Society for NeuroEconomics
NEUROSCIENCE • PSYCHOLOGY • ECONOMICS

20th Annual Meeting
Crystal City,
Arlington, VA
Sep 30 – Oct 2, 2022

Orthogonal Neurocomputational Modules that Shape Levels of Rationality in Strategic Interactions

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Introduction

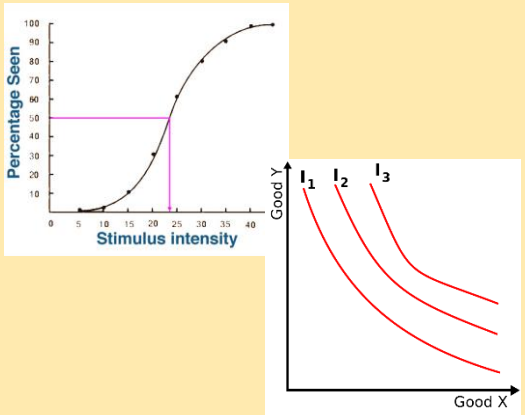
Research question

Some people think more steps ahead when facing strategic interactions

Theoretical tools to model subjects' levels of reasoning

Understand the neurocomputational cognitive modules that shape levels of rationality

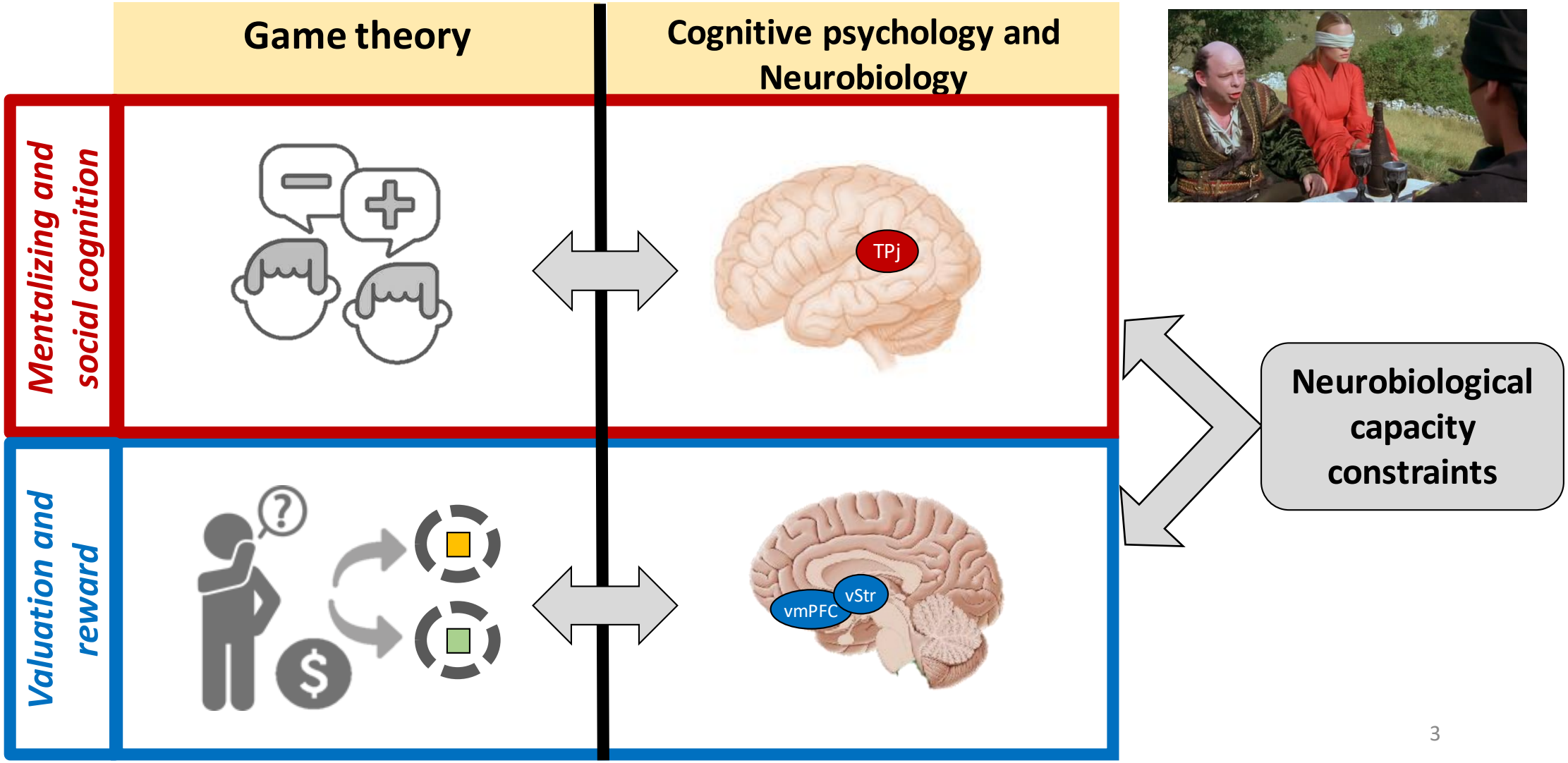
Design concepts from psychophysics and modeling approach from Revealed Preference Theory



Level-k Model (Nagel, 1995)
Cognitive Hierarchy Model (Camerer, Ho & Chong, 2004)
Epistemic Game Theory (Brandenburger & Dekel, 1993)

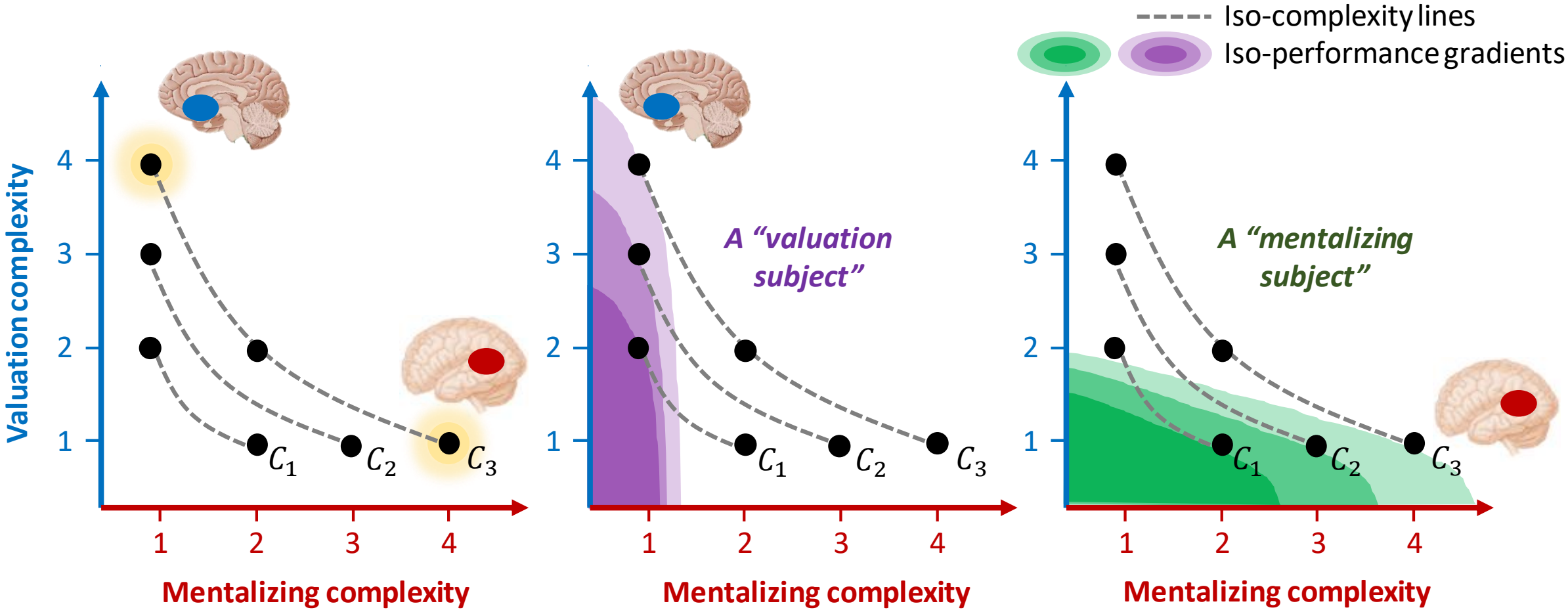
Introduction

Orthogonalizing the cognitive modules of strategic interactions



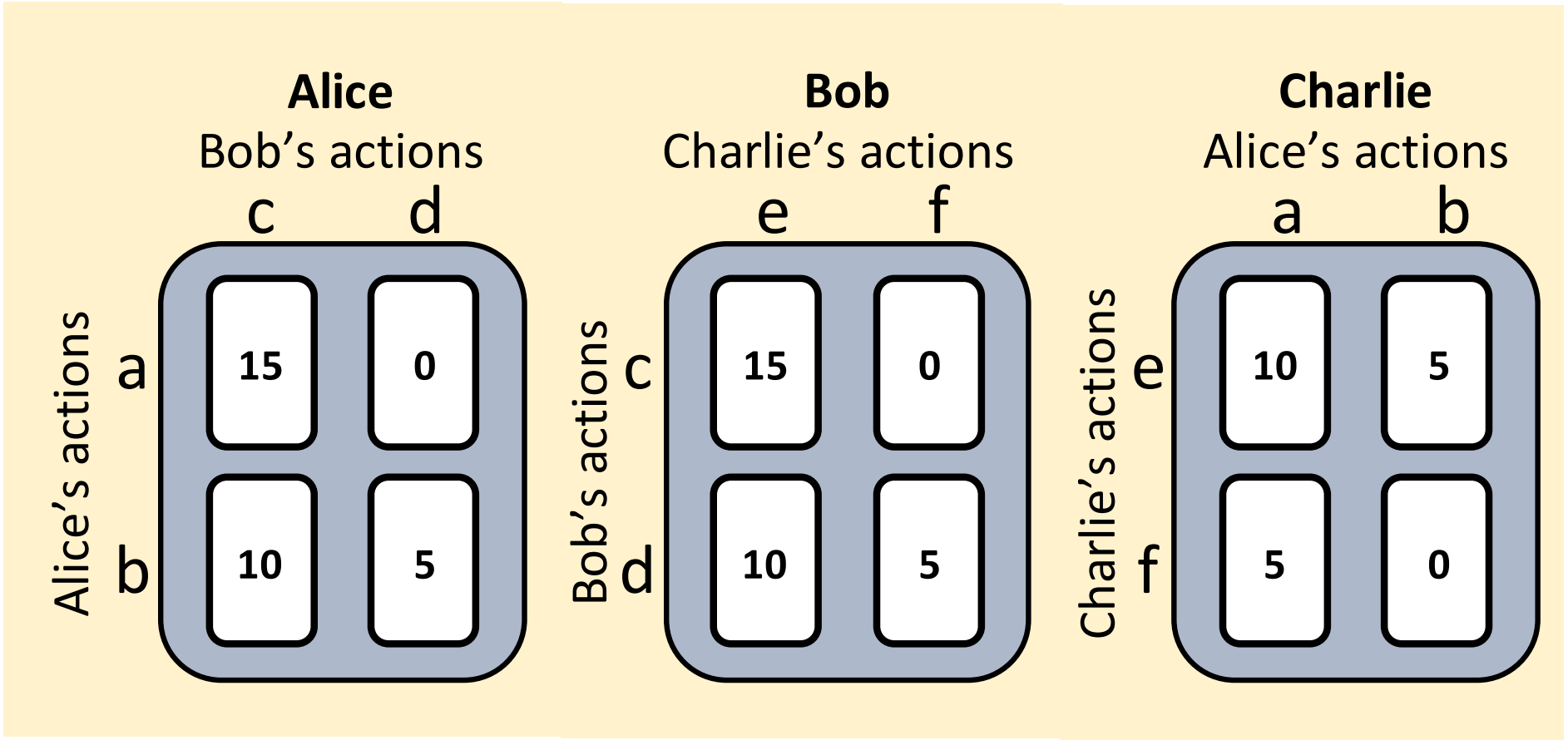
Computational framework

Capacity tradeoffs between social and valuation demands



Task

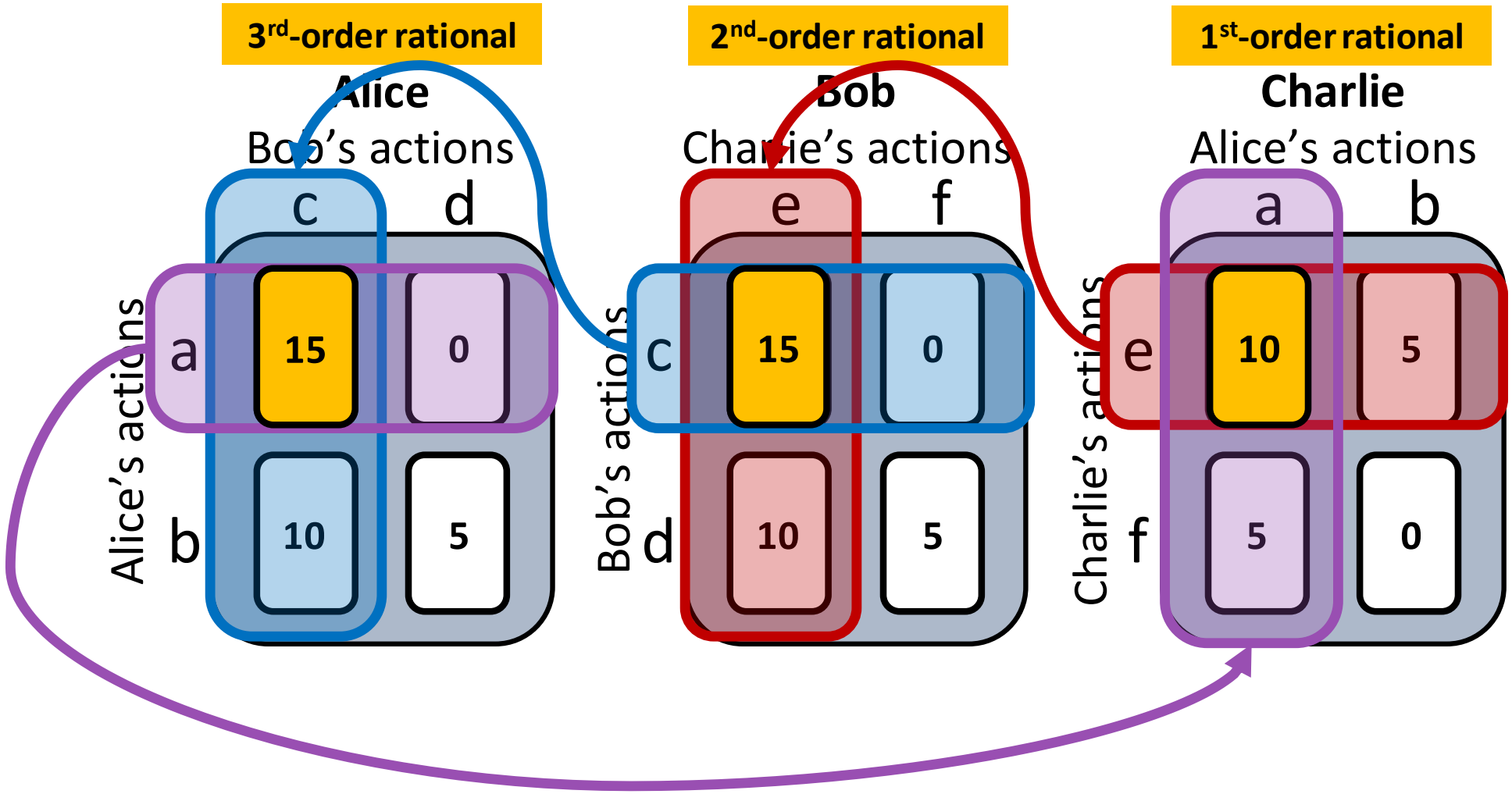
The Ring Game



Kneeland (Econometrica,2015)

Task

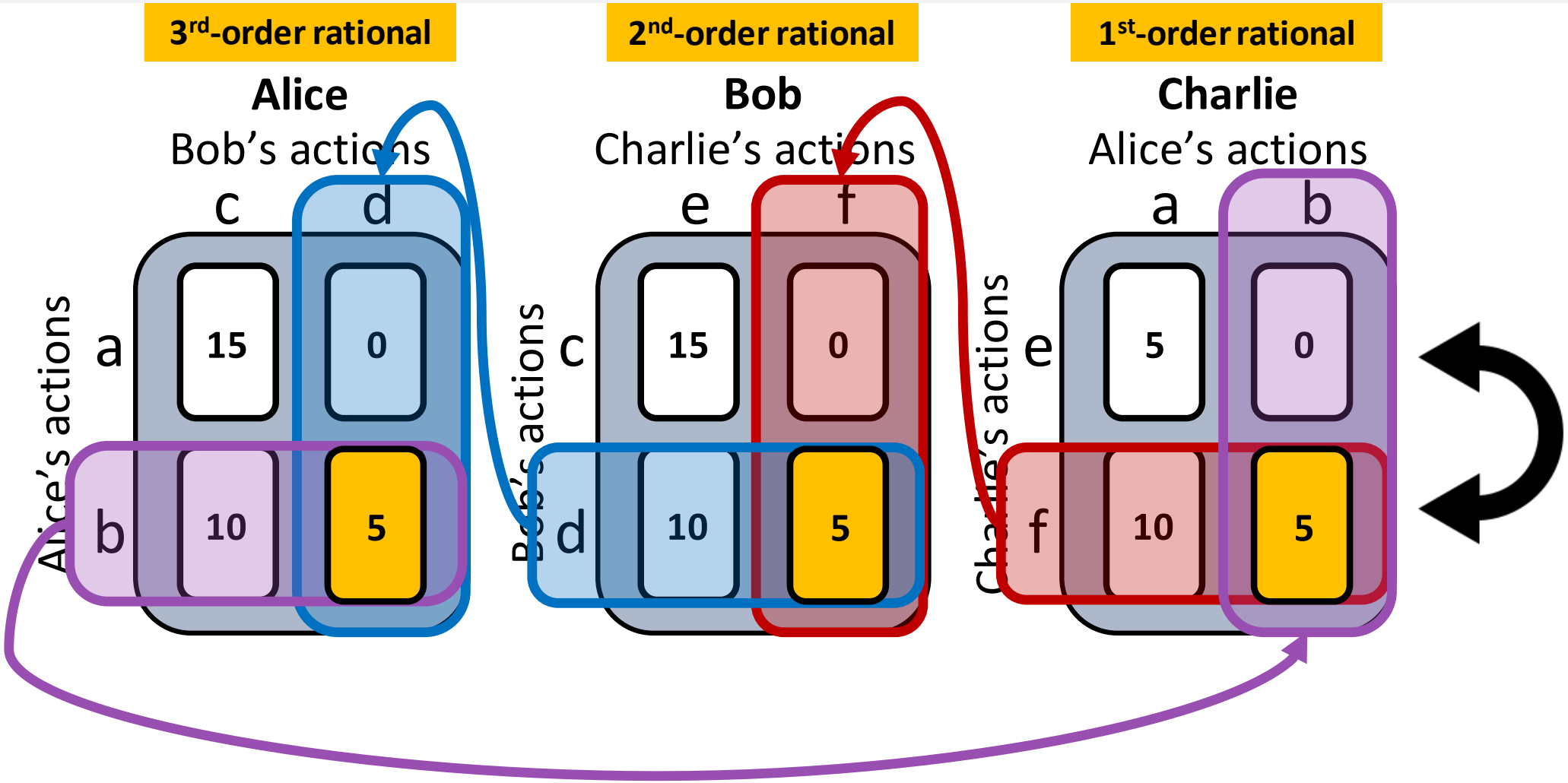
Levels of rationality



Kneeland (Econometrica,2015)

Task

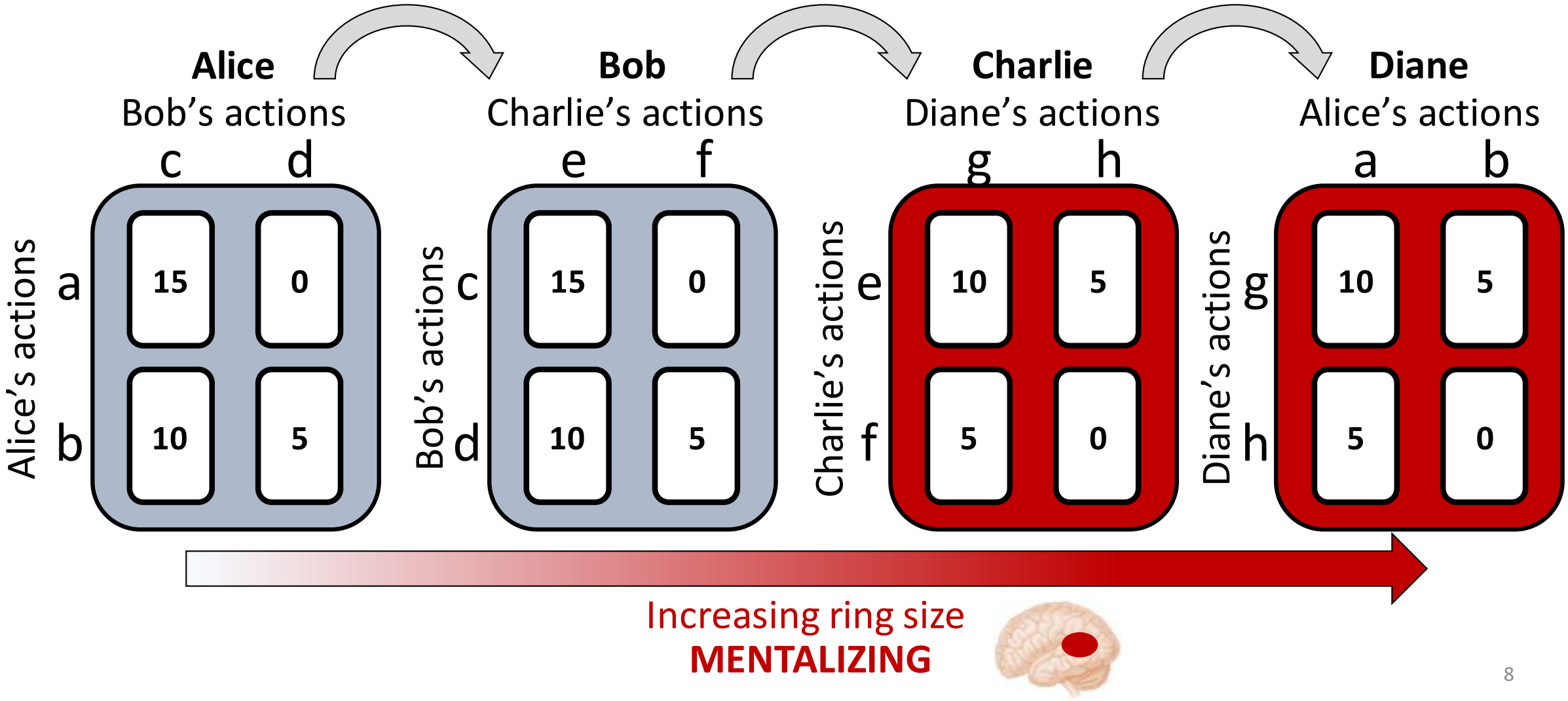
Exclusion Restriction criterion and identification strategy



Kneeland (Econometrica,2015)

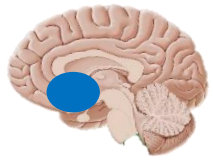
Task

Testing the **MENTALIZING** axis



Task

Testing the **VALUATION** axis



VALUATION

Increasing choice set size

Alice

Bob's actions

Alice's actions	e	f	g	h
a	13	2	10	5
b	6	4	8	12
c	8	15	3	4
d	5	1	14	10

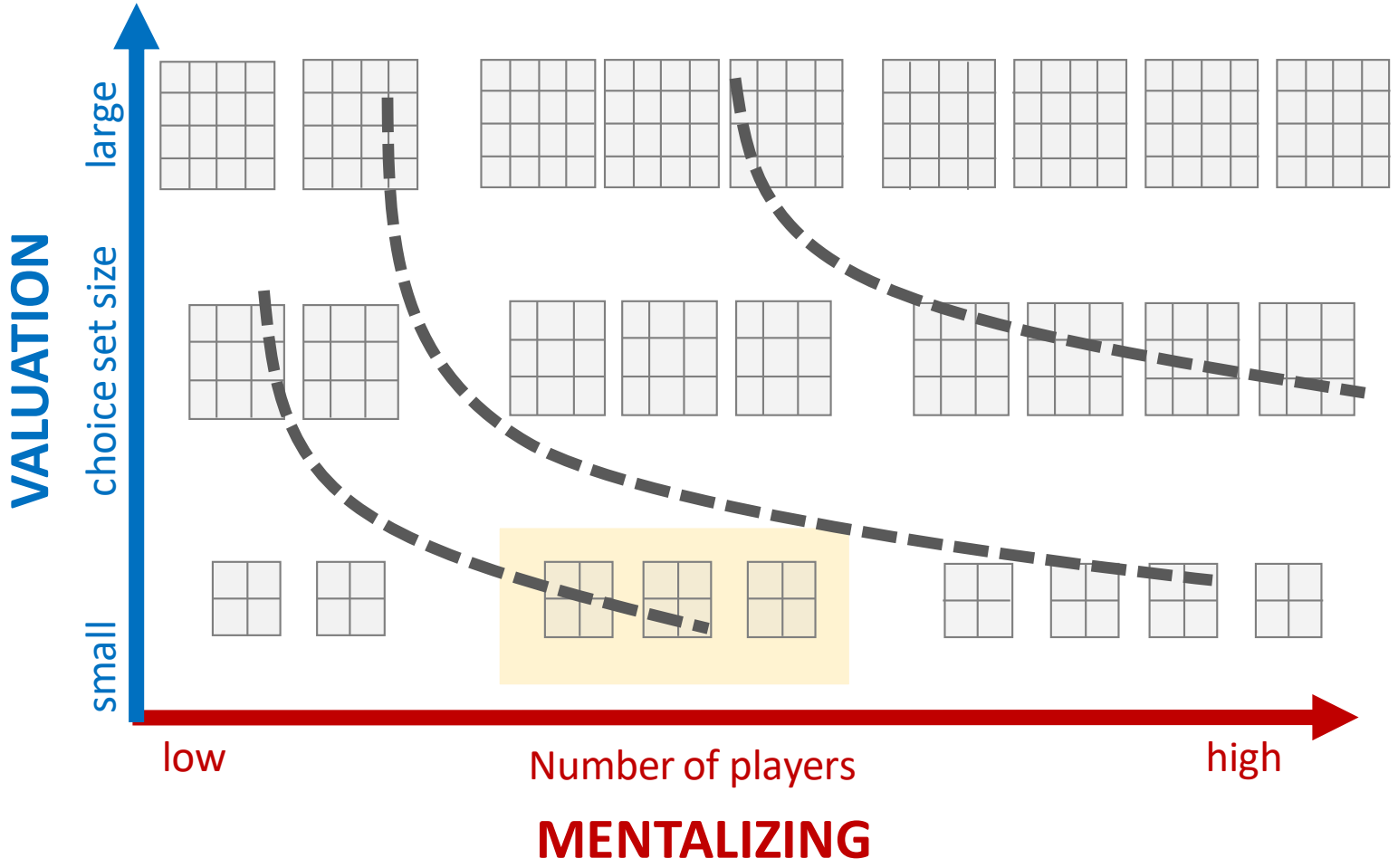
Bob

Alice's actions

Bob's actions	a	b	c	d
e	11	9	2	8
f	15	10	5	10
g	11	6	4	9
h	12	8	4	6

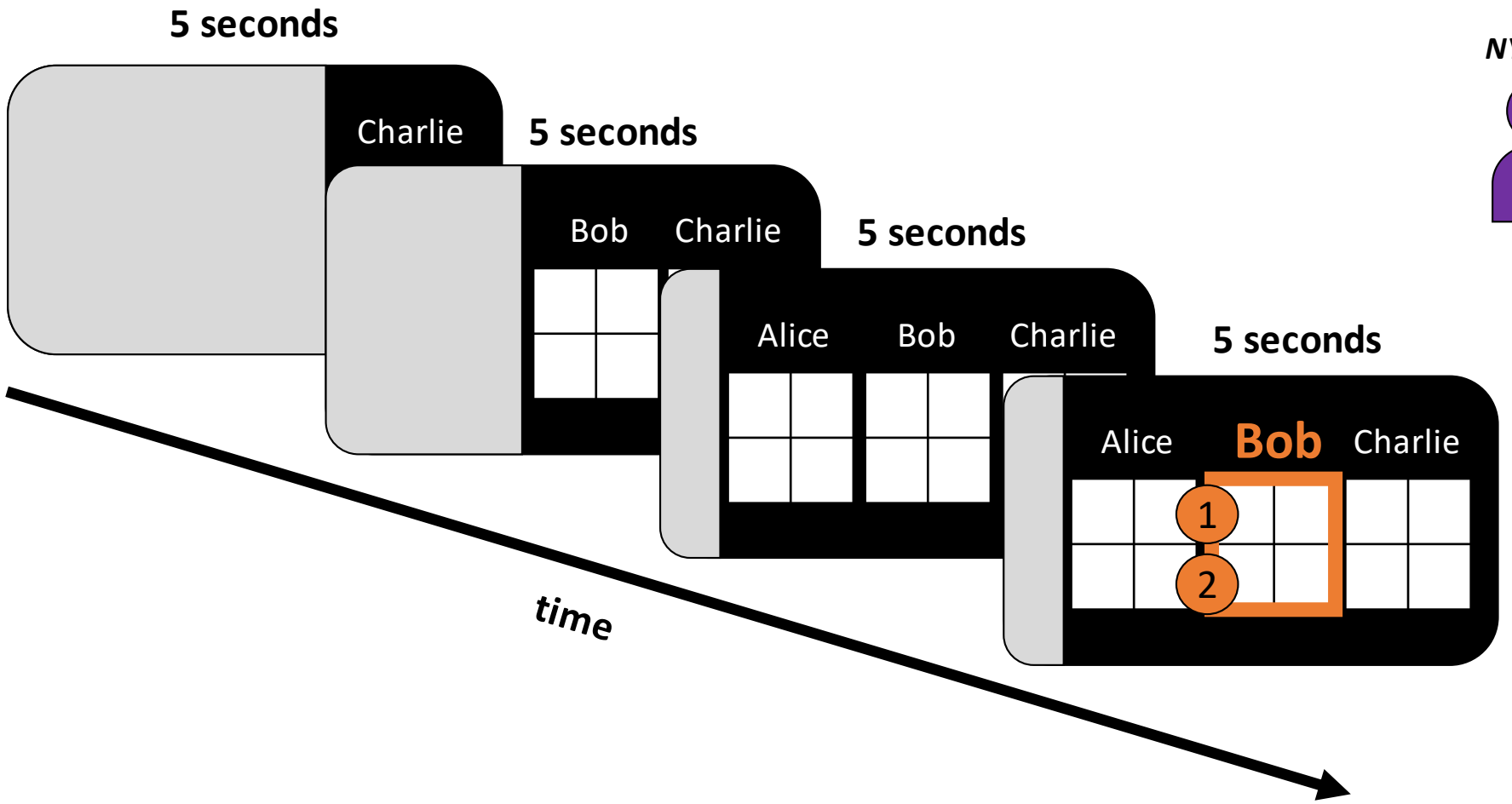
Experimental design

A full array of rings to disentangle mentalizing from valuation demands

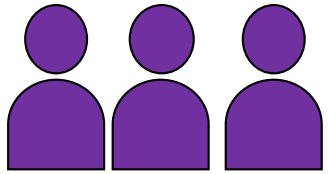


Experimental design

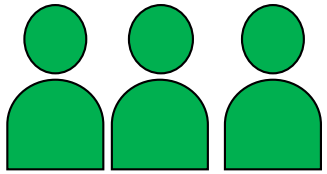
Procedure



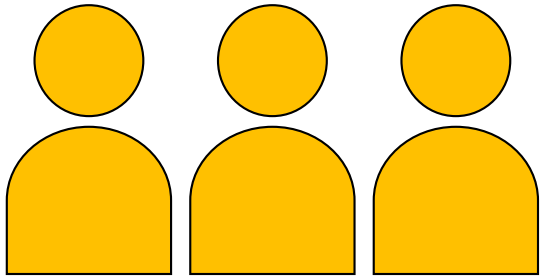
NYU students, N=54



CraigsList sample, N=56

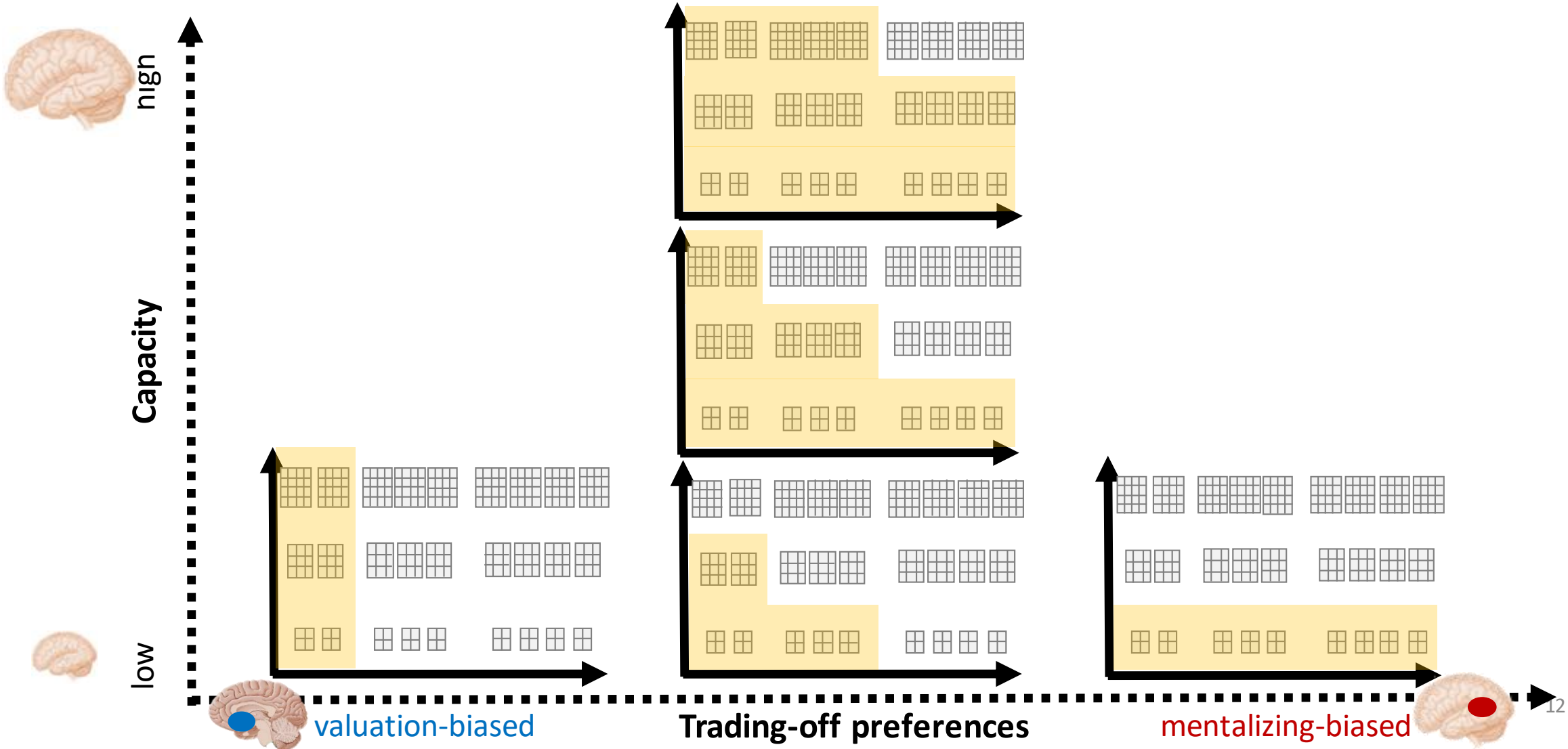


combined sample, N=110



Capacity frontiers: identification of cognitive capacity and trade-offs

A revealed preference approach



Individual level results

$$performance\ index = \frac{\%\ strategic\ -\ chance\ level}{1\ -\ chance\ level}$$

high

Capacity

low

valuation-biased

Sub. 186

Choice set size (valuation complexity)

4
3
2

2 3 4

Number of players (Mentalizing complexity)

Sub. 110

Choice set size (valuation complexity)

4
3
2

2 3 4

Number of players (Mentalizing complexity)

Sub. 405

Choice set size (valuation complexity)

4
3
2

2 3 4

Number of players (Mentalizing complexity)

Sub. 507

Choice set size (valuation complexity)

4
3
2

2 3 4

Number of players (Mentalizing complexity)

s

mentalizing-biased

Fully rational

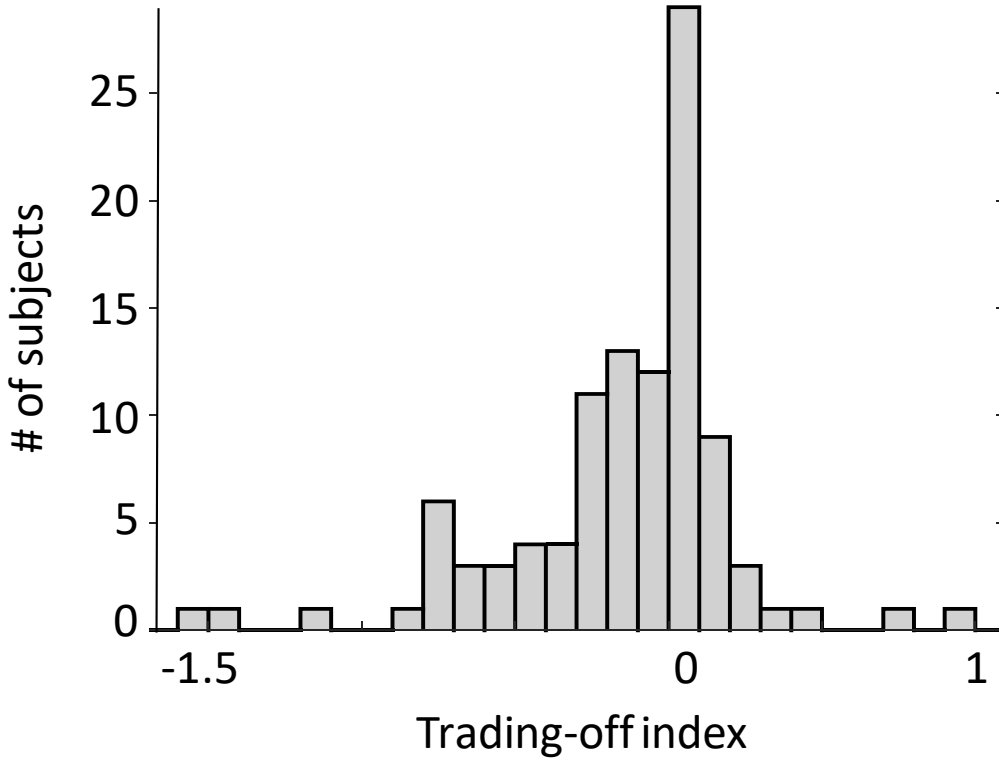
1

Performance index

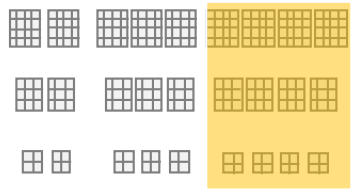
0

Random choice

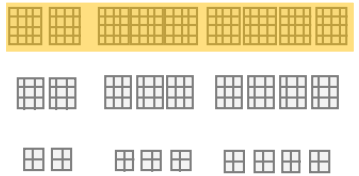
Quantifying capacity and trading-off preferences



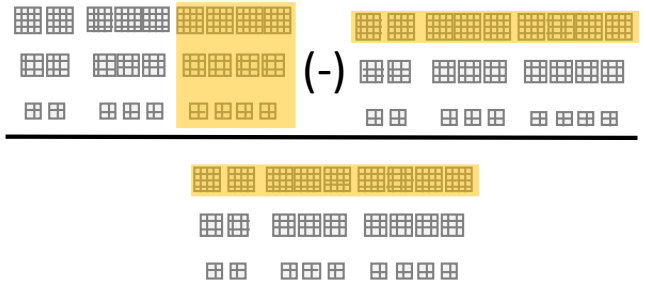
$$mentailing\ score = perfrmance\ index\ 4p\ rings$$



$$valuation\ score = performance\ index\ 4 * 4\ matrices$$



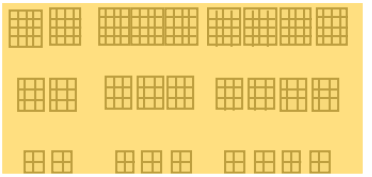
$$trading\ off\ index = \frac{(mentalizing\ score\ - valuation\ score)}{valuation\ score}$$

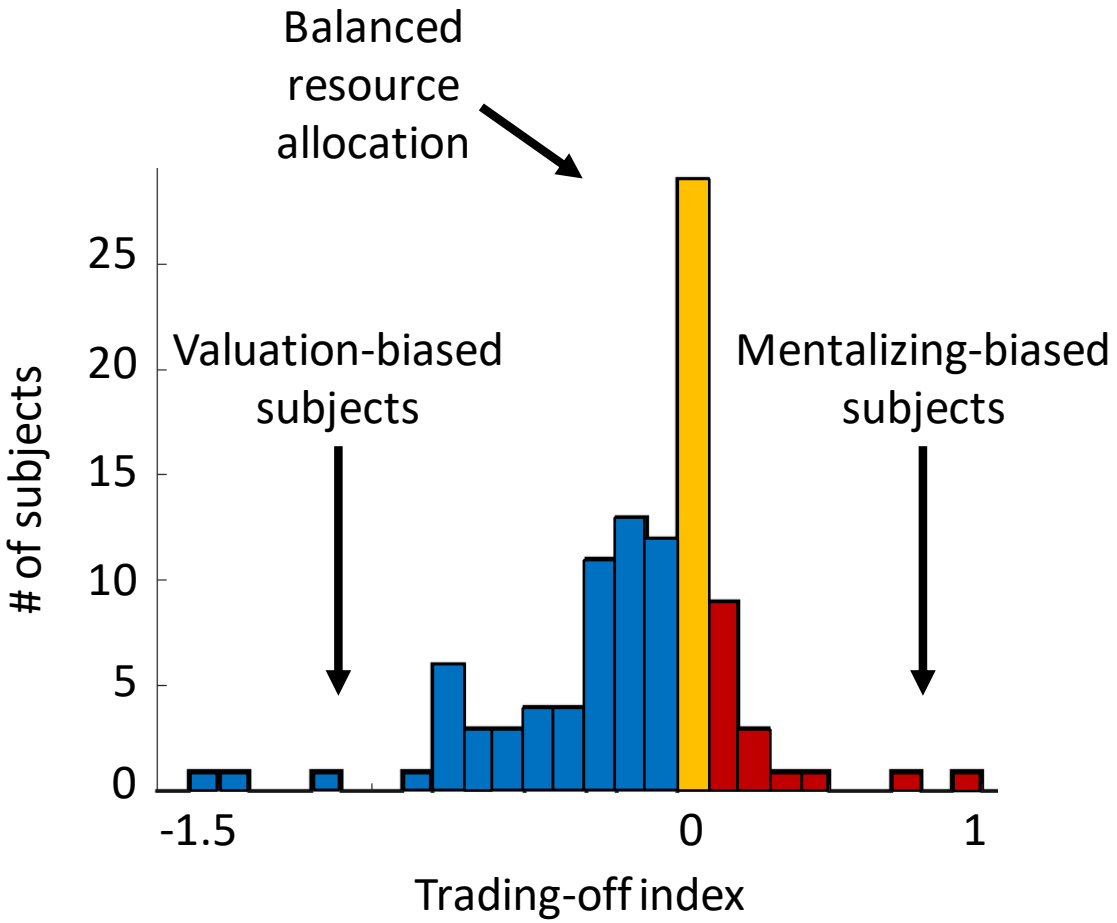


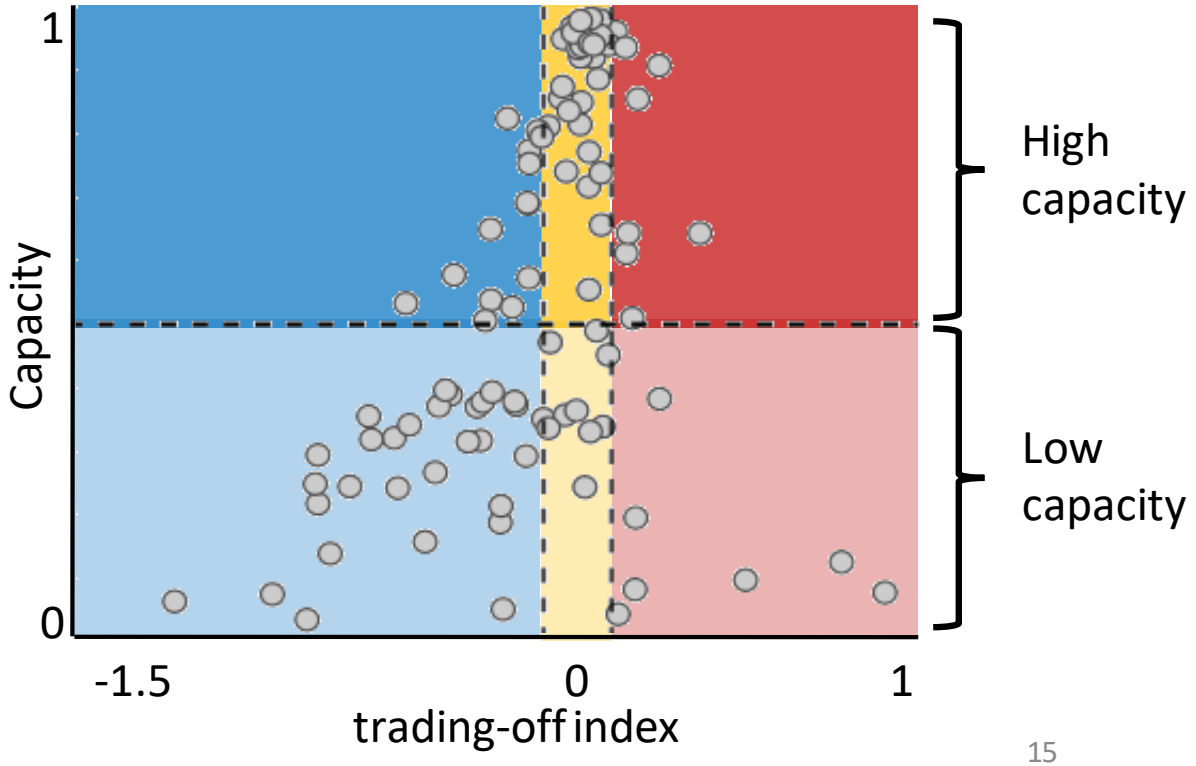
Quantifying capacity and trading-off preferences

$$trading\ of f index\ = \frac{(mentalizing\ score\ - valuation\ score)}{valuation\ score}$$

$$Capacity = \ Average\ performance =$$

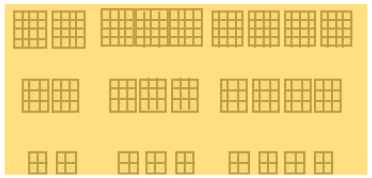


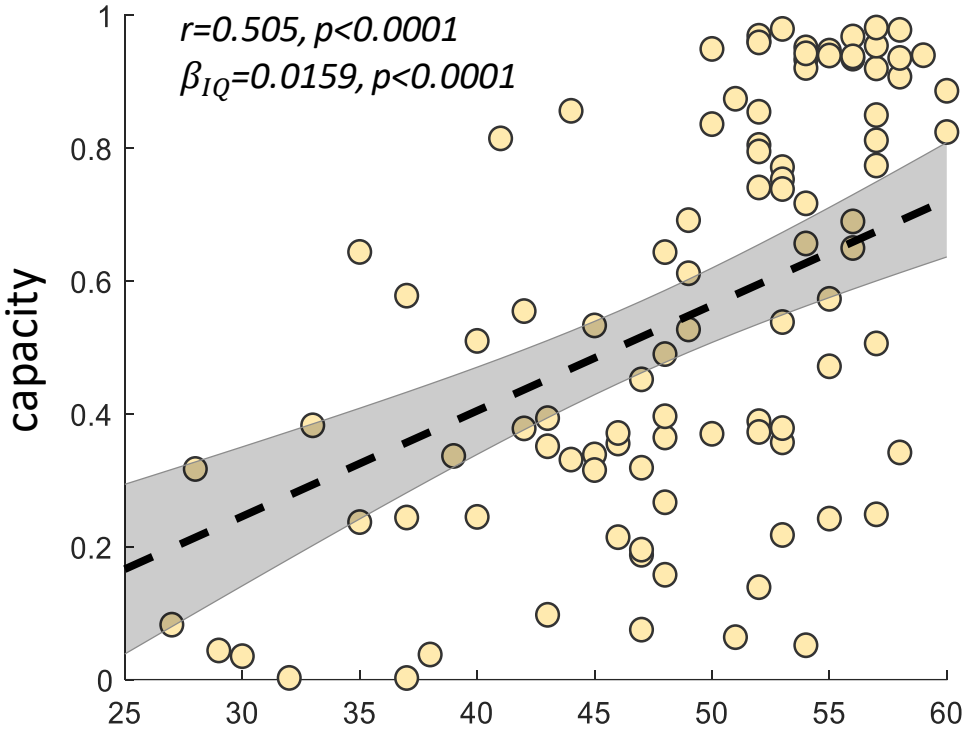




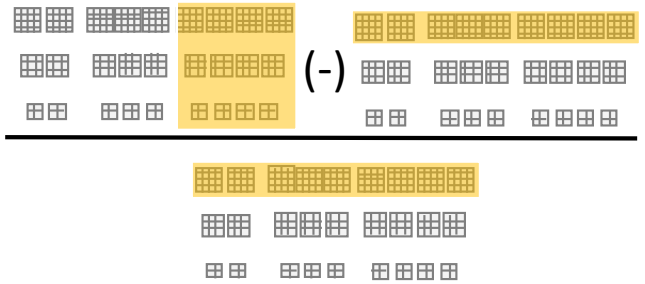
Validating the results

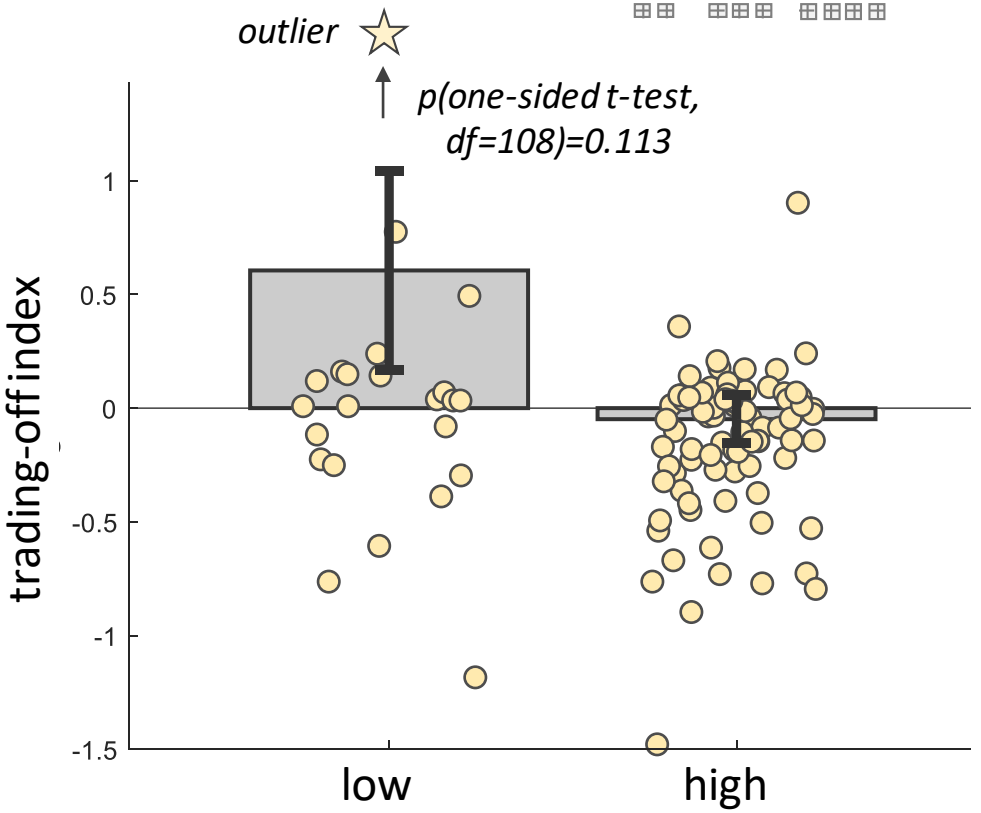
Capacity =



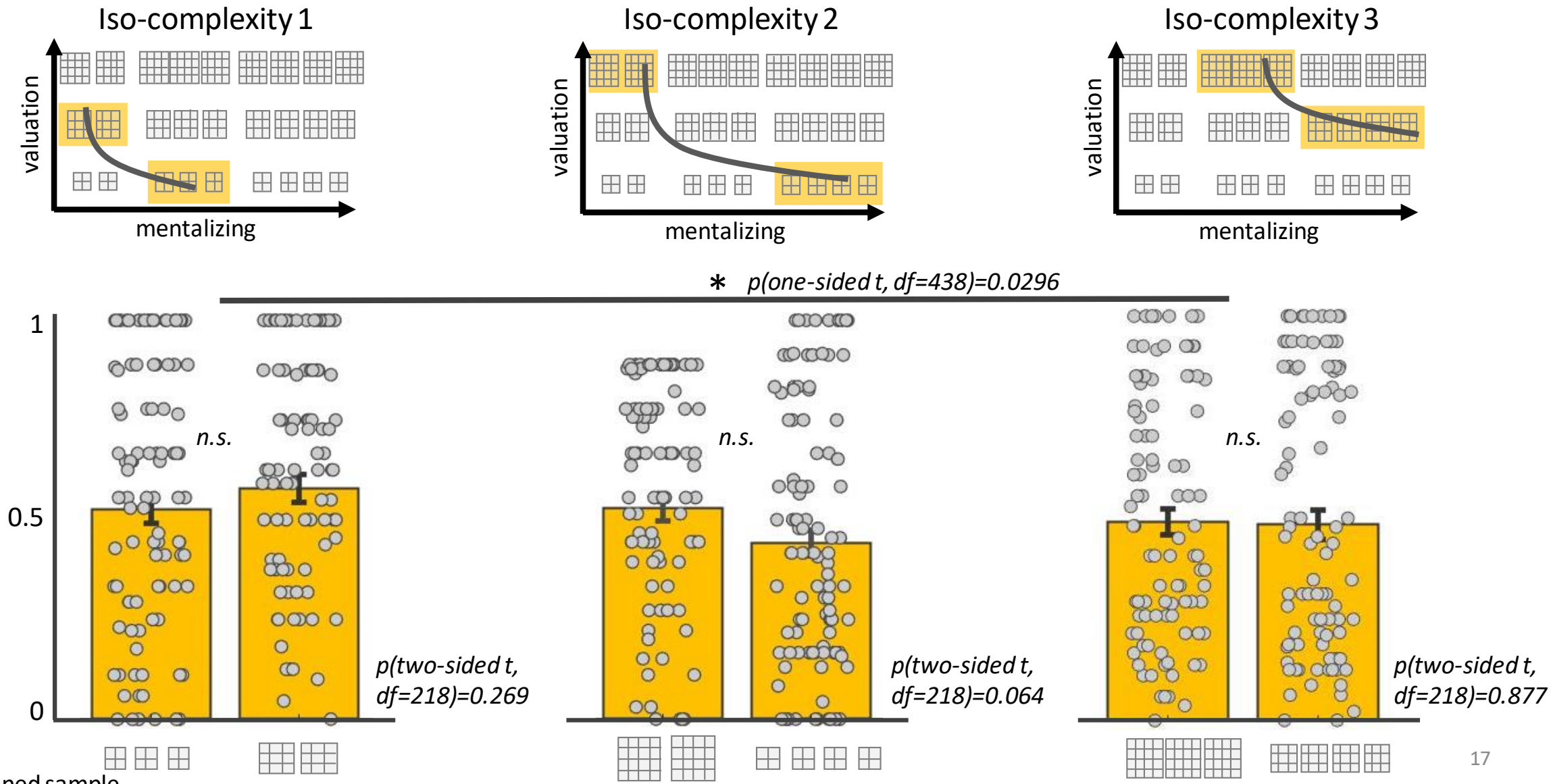


Trading-off index =



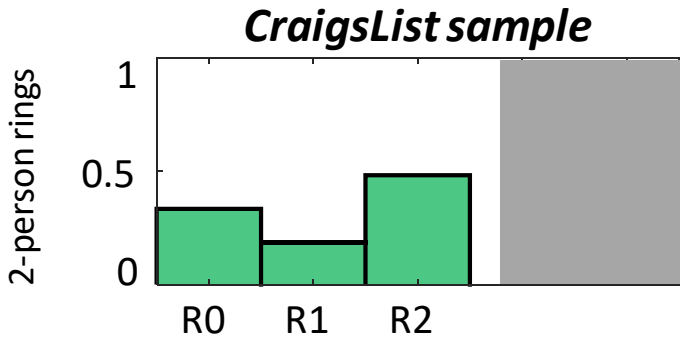


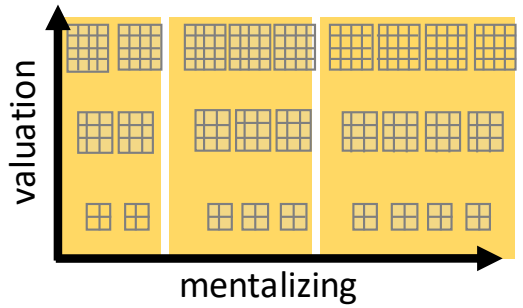
Performance on iso-complexity lines



(*) Combined sample

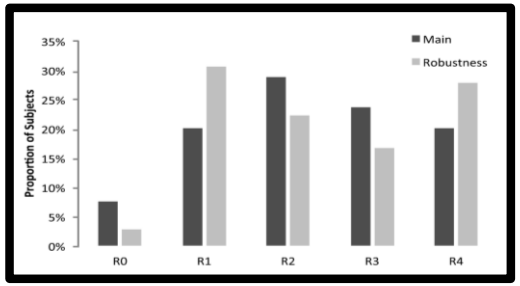
Identification of rationality levels





Frequency

Kneeland (2015)

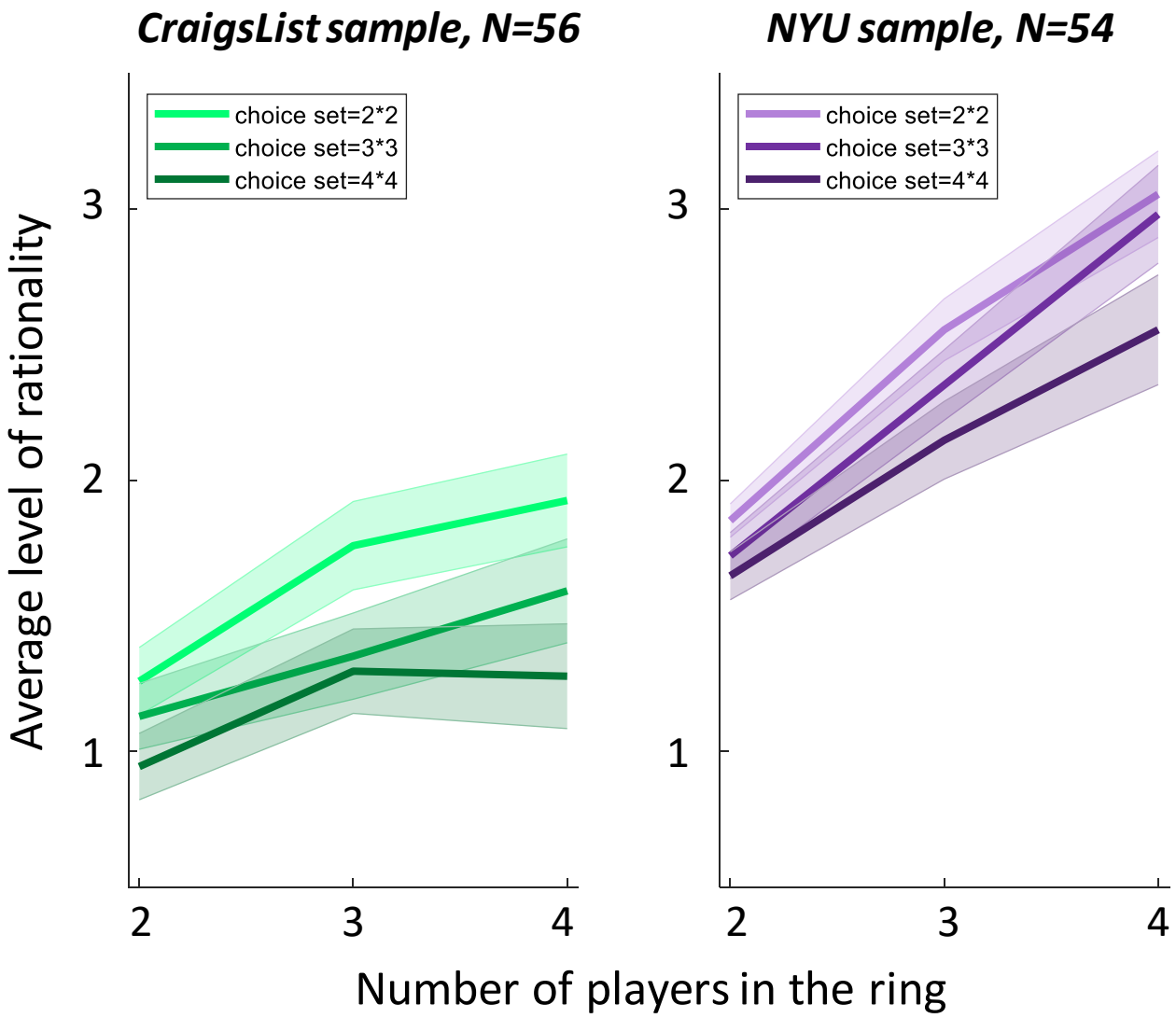


Median level of rationality

Psychometric curves of strategic reasoning

NYU sample

CraigsList sample



CraigsList regressions (with FEs):

$\beta_{num\_players}$ = 0.101 , p<0.0001

$\beta_{choice\_set\_size}$ = 0.044, p=0.661

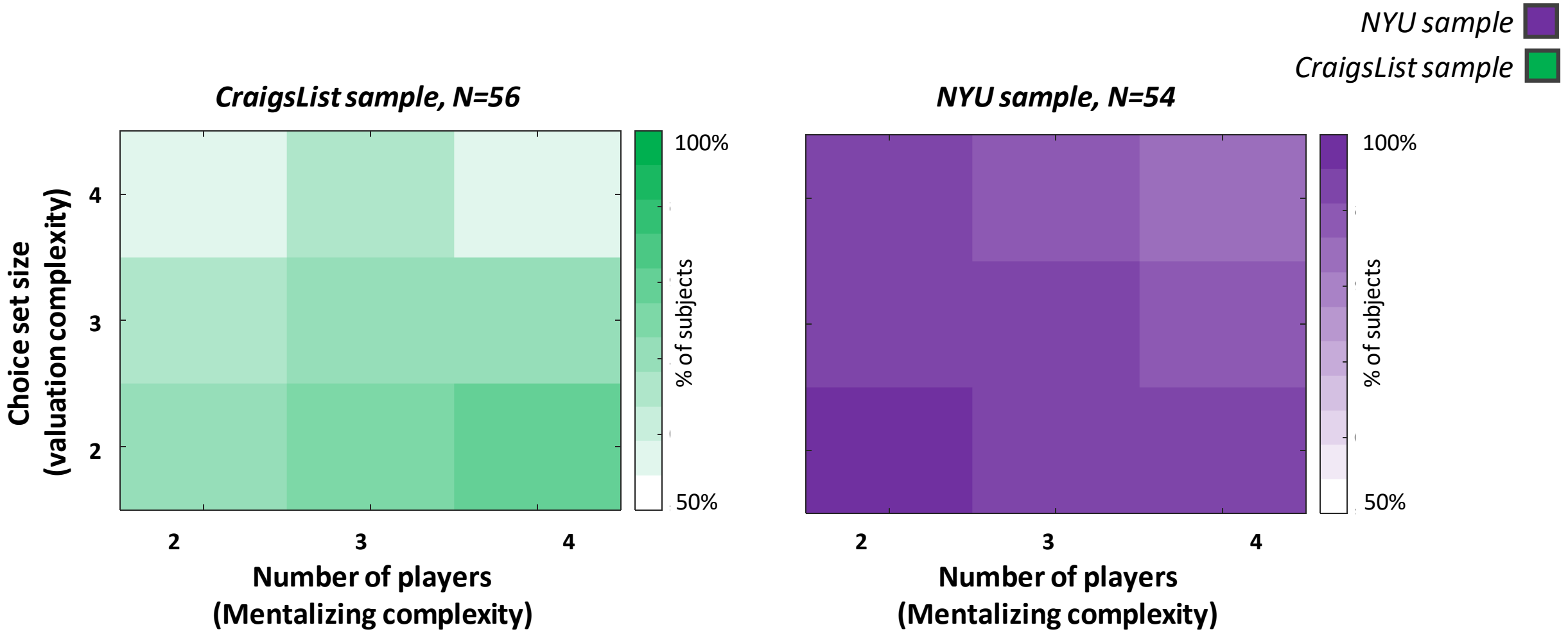
$\beta_{interaction}$ = -0. 1 , p=0.002

NYU regressions (with FEs):

$\beta_{num\_players}$ = 0.560 , p<0.0001

$\beta_{choice\_set\_size}$ = -0.177, p<0.0001

Chances of being (at least) rational of level 1

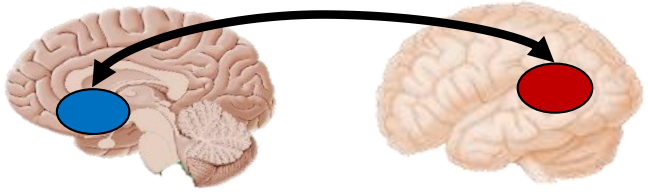


CraigsList regressions (logit, with FEs):
$\beta_{num\_players} = 0.655$, $p<0.0001$
$\beta_{interaction} = -0.073$, $p<0.0001$

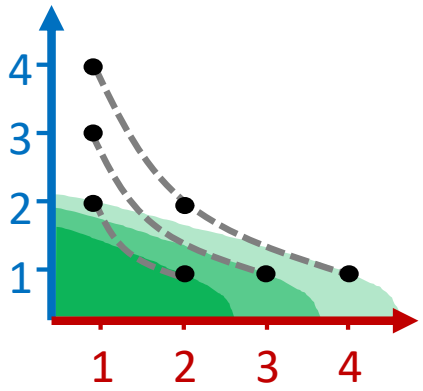
NYU regressions (logit, with FEs):
$\beta_{num\_players} = 0.806$, $p<0.0001$
$\beta_{interaction} = -0.208$, $p<0.0001$

Summary

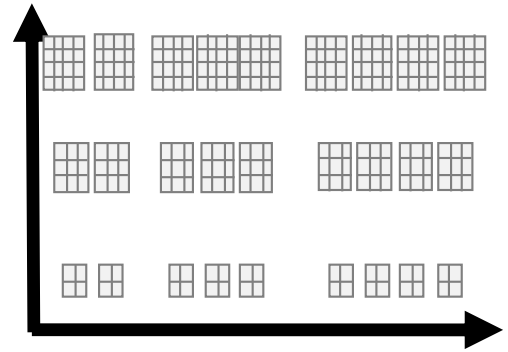
Neurocomputational foundations of levels of rationality



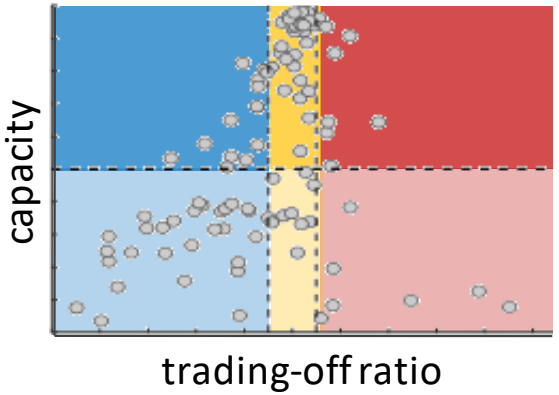
Novel framework



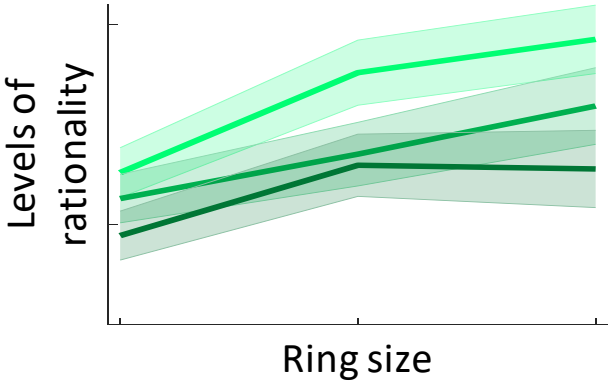
Operationalization



Mapping trading-off preferences and capacity



Psychometric analysis



Future directions

Thank you

Glimcher lab members

Dr. Paul Glimcher
Dr. Kenway Louie
Dr. Candace Raio
Dr. Bo Shen
Dr. Aysu Secmen
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Zih-Yun (Eve) Yan
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Aadith Vittala
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