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

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Motivation

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?

Overview

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

Overview

Laboratory Experiments

Revealed preference setup with decision-making under risk

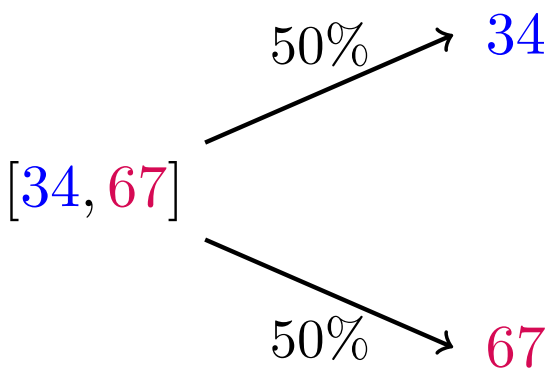
1. Audio vs. Visual treatments
   - Natural human speech
2. Calibrated Audio vs. Calibrated Visual treatments
   - Slower speed

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

Note: 5 experimental tokens = 1 CNY

Decision Problem Entry

Audio Treatment

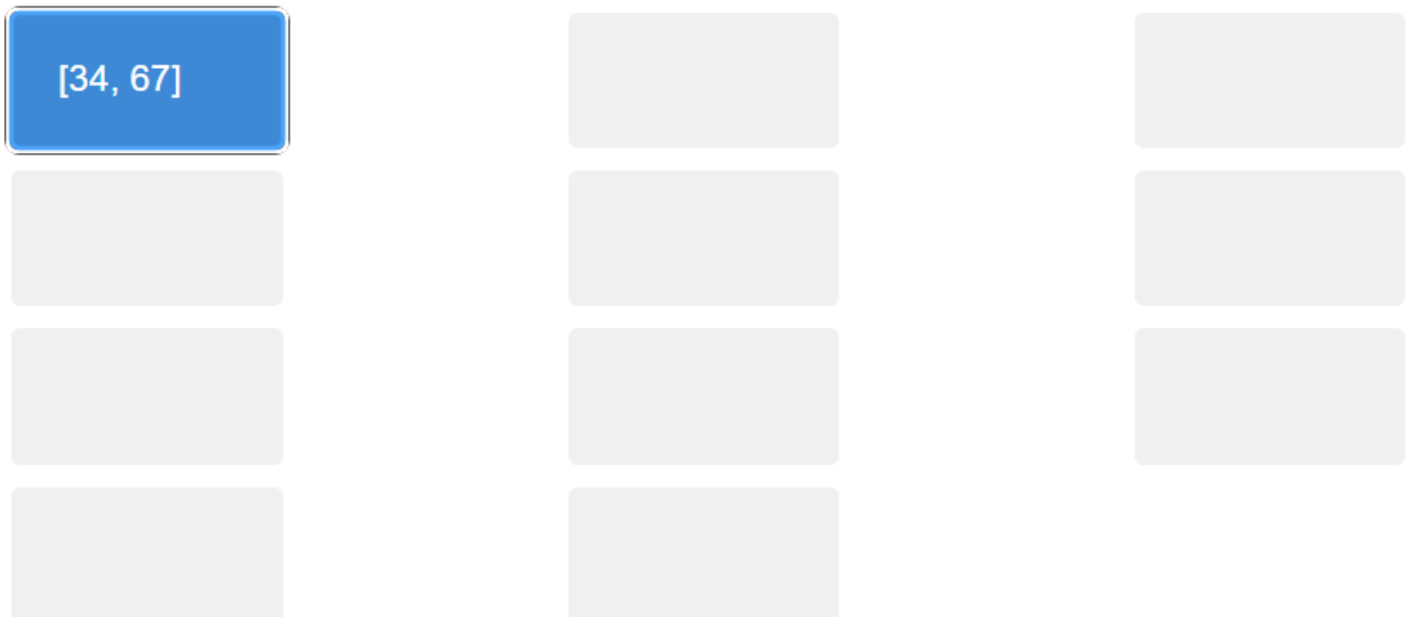
Natural speech respecting prosody and pauses:

- 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)

Visual Treatment

Display one option at a time:

- Duration: 4 seconds



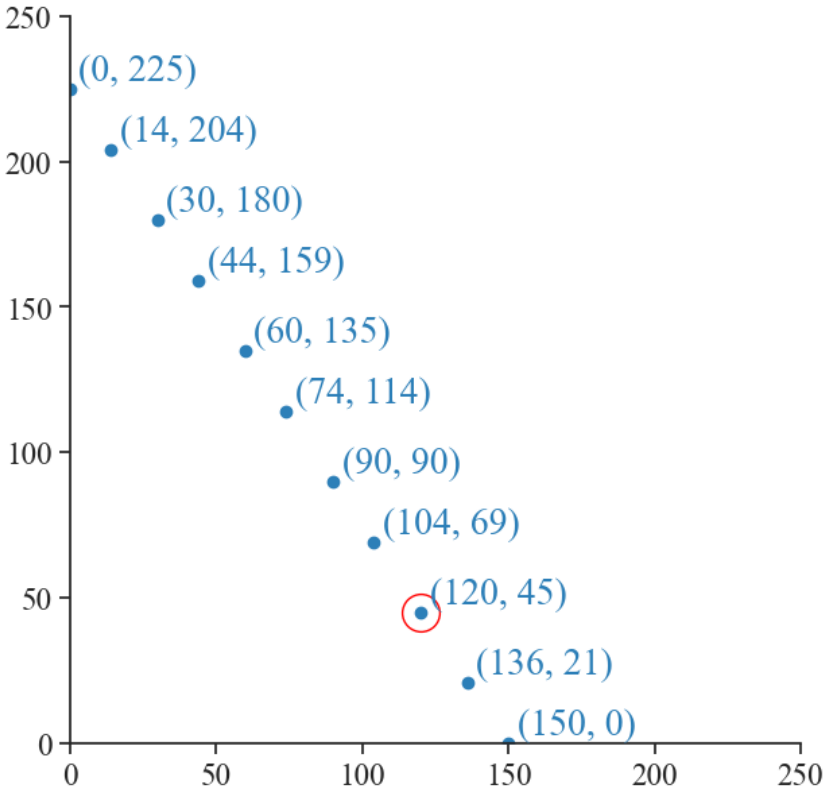
Consistency with Preference Maximization

- 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

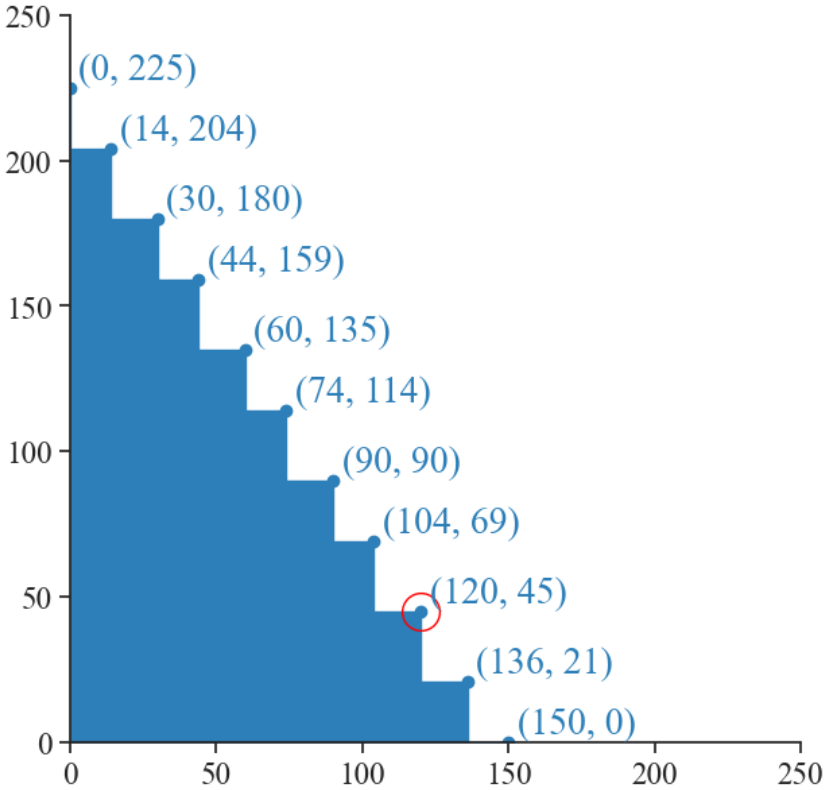
Houtman–Maks Index (HMI)

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

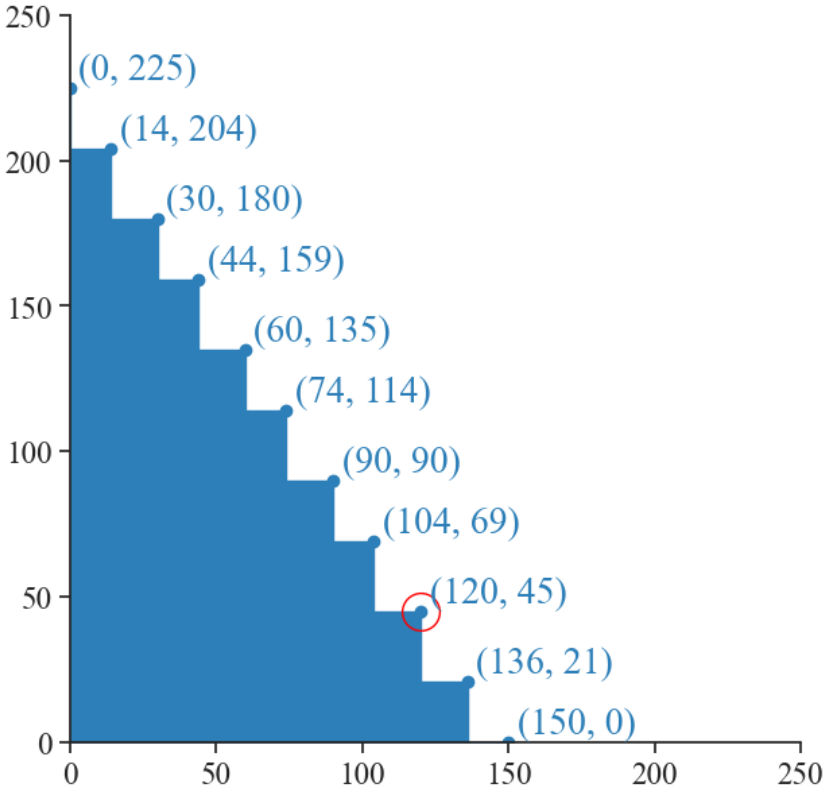
Testing Economic Rationality

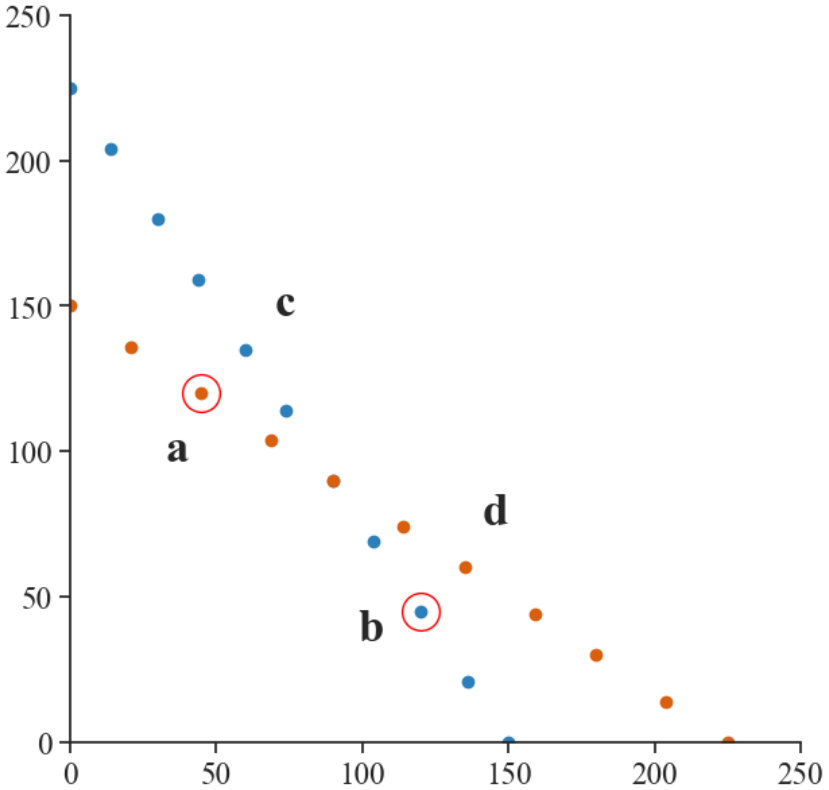


Testing Economic Rationality



Testing Economic Rationality





- $a \succeq b$ but not $b \succeq a$ (as $d \gg b$)
- $b \succeq a$ but not $a \succeq b$ (as $c \gg a$)

} **Inconsistency!**

Experiment 1: Procedure

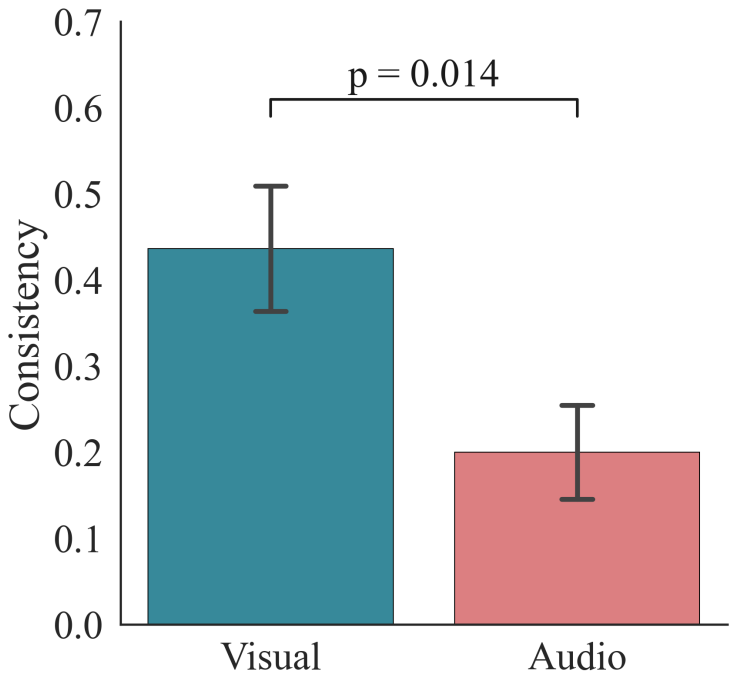
Laboratory Experiment

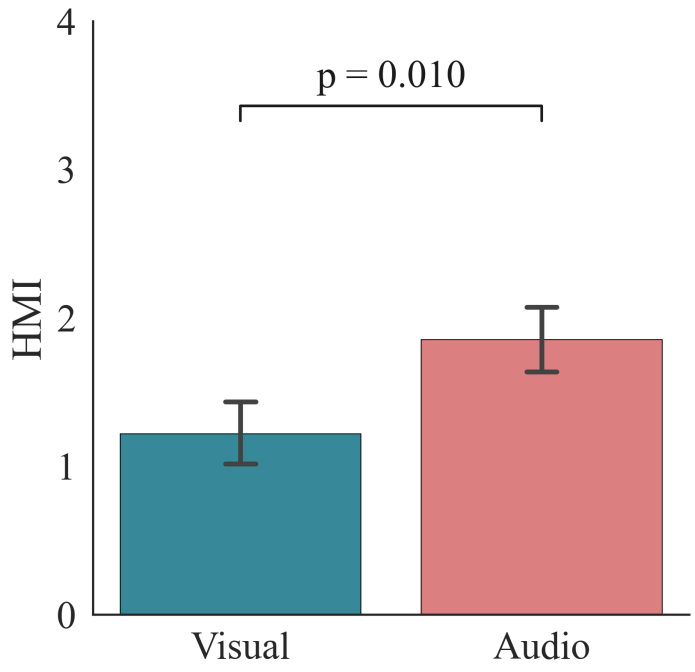
- Adequate distance to minimize noise
- Comprehension tests
- Controls:
  - Cognitive ability
  - Demographics
  - Decision time

Sample

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

Experiment 1: Economic Rationality



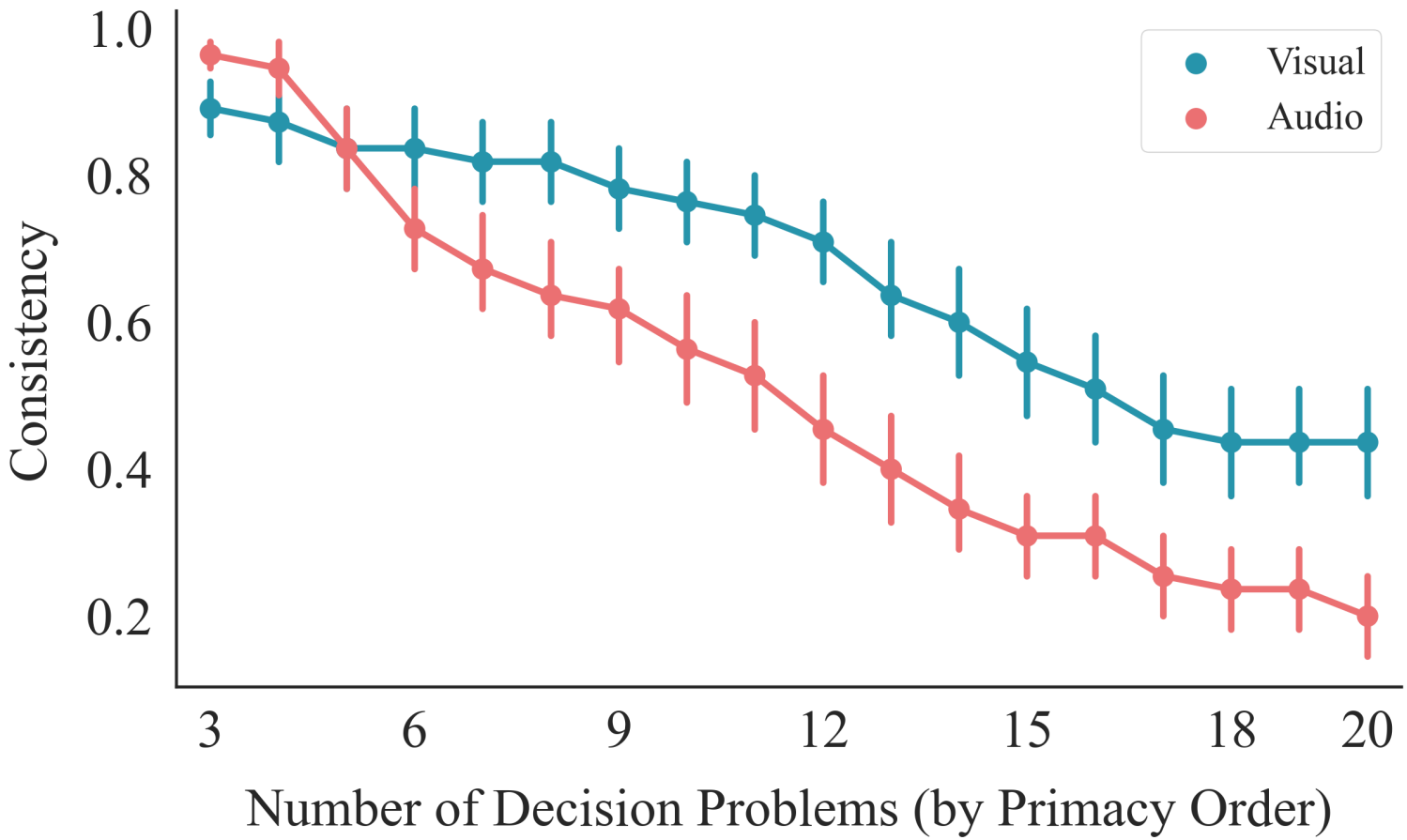


Audio (vs. Visual):

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

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

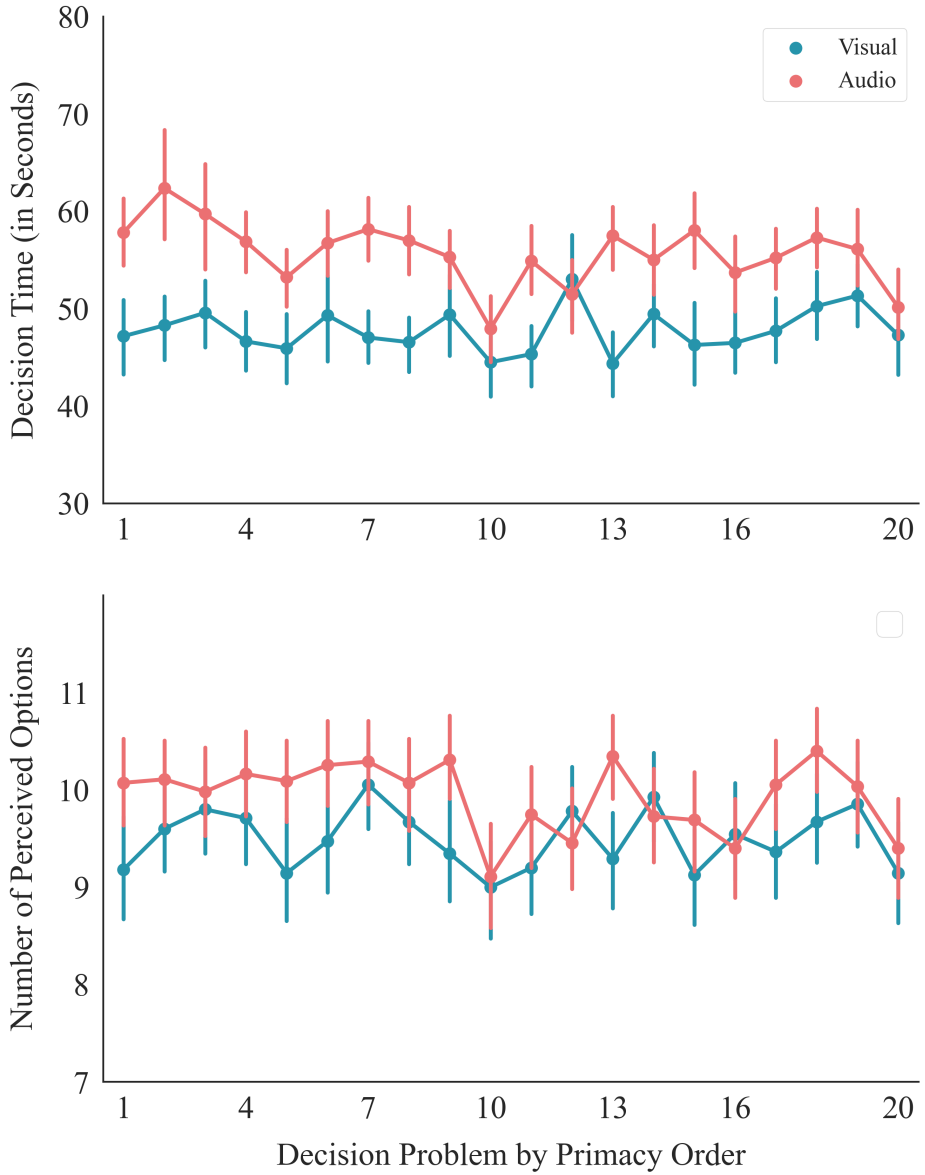
Experiment 1: Economic Rationality Dynamics



- 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

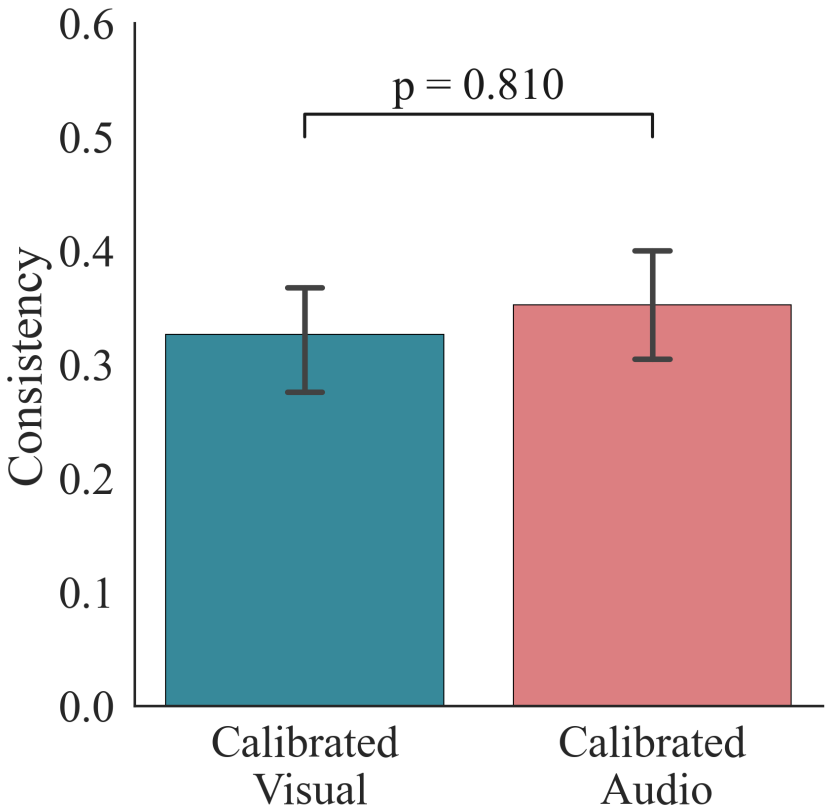
Sequential display of each digit:

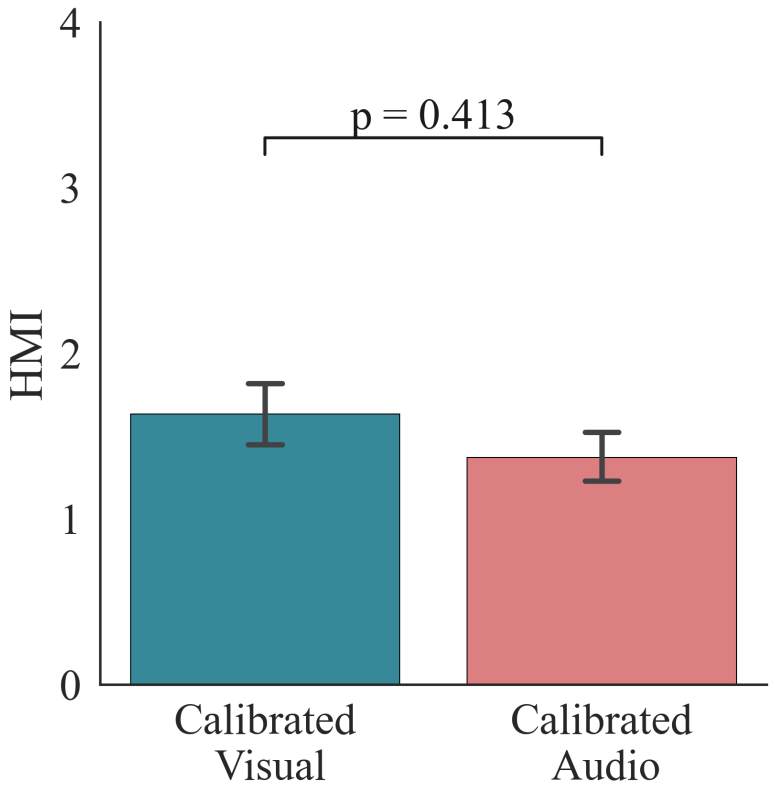
- Duration of each digit: 1 seconds
- Mean option duration: 4.9s
- Example: “3”,“4”—“6”, “7” (4.5s)

Experiment 2: Procedure

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

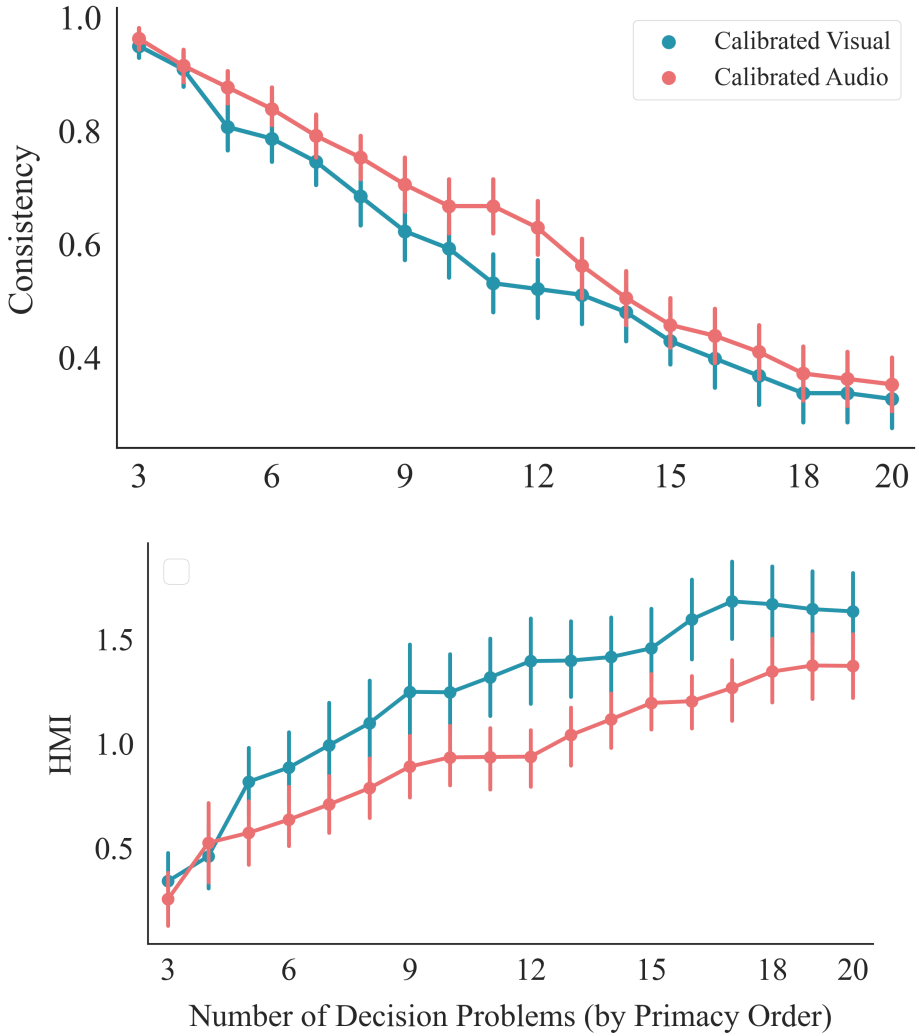
Experiment 2: Economic Rationality



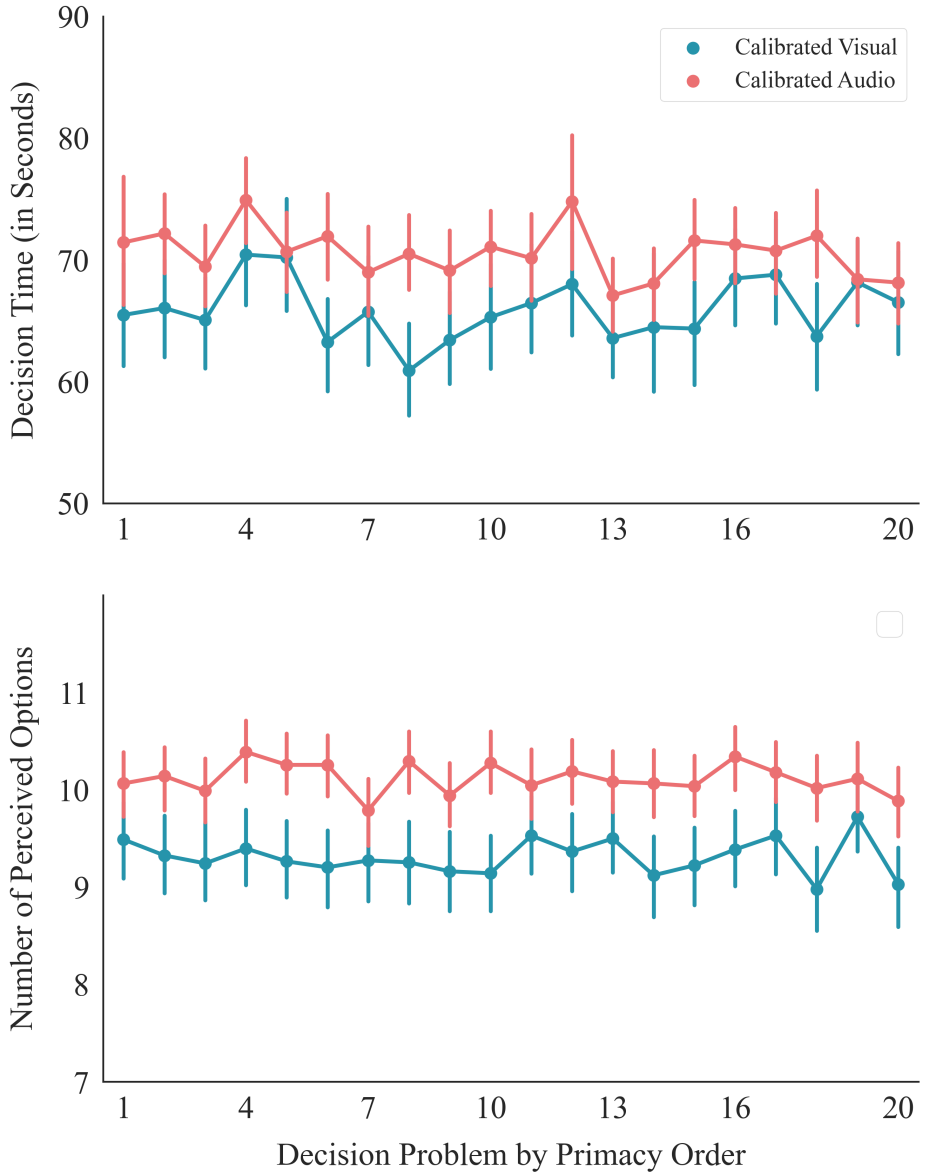


Error bars indicate the standard error of means; P-values from the chi-square and the Mann-Whitney U-Test, respectively

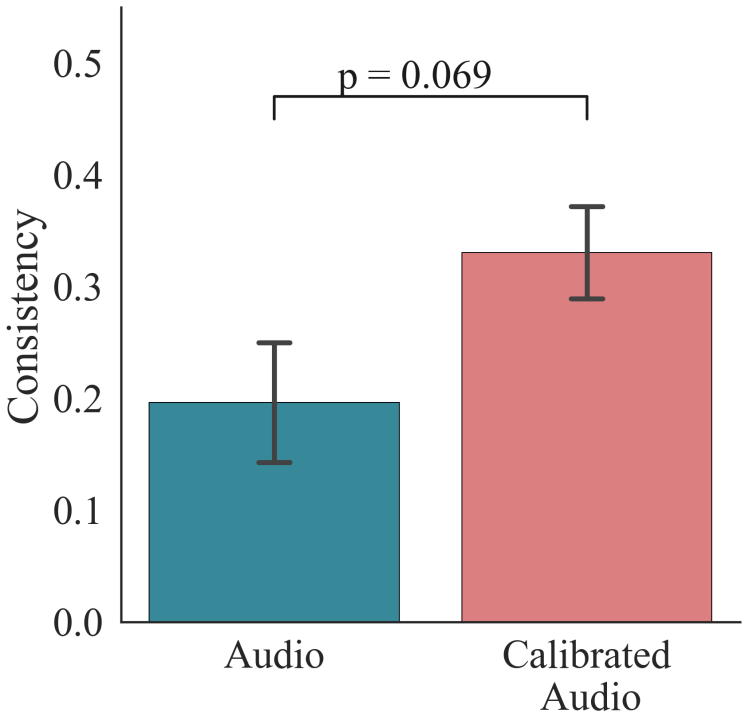
Experiment 2: Economic Rationality Dynamics

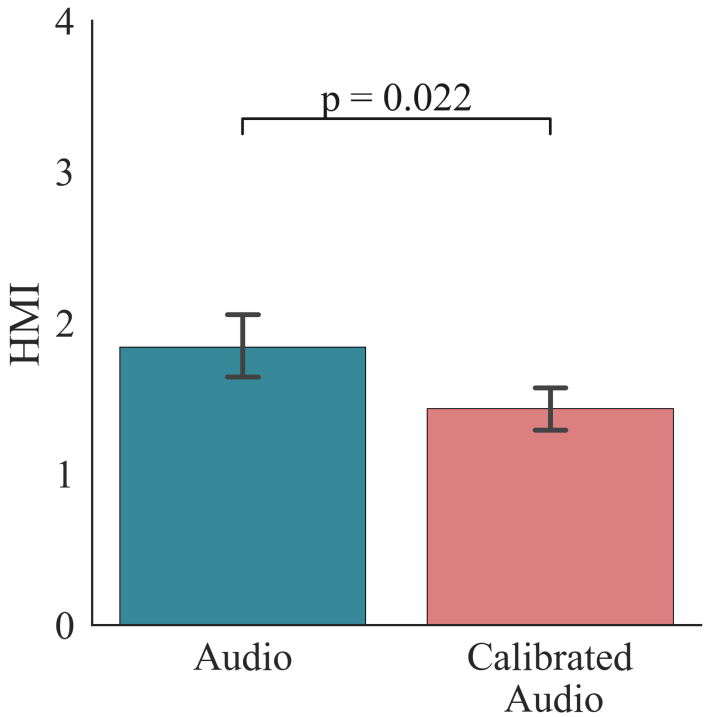


Experiment 2: Perceptual Behavior Dynamics



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

Estimating Risk Preferences

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

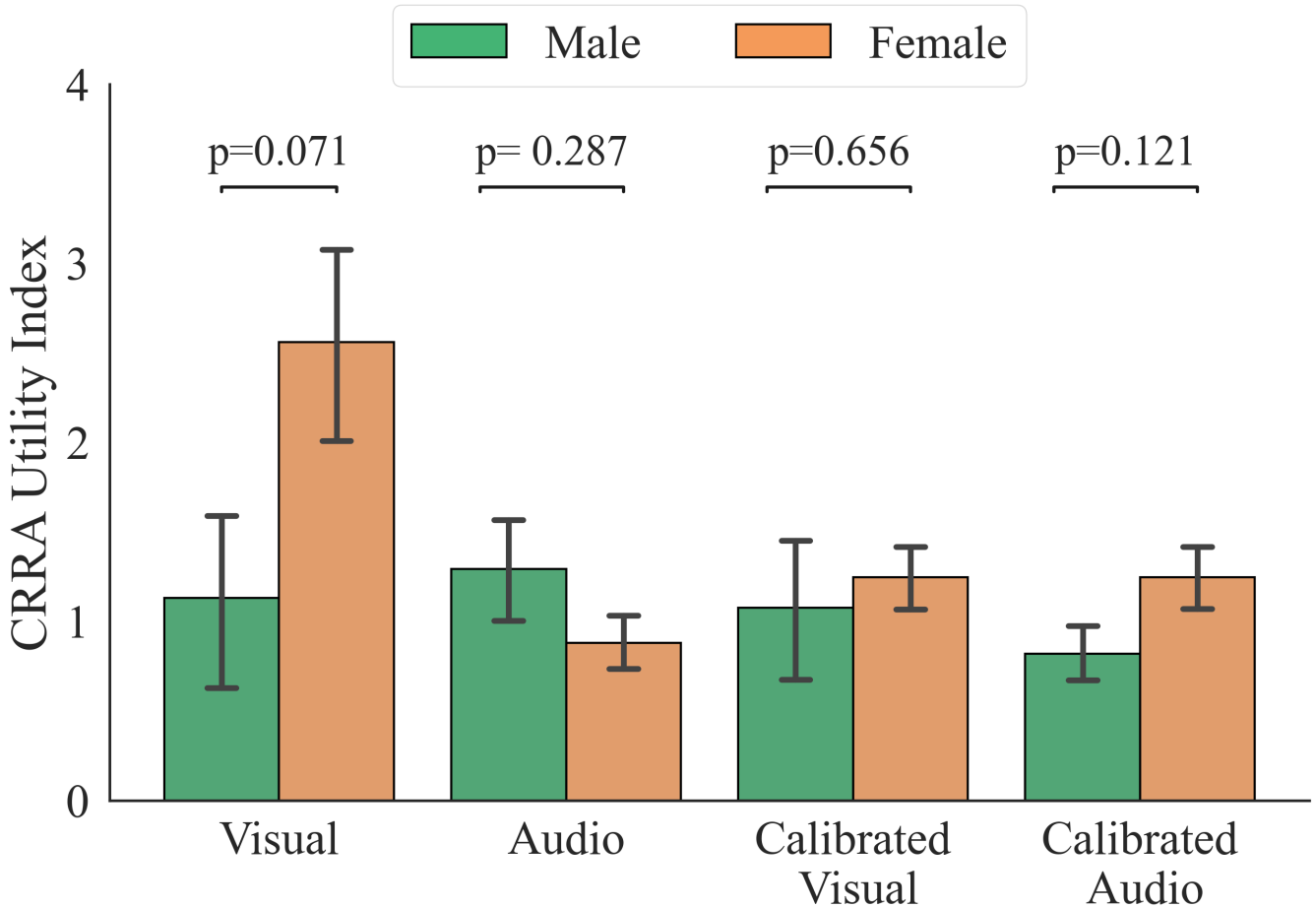
$$\min_{\rho} \sum_{i=1}^{20} \left\| (x_1^i, x_2^i) - \arg\max_{x^i \in M^i} \left(0.5u(x_1^i; \rho) + 0.5u(x_2^i; \rho) \right) \right\|;$$

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

- where ρ is the CRRA utility index

Estimated Risk Preferences Across Treatments

Sample with HMI (with first order stochastic dominance) ≤ 1:



- Risk aversion of females ↓

Note: P-values are obtained from the t-test

Discussion

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?

GARP

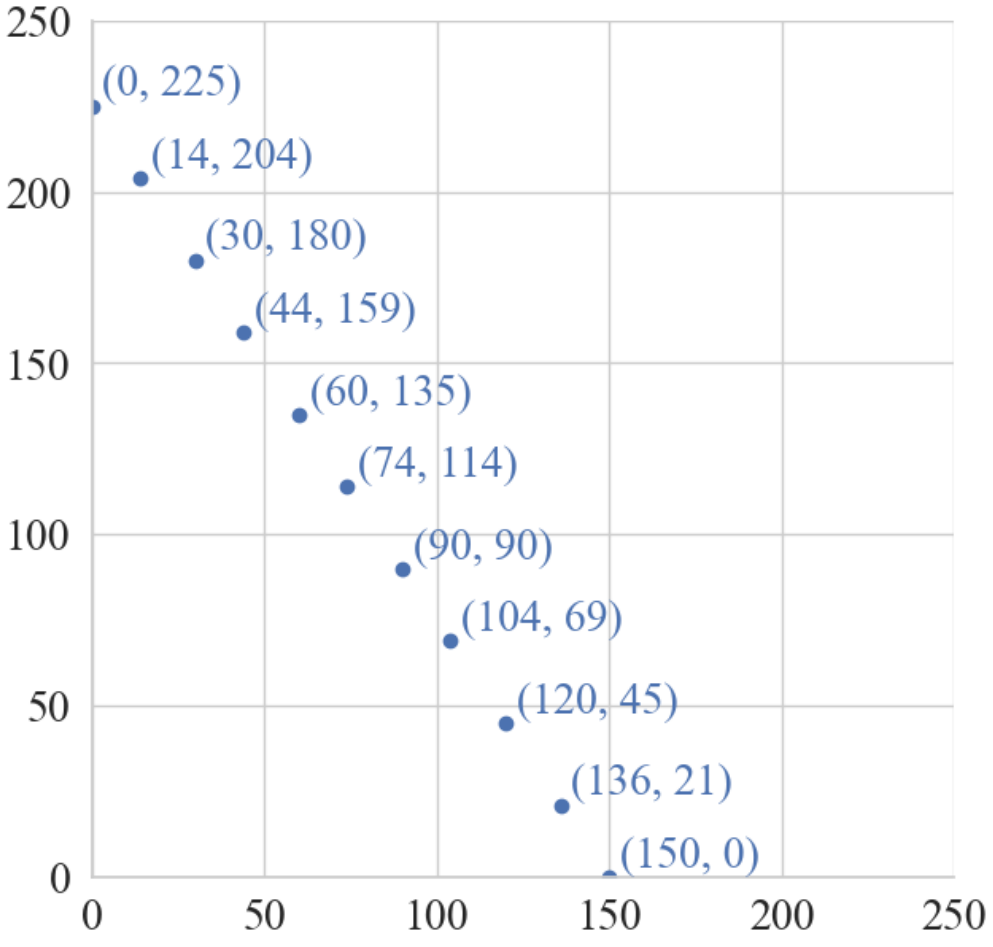
For any two menus A, B and choices $c(A) = x, c(B) = y$:

- $xR^D y$ if there exists some $z \in A$ such that $z \geq y$
- $xR^S y$ if there exists some $z \in A$ such that $z \gg y$
- xRy if there exists some sequence $\{x, z_1, z_2 \ldots, z_k, y\}$ such that $xR^D z_1$, $z_1 R^D z_2$,..., $z_k R^D y$.

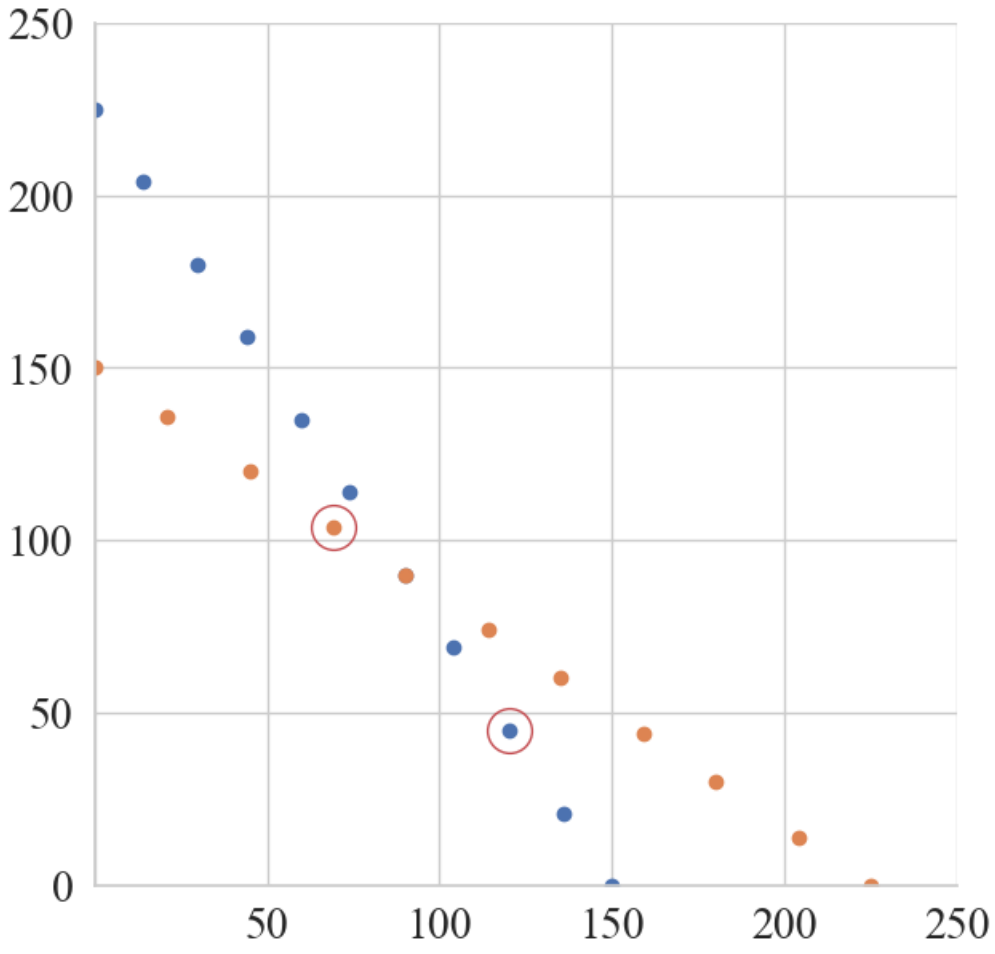
GARP requires:

- xRy implies that $yR^S x$ does not hold.

Graphical Representation of Decision Problems



Graphical Representation of GARP Violation



- Strictly prefers a to b
- Strictly prefers b to a

} **Inconsistency!**

Control Variables

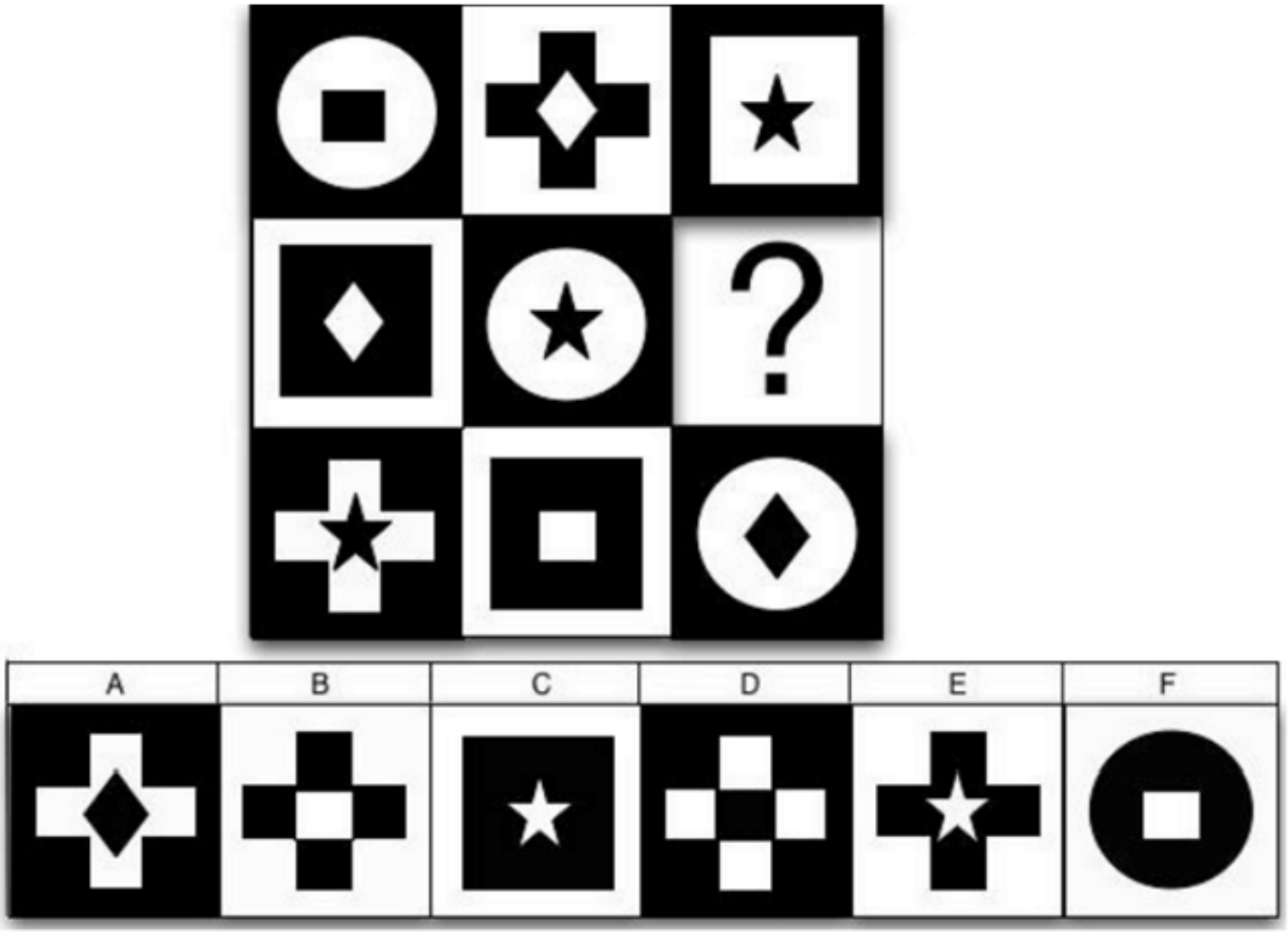
Cognitive Ability

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

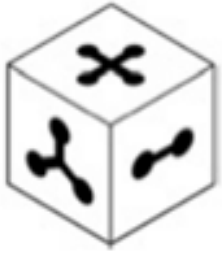
Additional Information

- Demographics: age, gender, education
- Response time

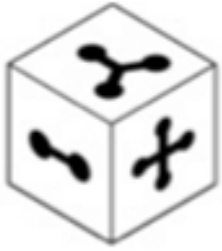
International Cognitive Ability Resource



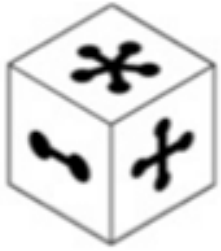
International Cognitive Ability Resource



X



A

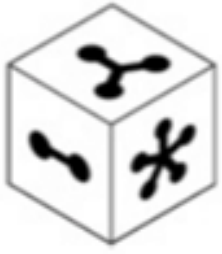


B

C

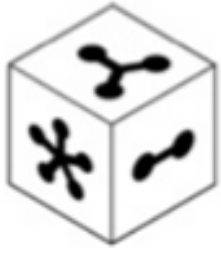
None of the cubes could be a rotation.

D



E

F



G

I do not know the solution.

H

Stroop Task

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

Please press `r` for red, `g` for green, `b` for blue and `o` for orange.

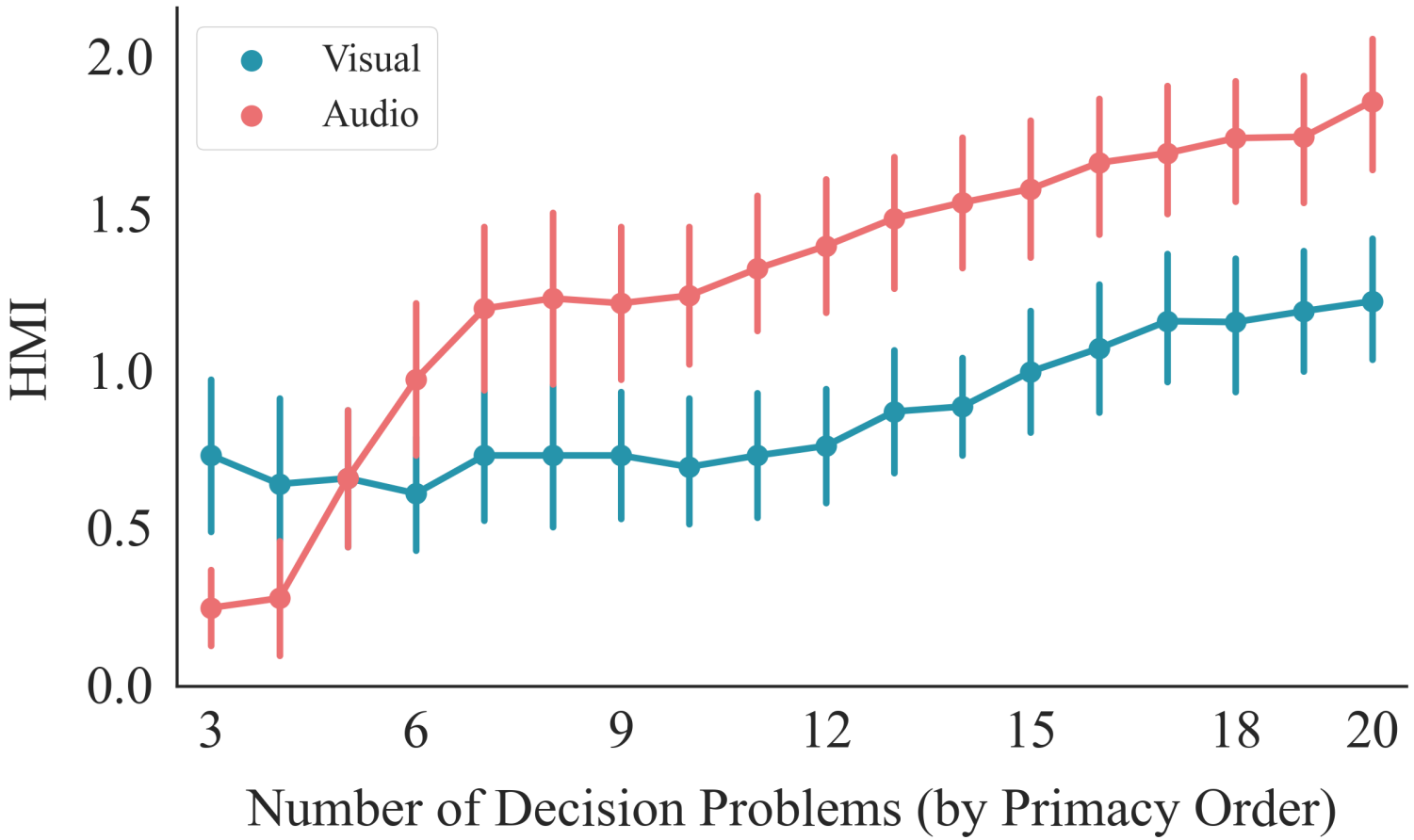
If the screen does not respond, please click on this bar.

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

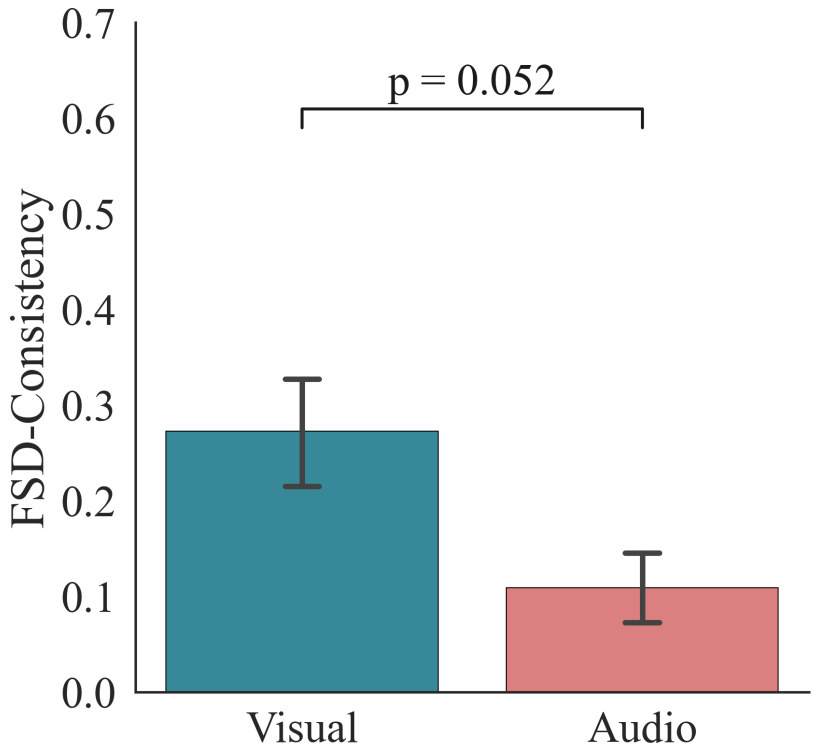


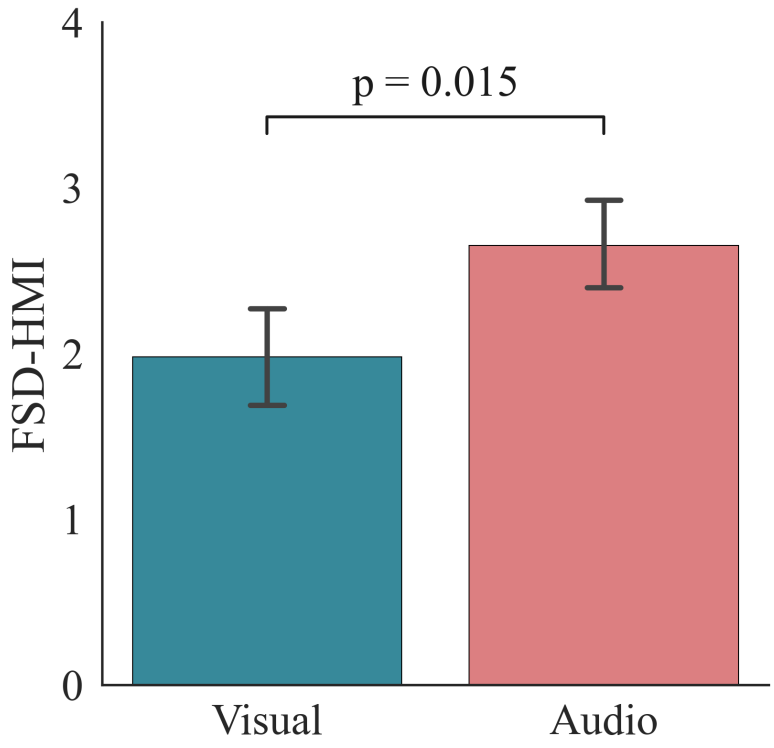
Note: Error bars indicate the standard error of means

First-Order Stochastic Dominance (FSD)

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

Experiment 1: Economic Rationality (FSD)



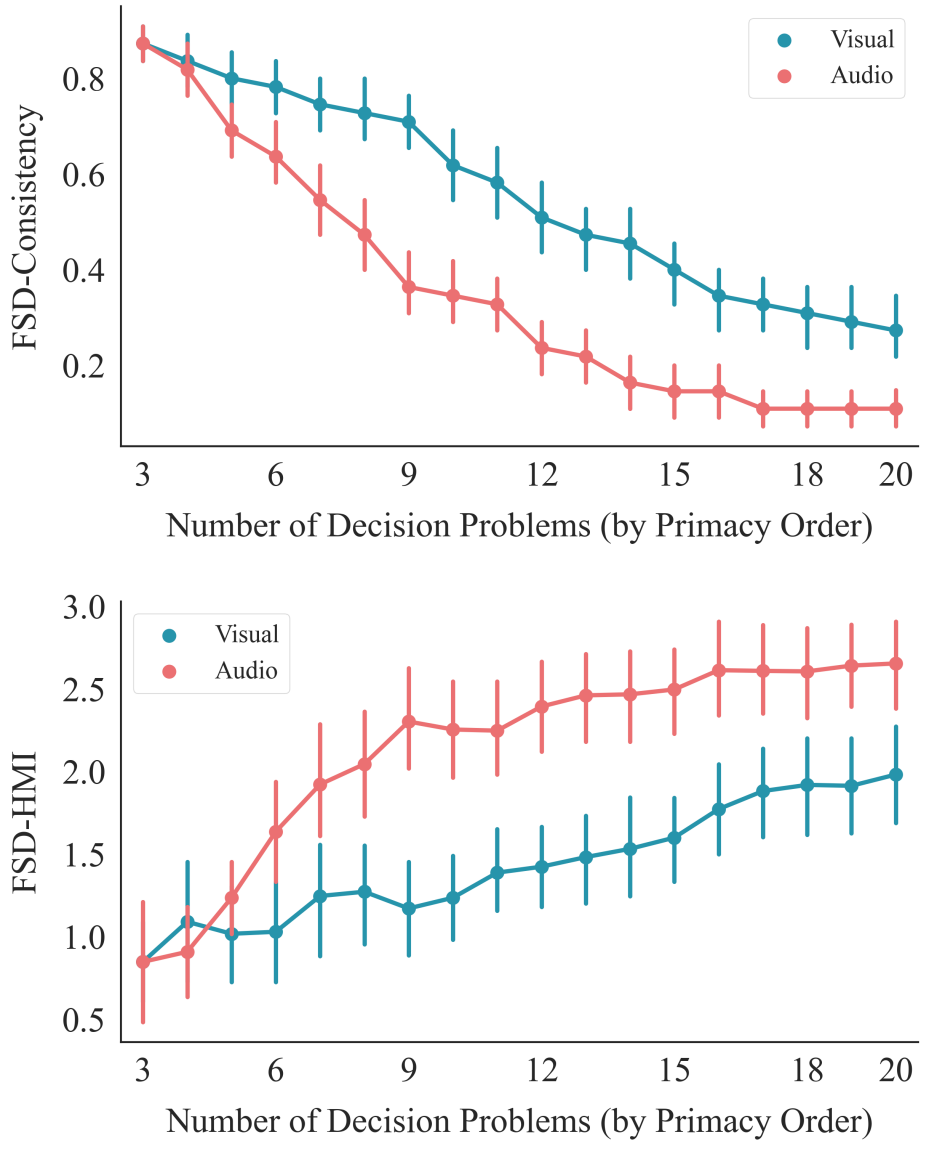


Audio (vs. Visual):

- ↓ 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

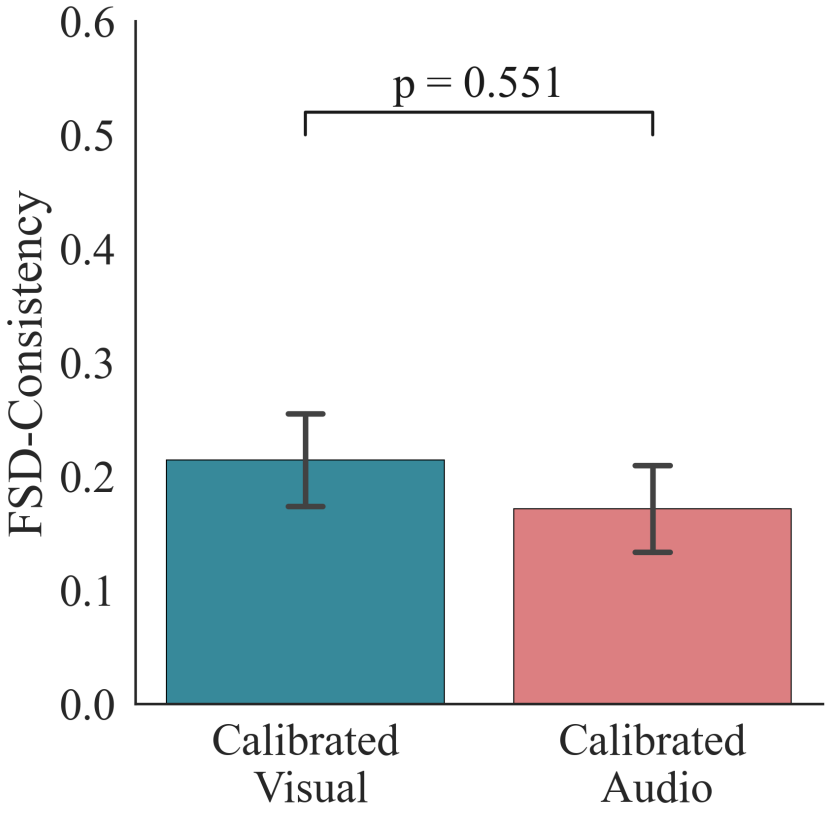
Calibrated Visual Treatment

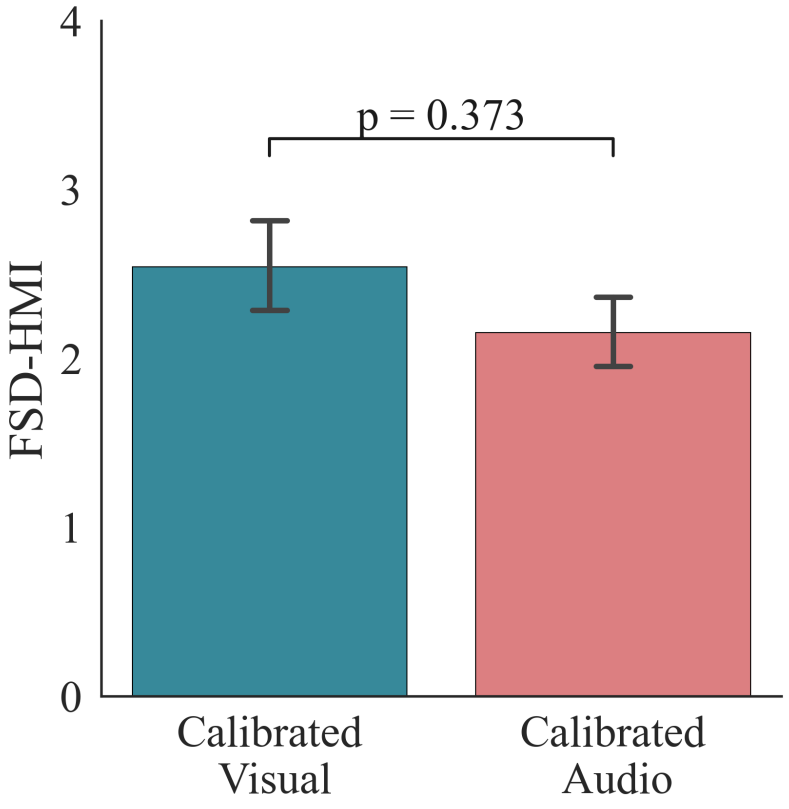
Calibrated Visual Treatment

Calibrated Visual Treatment

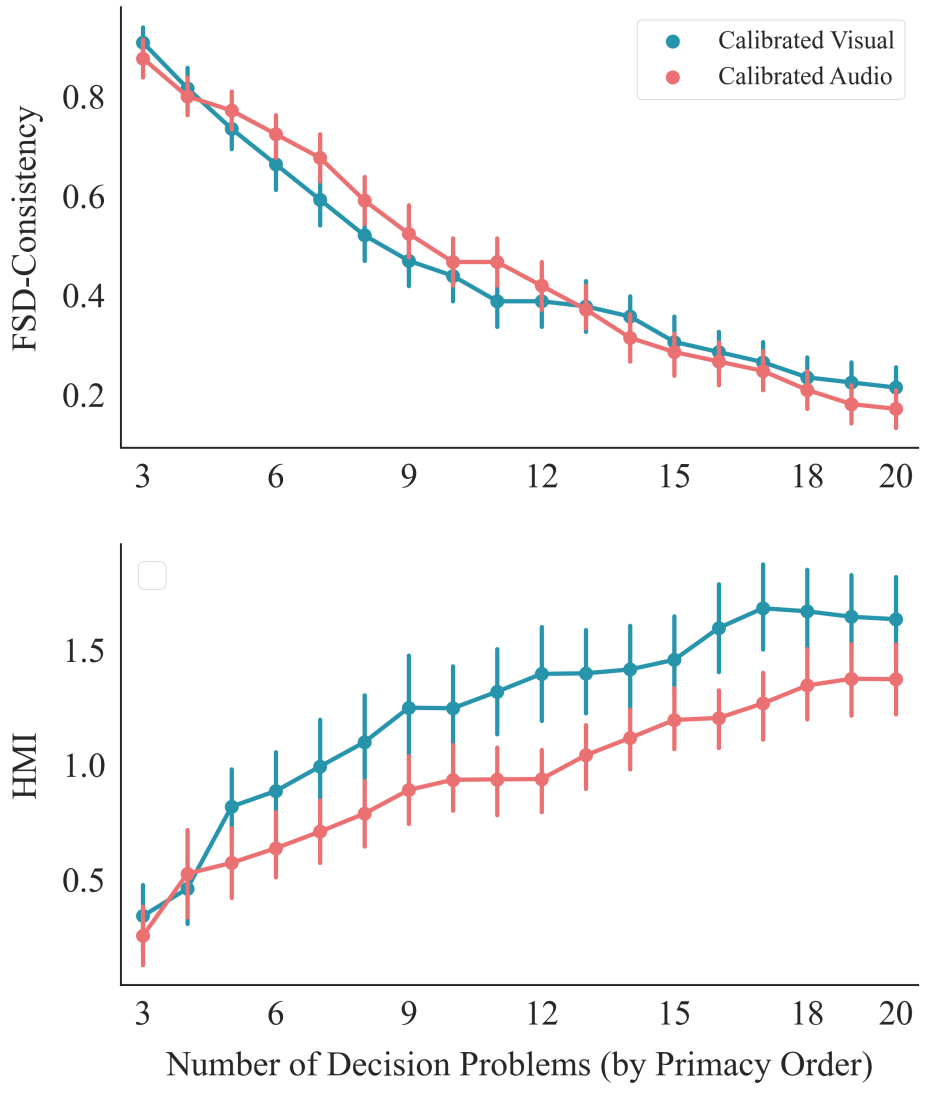
Calibrated Visual Treatment

Experiment 2: Economic Rationality (FSD)

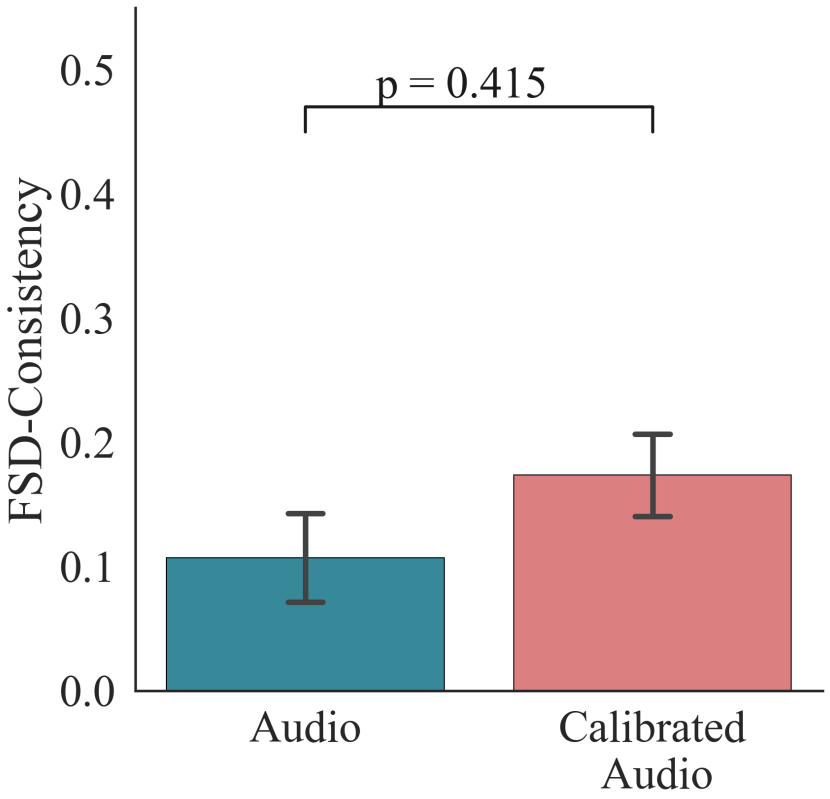


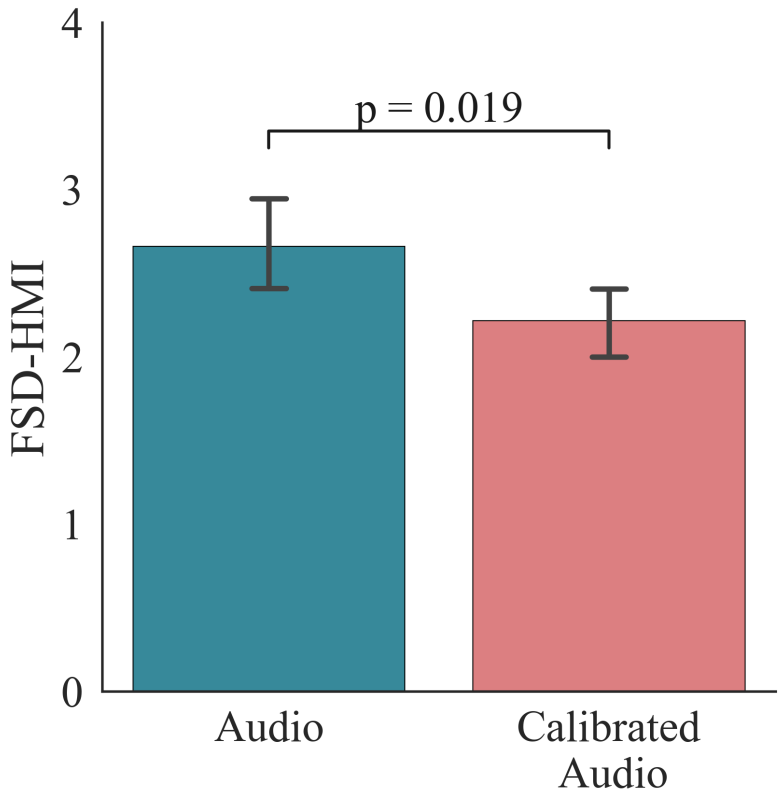


Experiment 2: Economic Rationality (FSD) Dynamics



Calibrated Audio vs. Audio (FSD)





Regressions on Risk Preferences

- Results based on the sample with FSD-HMI≤ 1:

	CRRA Utility Index			
	Calibrated Visual vs. Visual		Calibrated Audio vs. Visual	
	(1)	(2)	(3)	(4)
Female	1.101***	2.452***	1.096***	2.412***
	(0.352)	(0.658)	(0.309)	(0.680)
Sequential Treatment	-1.080**	0.348	-0.711	0.508
	(0.491)	(0.301)	(0.582)	(0.410)
Female $\times$ Sequential Treatment		-2.449***		-1.982**
		(0.769)		(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; *** $p < 0.01$, ** $p < 0.5$