

# **Rationality in preference formation**

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# 1) Transitivity of preferences

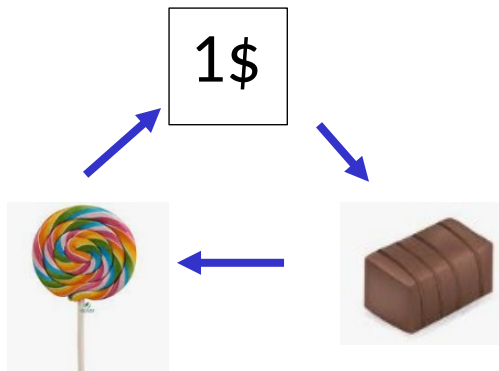
## *Transitivity as a measure of rationality*

Von Neumann–Morgenstern Utility Theorem (1947), central axioms of Rationality:

For every  $A$ ,  $B$  and  $C$  with  $A > B$  and  $B > C$  we must have  $A > C$

Choice Transitivity Violation (CTV) inconsistent with rationality

Inconsistent preference (CTV) cause losses: “*money pumps*”

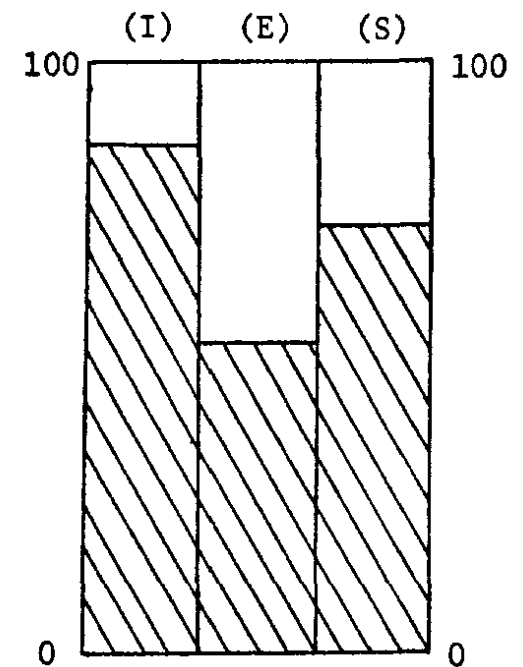


1. Buy chocolate for 1.1\$
2. Trade chocolate with lollipop
3. Sell the lollipop for 1\$
4. Lost 10¢

# Tversky (1969): violation of weak stochastic transitivity (WST) for *the lexicographic/TTB* strategy

**LEX selects the option with the best value on the most important attribute**

Applicant	Dimensions		
	I	E	S
a	63	96	95
b	66	90	85
c	69	84	75
d	72	78	65
e	75	72	55
f	78	66	45
g	81	60	35
h	84	54	25
i	87	48	15
j	90	42	5



An illustrative applicant's profile

I = intellectual ability, E = emotional stability, S = social facility.

**Intensive debate**

# Regenwetter et al. (2011) criticism of Tversky 1969

## Two arguments

1. Statistics test was not strict enough to conclude a violation of CT; Triangle-Inequality (*TI*) vs *WST*
2. Theoretical Criticism: the report of CTV may be an aggregation (averaging) artifact

Regenwetter et al, 2011; Psych Rev.

# Rationality in decision making

## 2. Invariance

Preference relation should not change with framing (selection-rejection) or choice context

Enriched

Mediocre

Shafir (1993)

*Bali*



Exotic

Expensive

versus

*Bournemouth*



Not exciting

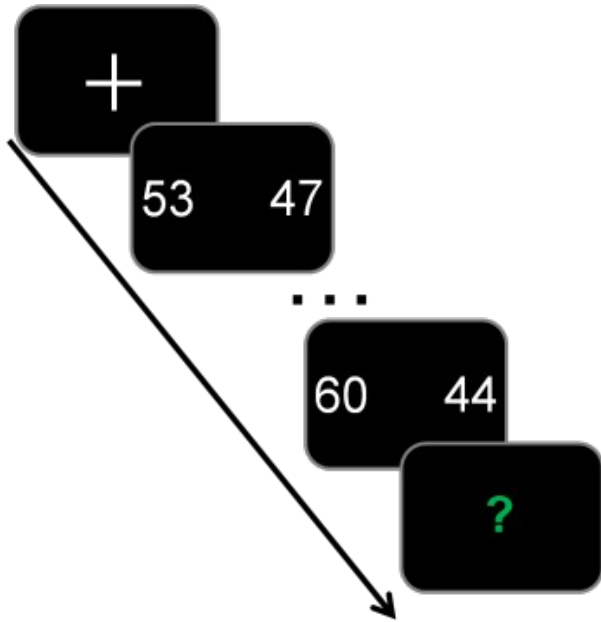
Not expensive

← Select?

← Reject?

People both select and reject  
the more variable option

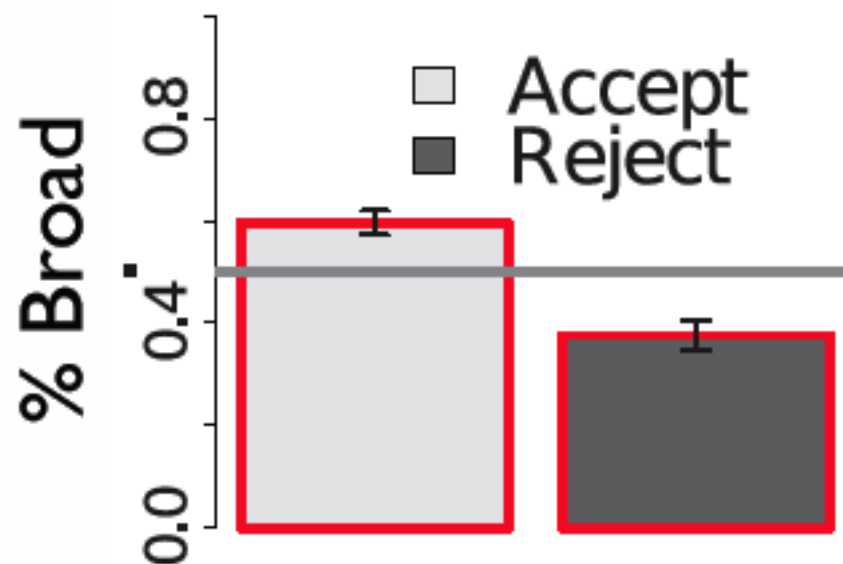
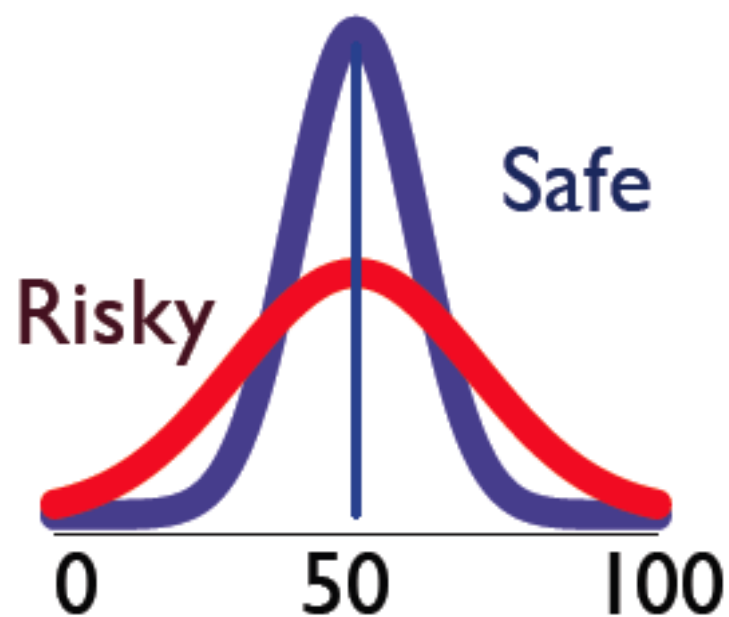
# Risk preferences (Tsestos et al., 2012; *PNAS*)



Bias towards the broad distribution → risk seeking

# Violation of invariance

Risk-attitudes obtained but easily pushed around



Risk-seeking when selecting  
Risk-aversion when rejecting

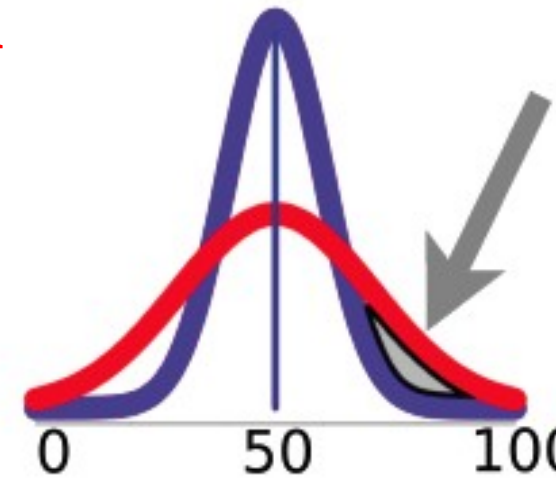
# Integration but with *saliency-based filtering*

## Selective integration model



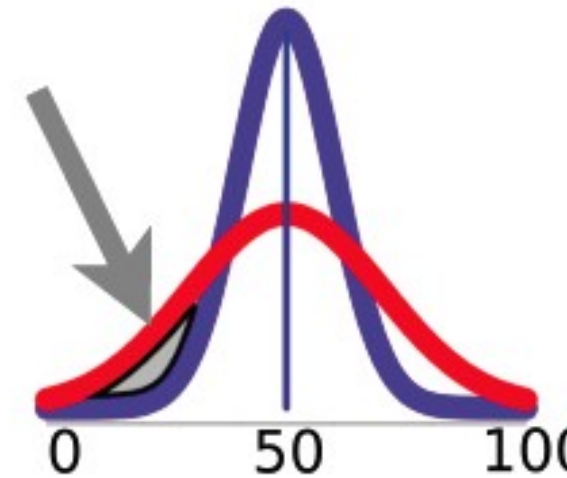
Select

Local maximum



Reject

Local minimum



**Approximates the FW-heuristic**



# A new Choice Transitivity Violation (CTV)

(Tsetsos et al., 2016; *PNAS*)



Building the alternatives:

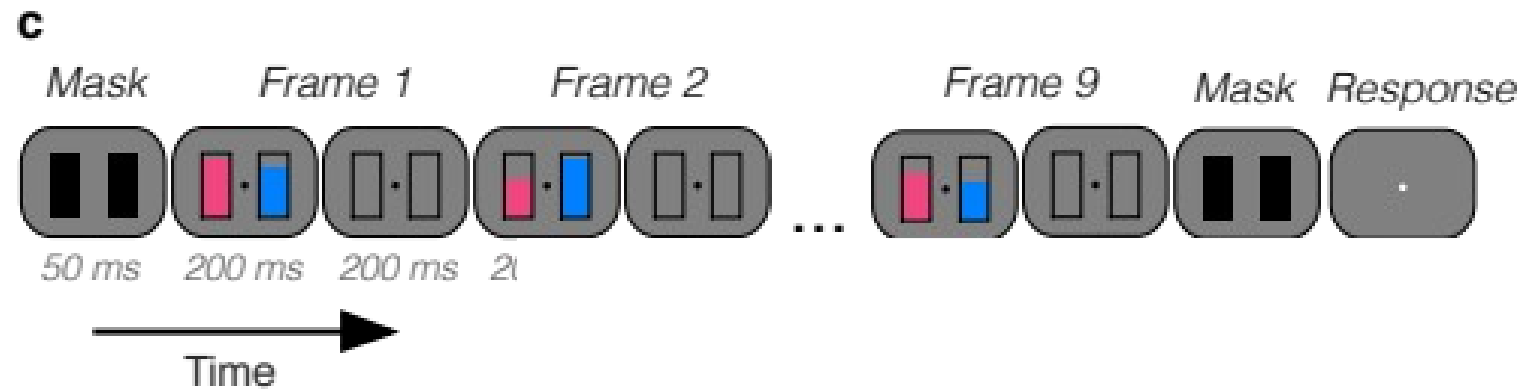
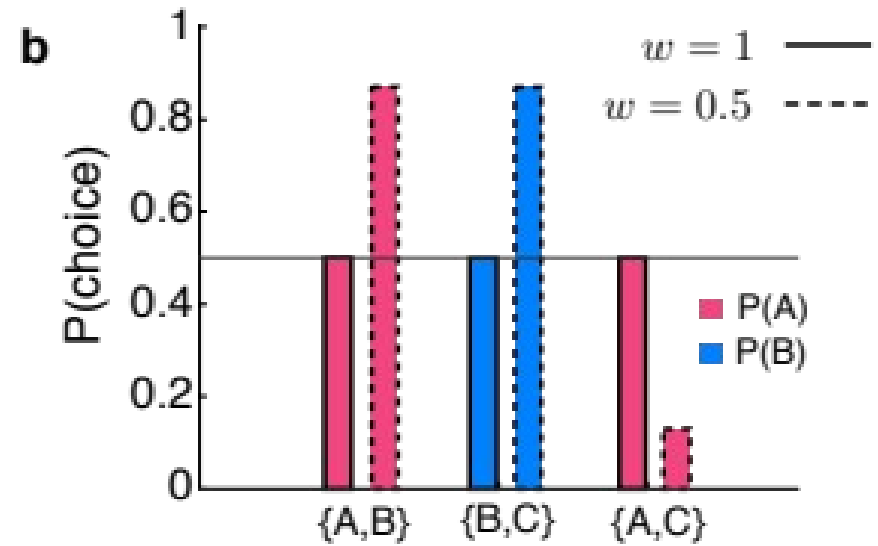
<i>Attributes</i>	A	B	C	
1	20	15	10	$A \rightarrow B$
2	15	10	20	$B \rightarrow C$
3	10	20	15	$C \rightarrow A$
Total Value	45	45	45	

Pairwise comparisons between alternatives

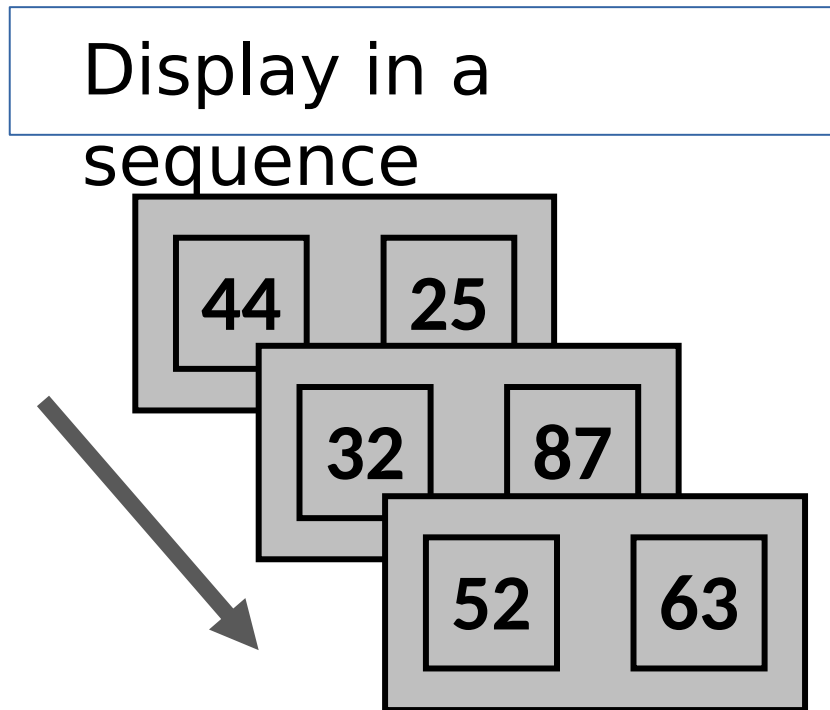
Economic irrationality is optimal during noisy decision making  
(**Tsetsos** et al, 2016)

# Selective integration → CTV (Tsetsos et al., 2016; *PNAS*)

<i>Attributes</i>	<b>a</b>			
	A	B	C	
1	20	15	10	$A \rightarrow B$
2	15	10	20	$B \rightarrow C$
3	10	20	15	$C \rightarrow A$
Total Value	45	45	45	



# Potential averaging artifact confound?



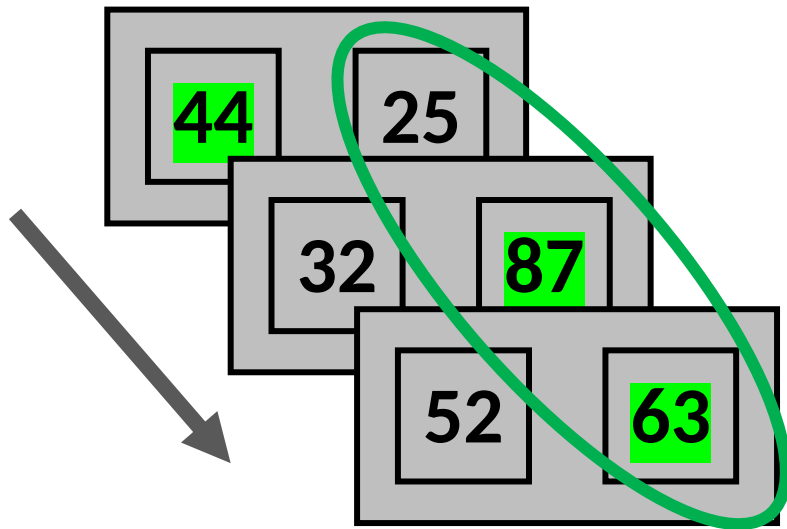
Example of sequence display



	A	B
Attribute 1	44	25
Attribute 2	32	87
Attribute 3	52	63

# Transitivity Violation

Preference according to **Frequent Winner (FW)**

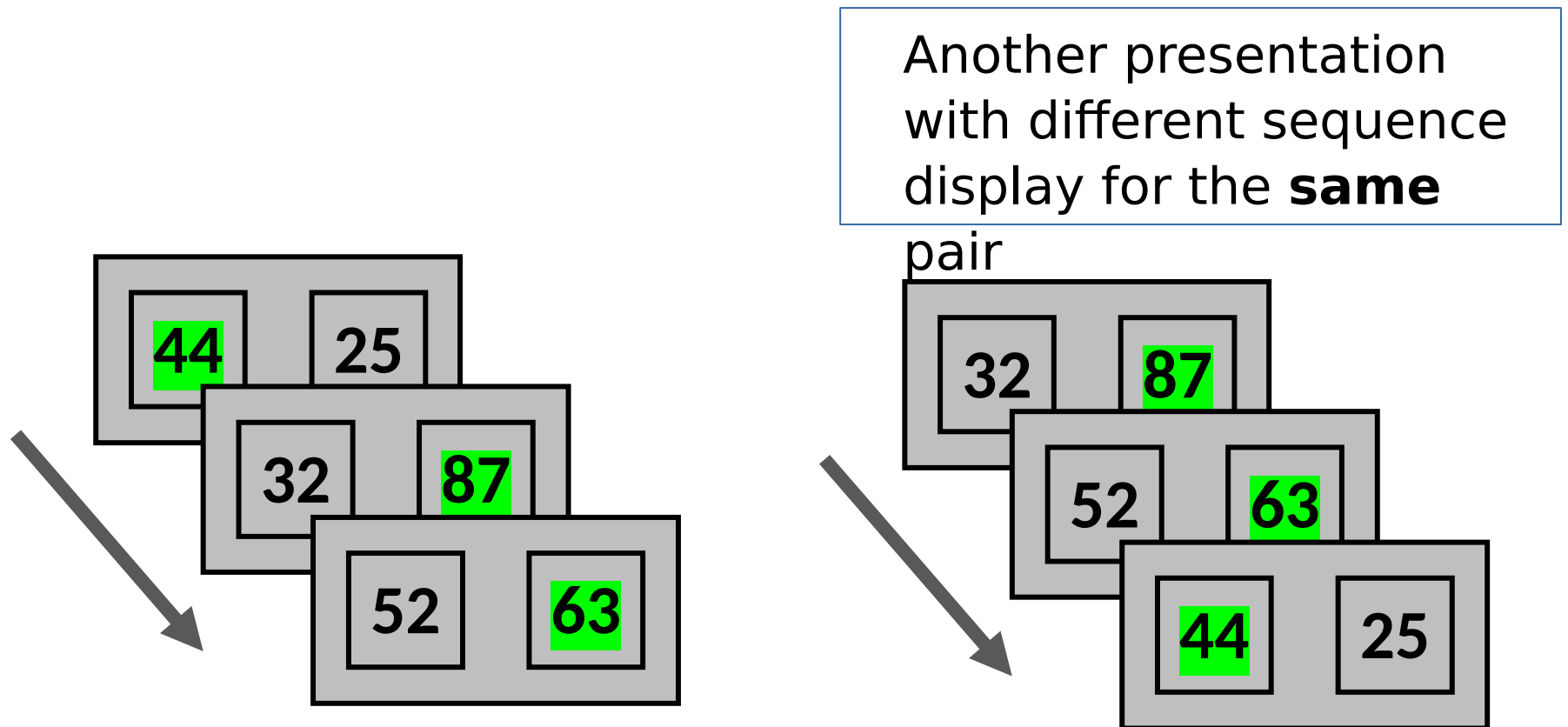


Based on Frequent Winner strategy right alternative will be preferred

Economic irrationality is optimal during noisy decision making  
(Tsetcos et al. 2016)

# Transitivity Violation

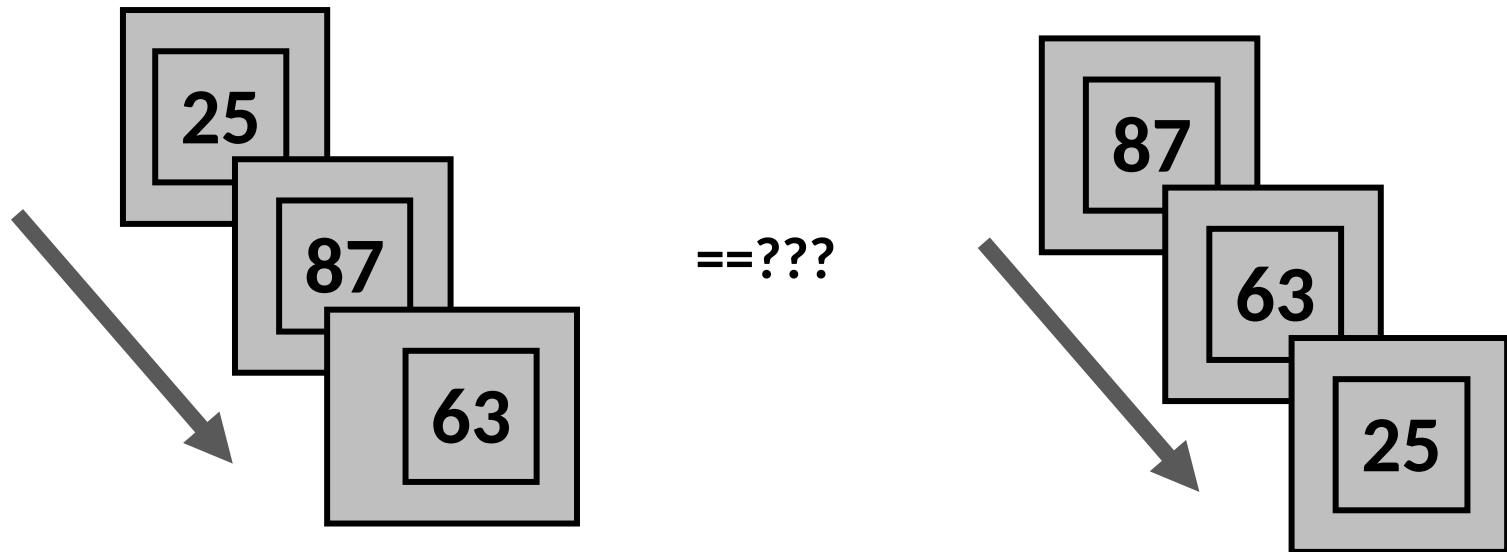
Shuffling the order to avoid recency/primacy effects



Economic irrationality is optimal during noisy decision making (Tsetsos et al, 2016)

# Criticism on Tsetso's (2016)

- Still exposed to Regenwetter's aggregation (averaging) artifact argument.
- Because of the attributes shuffling (within the alternatives), they are not exactly "the same" alternative



# New experiment

Pessach

Gil



## Motivation

Repeat Tsetsos' research under more restrictive conditions that avoid the potential averaging artifacts

## General paradigm

Presenting the choices within a single display (in same trial) and by that, avoiding sub-conditions (Tsetsos' shuffling)

## Dependent Variable: CTV (violations of WST & TI)

# Method

## Participants

24 Students, age 21-28

## Stimuli

Alternative

S:

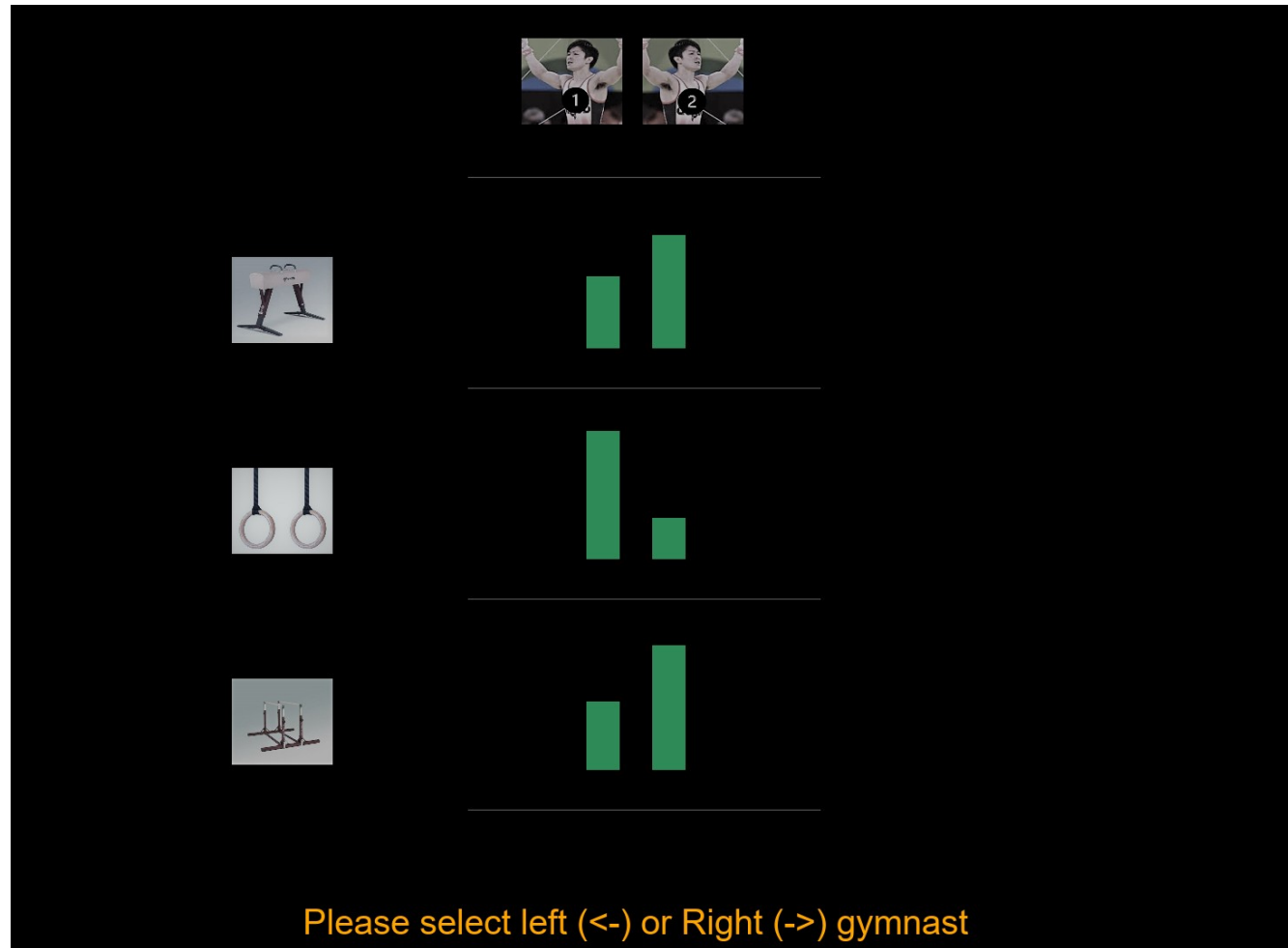
2

Attribute

S:

3

devices





## Procedure

- **Instruction**

Help select athlete who will be represent the country at the next Olympics in Gymnastics. Only one athlete can represent the country and therefore, the Olympic Committee must choose the best one.

You will be asked to choose each time a gymnast preferred from two, based on their scores in a competition on different devices. Thus, assisting the Olympic Committee in the selection.

A series of early competition results will appear, each time the scores of two gymnasts, on three different devices: pommel horse (side horse), rings, and parallel bars.

The 3 devices are equally important.

# Experiment 1 Method

## Choice types – the trials

### 1. Critical Variants (A,B, C)

Three gymnasts have “almost equal” scores totally on three devices.

From each variant 3 pairs choices are displayed (a pair in a trial).

### 2. Fillers

Choices between pair of gymnasts that have noticeable scores difference (total on 3 devices)

40 blocks: each critical pair A-B repeated 40 times;  
compute  $P(A,B)$ ,  $P(B,C)$ ,  $P(A,C)$ ; Estimate violation of **WST, TI**

# Exp-1: Results

- About 1/3 of participants violated **TI**.

Q: Why only 1/3?

A: Because people are generally consistent. Something remarkable is required for violating transitivity; In Tversky (1969), the CTV was about 30% too.

- dependency on additional factors

## 2) Heuristics vs Normative models of complex choice

SI □ FW-heuristic □ framing violation, CTV

**Complex decisions (multi-attribute) require heuristics**

- **FW**
- **TTB**

**Save resources but they have a cost □ rationality violations**

**Do we need to rely on heuristics in multi-attribute DM?**

# The rise of heuristics

- Simplified strategies to make decisions based on partial information; ***within-attribute*** (e.g., *TTB*, *FW*)
- In complex-DM people use heuristic strategies

(Tversky, 1969,1972; Payne, Bettman & Johnson,1993; Gigerenzer, 2004)

## **The dual framework theory (Kahneman & Frederick, 2002):**

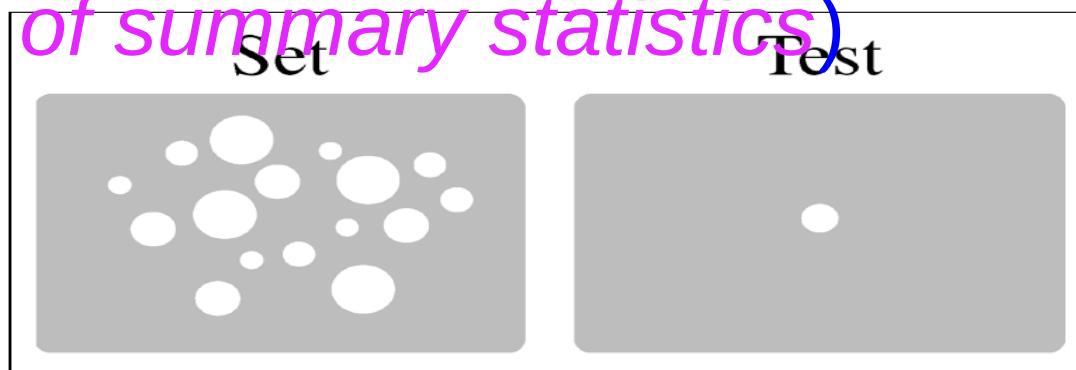
- i) System-1 (intuitive/heuristic; fast, automatic, but imprecise)
- ii) System-2 (reflective, rule-based, controlled/slow, accurate).

# An alternative hypothesis

- Challenge the bounded-rationality/homo-economicus association of *intuition* with *heuristics*

## Hypotheses:

- efficient intuition in DM is possible
- A mechanism for intuitive complex decisions (*extraction of summary statistics*)



**Fig. 1.** Schematic representation of the two intervals used in each trial. Observers first saw a set of circles for 500 ms, and then a test stimulus consisting of one or two test spots. This example shows a set of 16 items with a similarity factor of 1.4, and a single test spot.



# Efficient multi-attribute-DM

(Brusovansky, Glickman & Usher, 2018; *PBR.*)

## Experimental Design:

26 Participants had to decide on each trial which one of 2 job candidates is better suited for a job. Three jobs, one with 3, one with 4, one with 5 relevant attributes with different importance (importance weights). 200 trials for each job.

Candidates receive ratings of 1-9 on each attribute. To answer correctly one needs to estimate the weighted average of both candidates.

Time limit: 4 seconds.

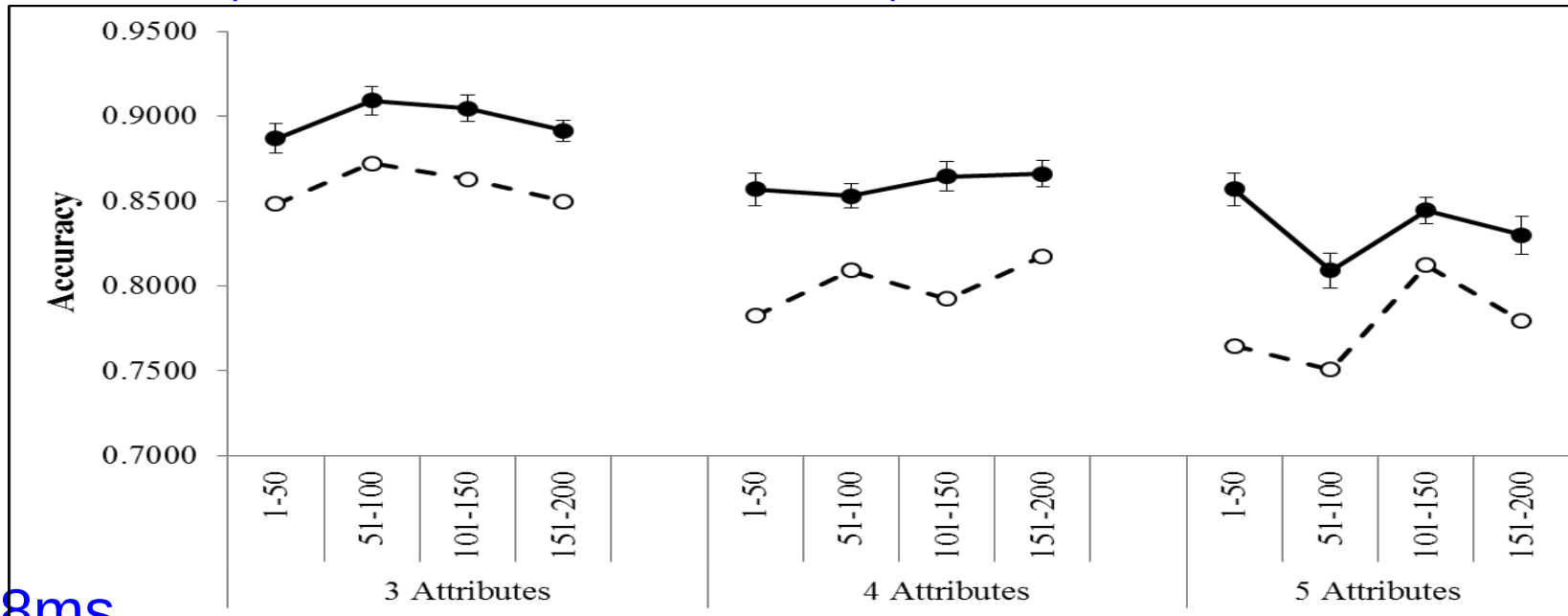
For example, a job with 4 attributes:

	A	B
<b>Intelligence – 4</b>	3	6
<b>Work Ethic – 3</b>	5	5
<b>Easy To Work With – 2</b>	9	4
<b>Creativity – 1</b>	7	2
<b>Weighted Average</b>	<b>5.2</b>	<b>4.9</b>

# Results

Accuracy:

Three attributes – 90%; Four Attributes – 86%; Five Attributes – 84%



Mean RT: 1578ms

Negative correlations between RT and accuracy, after controlling for difficulty ( $p$ 's < .05).



# Strategy Classifications

Three tested strategies: *WADD*, *TTB*, *EQW-TTB*.

$26 \times 3 = 78$  possible classifications.

Strategy	Number of Attributes		
	3	4	5
WADD	16	14	17
TTB	7	9	8
EQW-TTB	3	2	1
WADD/TTB*	0	1	0

Of the 78 classifications: 60% WADD, 31% TTB, 8% EQW-TTB

## conclusion & research question

- Compensatory strategies for complex decisions can be deployed rapidly (as against the bounded rationality assumption), which does not allow time for symbolic/controlled calculations.
- **Can we rely on holistic within-alternative processing to improve multi-attribute DM?**

# Reduction of irrationality: CTV



(Pessach, 2022)

## Motivation

- Does CTV depend on the way that choice information is grouped “by attributes” or “by alternatives”
- Within-alternative processing may involve a holistic summary-statistic intuition based judgement: reduced violations

## General paradigm

Two conditions within-subject design. Two sessions, each one similar to Exp-1 however the display is presented either when scores are grouped “by attributes” or “by alternatives”. The order is counterbalanced.

# Exp 2/3 Method

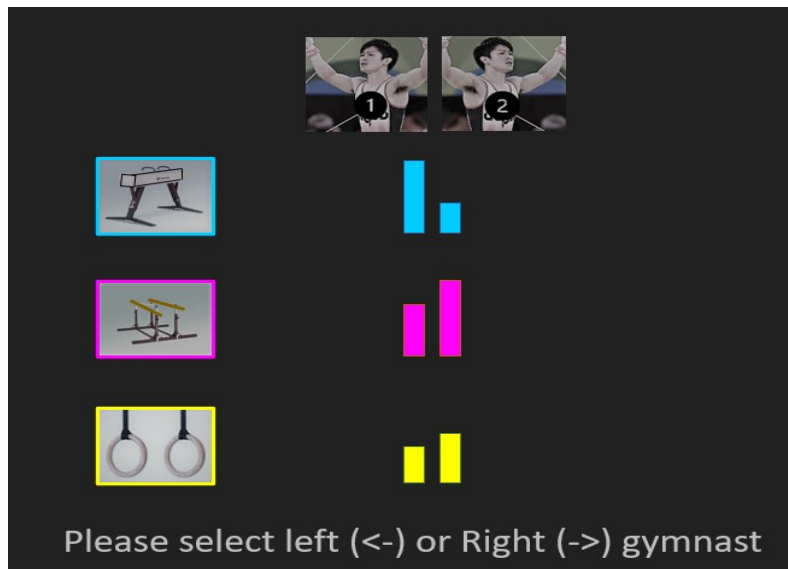
## Procedure

- Instructions were like in Exp-1 however included the required adjustment to the “2 conditions” design:

*“The bars may be displayed vertically or horizontally, depending on the format that the company that collected the data uses. Also, there is a difference between the companies in the way the data is colored.”*

a) grouped by attribute

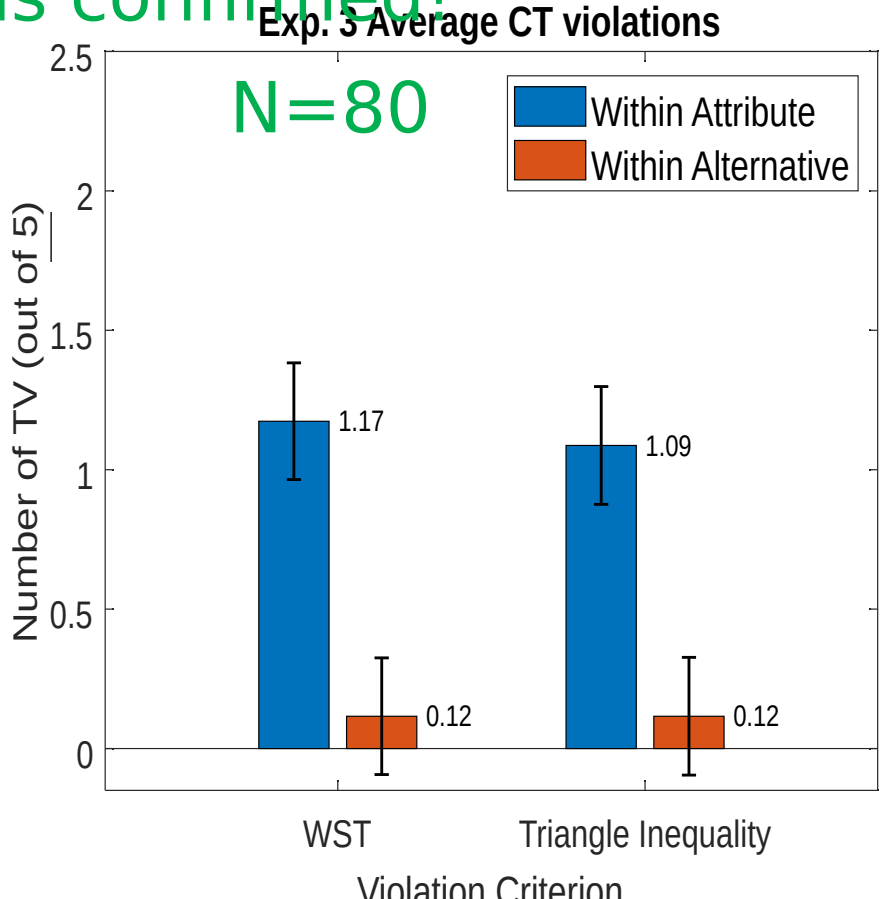
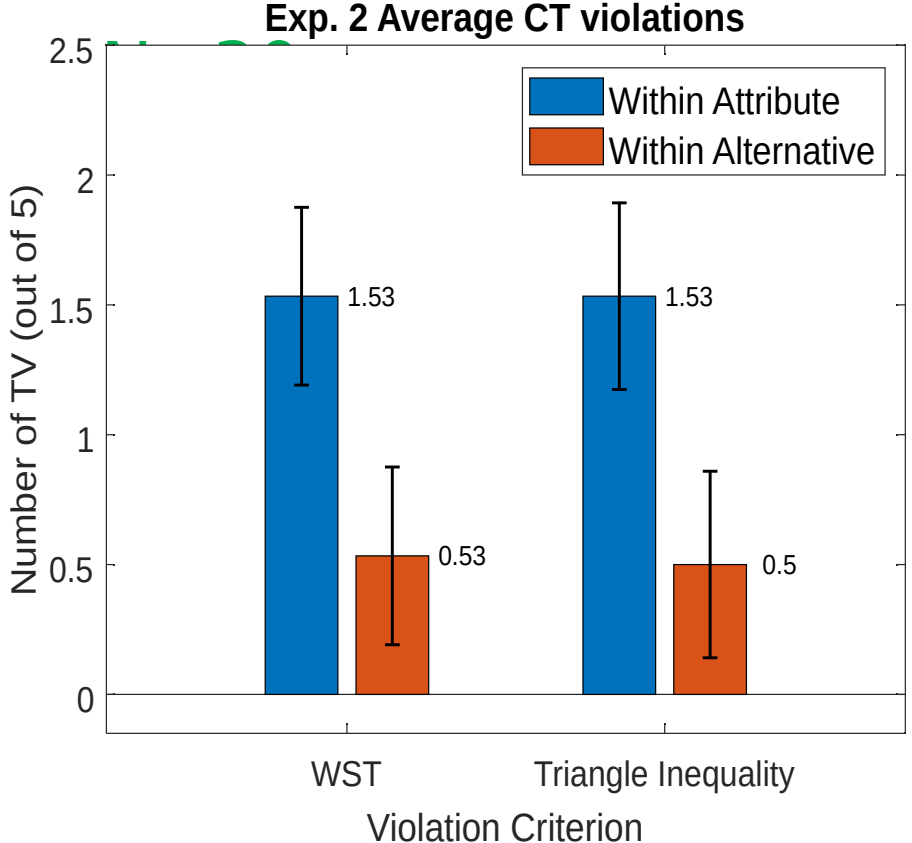
b) grouped by alternative



# Exp2-3: CTV depend on within-attribute processing

Null hypothesis (the “within attribute” and the “within alternative” number of Transitivity Violation distribution have the same median) was rejected with  $p\text{-value} < 0.01$ .

The study hypothesis was confirmed!



# Conclusions

- People violate rationality principles (framing, decoys, CTV)
- WE can understand these violations as a result of heuristic strategies (FW; TTB) that reduce choice complexity or mechanisms (SI) that give more weight to information that matches goal; protect from noise
- One can reduce irrationality by promoting within-alternative holistic valuation processing.

# Collaborators

**UK:** K. Tsetsos, Moshe Glickman & N. Chater

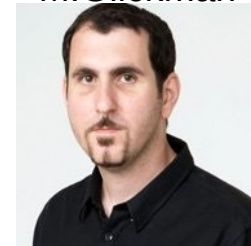
**TAU:** **Gilad Pessach**, Michael Brusovansky

**Funding:** ISF, I-Core

Michael Brusovansky



M. Glickman



K. Tsetsos



Gilad Pessach

