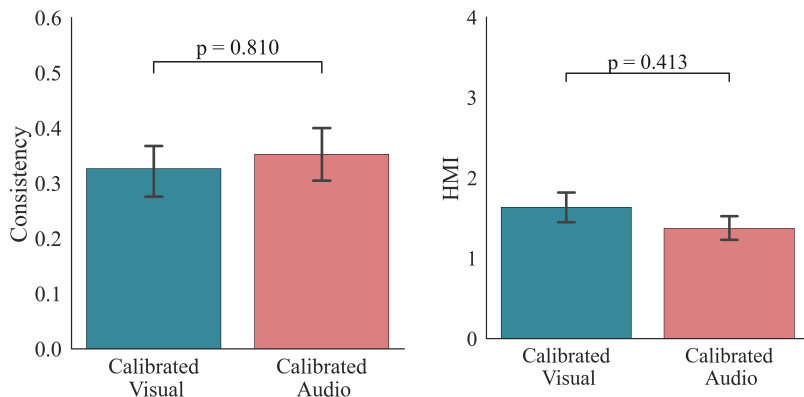
# Calibrated Visual Treatment

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## Experiment 2: Procedure

- Same logistics as Experiment 1
- 203 subjects:
  - 51% in the Calibrated Audio Treatment
  - Mean age  $\approx 23$ , female  $\approx 66\%$
  - All native in Mandarin

## Experiment 2: Economic Rationality

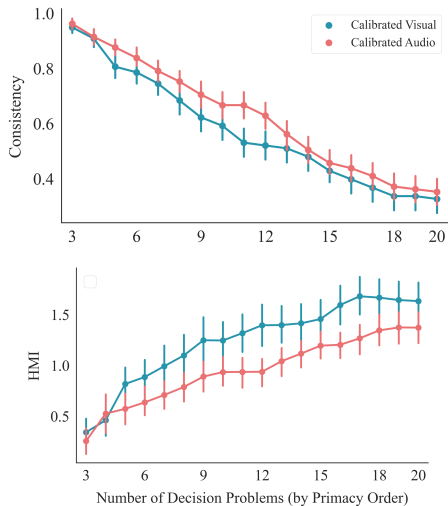


Similar levels in Calibrated Audio and Calibrated Visual:

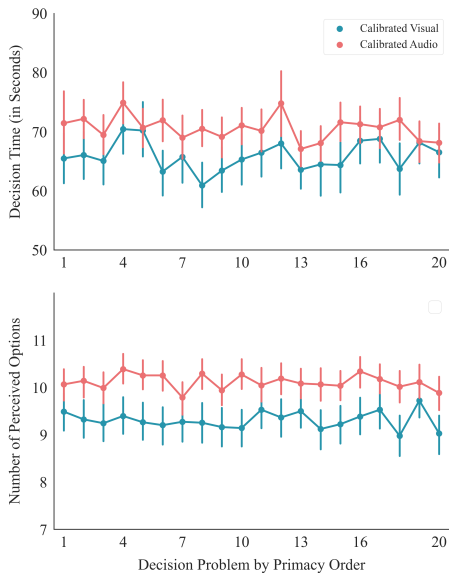
- Consistency: 0.327 vs. 0.352; HMI: 1.633 vs 1.371

Error bars indicate the standard error of means; P-values from the chi-square and the Mann-Whitney U-Test, respectively

## Experiment 2: Economic Rationality Dynamics

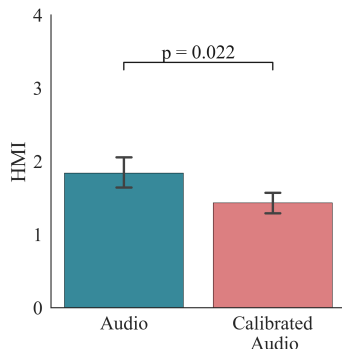
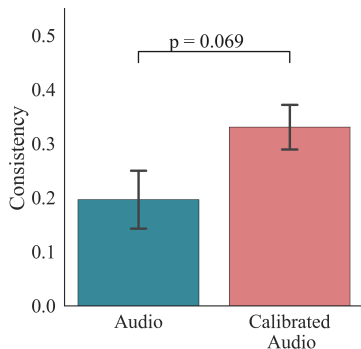


## Experiment 2: Perceptual Behavior Dynamics





# Calibrated Audio vs. Audio



## Calibrated Audio (vs. Audio):

- Improves consistency by 72% (0.2 vs. 0.352)
- Mitigates HMI by 35% (1.855 vs. 1.371)

Error bars indicate the standard error of means; P-values are obtained from the chi-square test

## Highlight

Impaired rationality in decisions made with audio descriptions:

- ① Sequential nature of audio information acquisition
- ② Severity linked to speed—slower may help

## Future Avenues

- Explore other choice domains with audio descriptions
- Integrated audiovisual information

# Thank You!

Any Question?

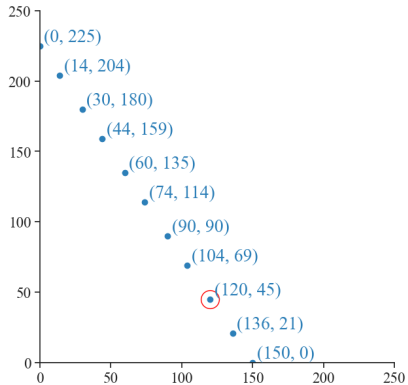
For any two menus  $A, B$  and choices  $c(A) = x, c(B) = y$ :

- $xR^Dy$  if there exists some  $z \in A$  such that  $z \geq y$
- $xR^Sy$  if there exists some  $z \in A$  such that  $z \gg y$
- $xRy$  if there exists some sequence  $\{x, z_1, z_2, \dots, z_k, y\}$  such that  $xR^Dz_1, z_1R^Dz_2, \dots, z_kR^Dy$ .

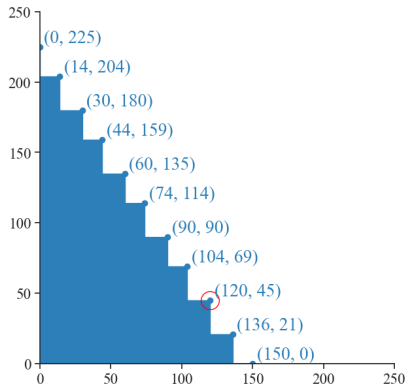
*GARP* requires:

- $xRy$  implies that  $yR^Sx$  does not hold.

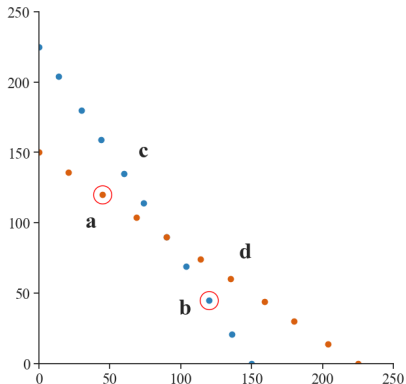
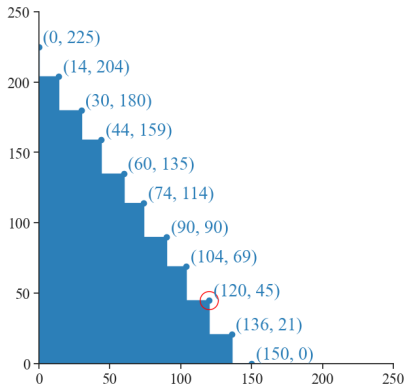
# Testing Economic Rationality



# Testing Economic Rationality



# Testing Economic Rationality

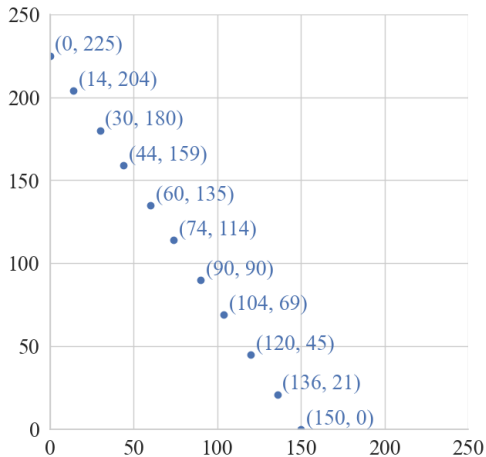


●  $a \succsim b$  but not  $b \succsim a$  (as  $d \gg b$ )

●  $b \succsim a$  but not  $a \succsim b$  (as  $c \gg a$ )

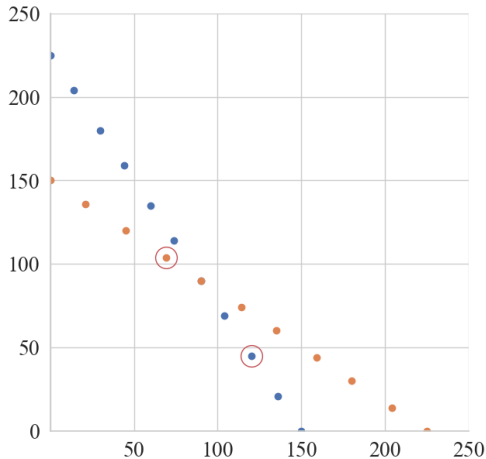
} **Inconsistency!**

# Graphical Representation of Decision Problems





# Graphical Representation of GARP Violation



- Strictly prefers a to b
  - Strictly prefers b to a
- } **Inconsistency!**

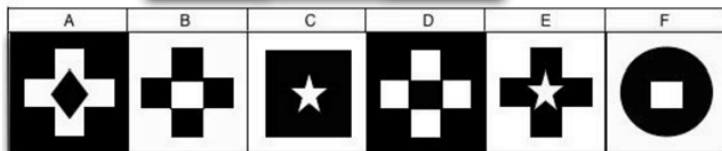
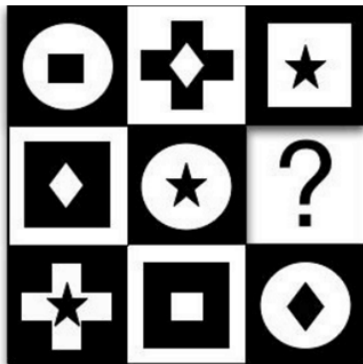
## Cognitive Ability

- Main: International Cognitive Ability Resource (Condon and Revelle, 2014)
- Selective attention (Stroop, 1935) and working memory capacity (Sternberg, 1966)

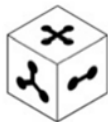
## Additional Information

- Demographics: age, gender, education
- Response time

# International Cognitive Ability Resource



# International Cognitive Ability Resource



X



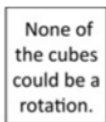
A



B



C



D



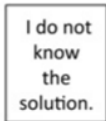
E



F



G



H

# Stroop Task

**blue**

What's the *color* of the word shown above?

Please press  for red,  for green,  for blue and  for orange.

If the screen does not respond, please click on this bar.

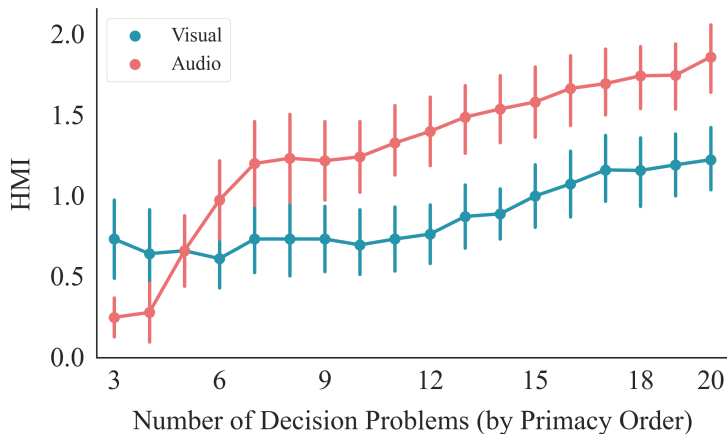
# Sternberg Task

**1**

Please memorize these digits.

If the screen does not respond, please click on this bar and then press space.

# Experiment 1: Economic Rationality Dynamics



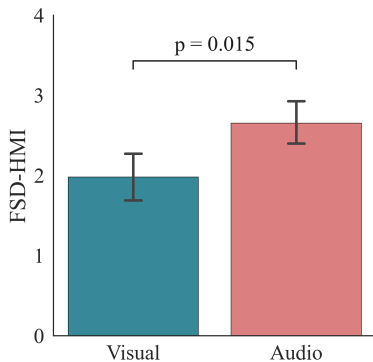
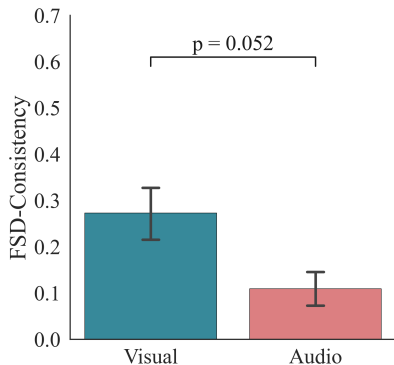
Note: Error bars indicate the standard error of means

## First-Order Stochastic Dominance (FSD)

- *FSD-Consistency*
- *FSD-HMI*



# Experiment 1: Economic Rationality (FSD)

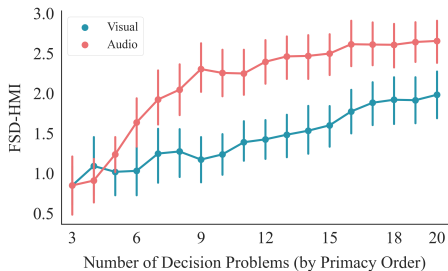
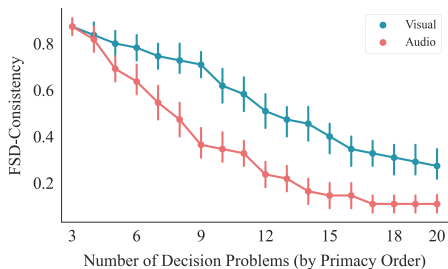


Audio (vs. Visual):

- ↓ FSD-consistency by 60%
- ↑ FSD-HMI by 34%

Note: Error bars indicate the standard error of means; P-values from the chi-square and the mann whitney u test.

# Experiment 1: Economic Rationality (FSD) Dynamics

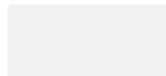
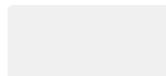
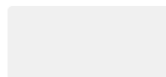
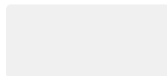
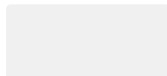
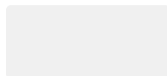
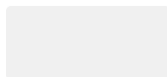
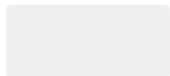
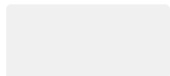
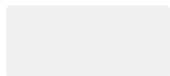


# Calibrated Visual Treatment

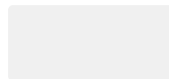
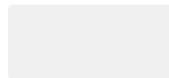
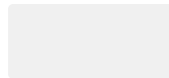
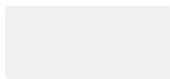
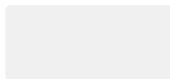
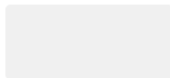
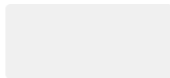
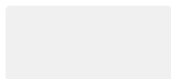
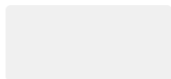
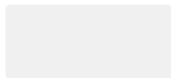
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# Calibrated Visual Treatment

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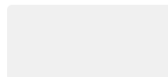
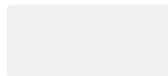
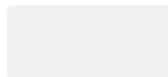
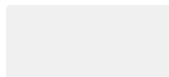
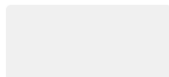
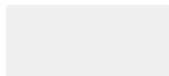
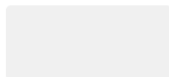
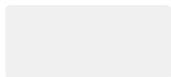
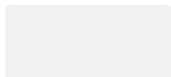
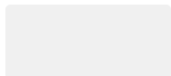


# Calibrated Visual Treatment



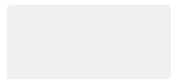
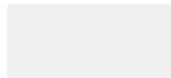
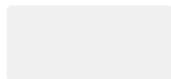
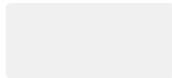
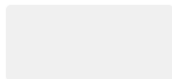
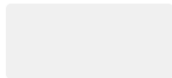
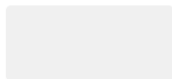
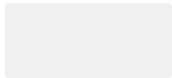
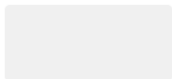
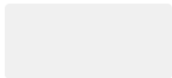
# Calibrated Visual Treatment

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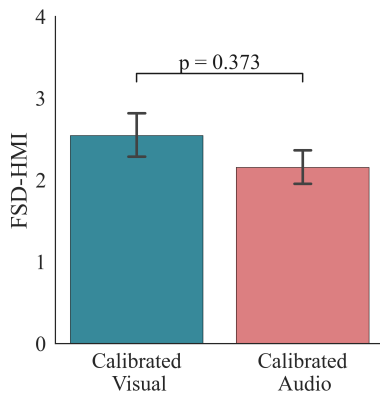
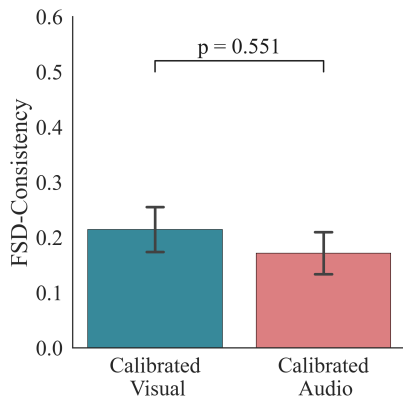


# Calibrated Visual Treatment

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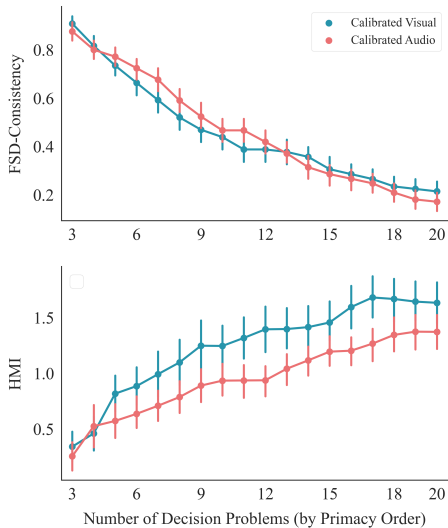


## Experiment 2: Economic Rationality (FSD)

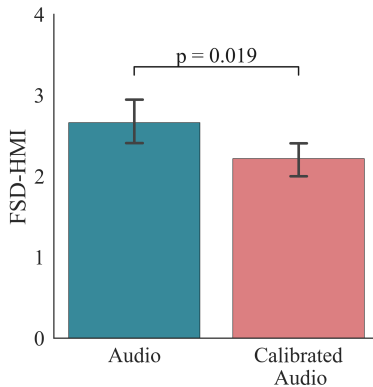
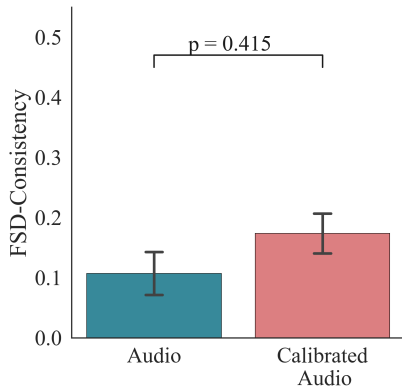




## Experiment 2: Economic Rationality (FSD) Dynamics



# Calibrated Audio vs. Audio (FSD)



# Estimating Risk Preferences

- Nonlinear least squares estimation method (Choi et al., 2007)
- Constant Relative Risk Aversion utility function:

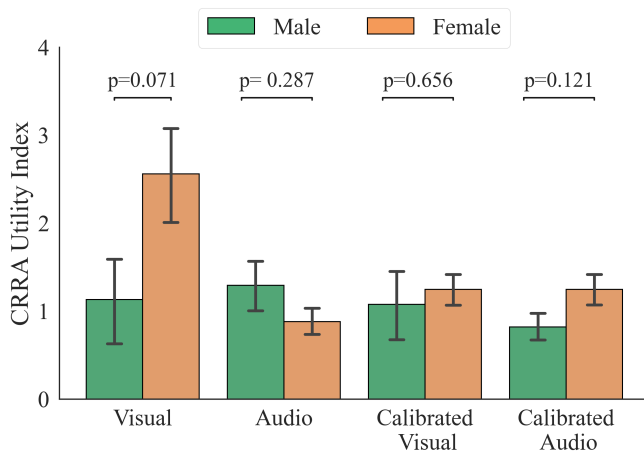
$$\min_{\rho} \sum_{i=1}^{20} \left\| (x_1^i, x_2^i) - \arg \max_{x^i \in M^i} \left( 0.5u(x_1^i; \rho) + 0.5u(x_2^i; \rho) \right) \right\|;$$

$$u(x_s^i; \rho) = \begin{cases} \frac{x_s^{i(1-\rho)}}{1-\rho} & , \rho \geq 0 \\ \ln(x_s^i) & , \rho = 1 \end{cases}, \text{ for } s = 1, 2;$$

- where  $\rho$  is the CRRA utility index

# Estimated Risk Preferences Across Treatments

Sample with HMI (with first order stochastic dominance)  $\leq 1$ :



- Risk aversion of females ↓

# Regressions on Risk Preferences

- Results based on the sample with  $FSD-HMI \leq 1$ :

	CRRA Utility Index			
	Calibrated Visual vs. Visual		Calibrated Audio vs. Visual	
	(1)	(2)	(3)	(4)
Female	1.101*** (0.352)	2.452*** (0.658)	1.096*** (0.309)	2.412*** (0.680)
Sequential Treatment	-1.080** (0.491)	0.348 (0.301)	-0.711 (0.582)	0.508 (0.410)
Female $\times$ Sequential Treatment		-2.449*** (0.769)		-1.982** (0.757)
Controls	Yes	Yes	Yes	Yes
Observations	73	73	87	87

Note: Controls include cognitive ability, demographics, and decision time; Robust standard errors in parentheses;  
\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$