Attention and Perception in Multi-Attribute Choice Problems

Silvio Ravaioli

C&D Lab Meeting - Columbia University

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Multi-attribute choice

- Multi-attribute choice problems are part of everyday life
- **Pricing**
  Main and ancillary goods, Shrouded price (taxes, shipping fees)
- **Health care plans**
  Premium, Deductible, Copayment, Out-of-pocket limit
- **Whiteboards**
  Price, Dimensions, Design, Rating

	 **This item** VIZ-PRO Magnetic Dry Erase Board, 36 X 24 Inches, Silver Aluminium Frame Add to Cart	 Quartet Magnetic Whiteboard, 17" x 23" White Board, Dry Erase Board, White Frame (MWDW1723M-WT) Add to Cart	 Magnetic White Board | Dry Erase Board | # 1 in Europe | Excellent for Office and Home - 24" x 18" Add to Cart	 VIZ-PRO Dry Erase Board/Whiteboard, Non-Magnetic, 36 X 24 Inches, Wall Mounted Board for School Office and Home Add to Cart
Customer Rating	★★★★☆ (912)	★★★★½ (1316)	★★★★☆ (34)	★★★★☆ (551)
Price	$31.90	$18.02	$24.45	$29.99
Shipping	FREE Shipping on orders over $25	FREE Shipping on orders over $25	FREE Shipping on orders over $25	FREE Shipping on orders over $25
Sold By	Tromba-Pro	Amazon.com	Iconik Direct	Tromba-Pro
Item Dimensions	40 x 0.98 x 25 in	23 x 1 x 17 in	24 x 18 x 0.7 in	34 x 20 x 0.8 in

Research Question

- **How does the DM integrate the available information?**
  - Systematic bias in the integration of information?
  - Range effect? Focusing or Relative thinking?

- **How does the DM select information?**
  - More attention towards common (Efficient coding) or rare outcomes (Salience)?
  - Systematic bias towards “positive evidence”?

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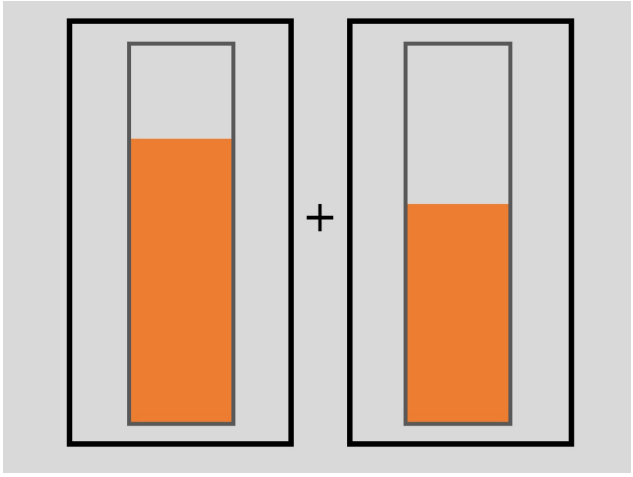
Experimental Project

- Lab experiment: binary choice between compound lotteries
- Multiple attributes represented by simple lotteries (probability of winning one point)
- Simple lotteries are displayed using bars of different length



Probability of winning is displayed using the length of the bar

Experimental Project

- Lab experiment: binary choice between compound lotteries
- Multiple attributes represented by simple lotteries (probability of winning one point)
- Simple lotteries are displayed using bars of different length
- Designs and results are connected with Arthur experiment:
  - Direct comparison across options
  - Visual representation (bars instead of numbers)
  - Tasks 2-3 introduce constraints in the information

Preview of Results

- Laboratory experiment in CELSS (n=23)
- **Main task**
  - Encoding bias in favor of positive (higher) values
  - More precision in the encoding of "common events"
  - No strong evidence of salience
  - Weber's law (perception of difference)
  - Strong recency effect in favor of late information
- **Two additional tasks: partial screen visible**
  - Restriction on visible values
  - Fewer observations are weighted more
  - Information selection in favor of "positive values"

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Literature review and Previous experimental results

- **Multi-attribute choice**:
  Andersson et al. 2016 (Focusing), Azar 2011, Somerville 2018 (Relative thinking), BGS (Salience), Gabaix and Laibson 2006 (shrouded attributes)

- **Noisy representation**:
  Li et al. 2017 (robust averaging), Spitzer et al. 2017 (selective overweight), Woodford 2012, Steiner and Stewart 2016, Gabaix and Laibson 2017, Tsetsos et al. 2016, Wei and Stocker 2015

- **Preference over non-instrumental information**:
  Kobayashi et al. 2019, van Lieshout et al. 2008, Charpentier, Bromberg-Martin, and Sharot 2018, Eliaz and Shotter 2007, Gneezy and Potters 1997

▸ Related Literature

Experimental Design - Main task

- Binary choice: compound lottery L(eft) vs R(ight)
- Six simple lotteries (attributes) equally likely to be selected
- Each sub-lottery is a 10-90% probability of winning one point
- Timing
  - $t = 1, 2, \ldots, 6$ the bars L_t and R_t are displayed simultaneously on the screen (200 ms bars + 200 ms blank)
  - $t = 7$ the sbj chooses L or R (10 seconds available)
  - $t = 8$ the outcome is revealed (win/lose the round)

▸ Experimental design

Experimental Design (Instructions, simple trial)

- "Choose your knight and defend the castle from enemies"

Figure 1: Instructions screen: all the lotteries are visible simultaneously

Experimental Design (Instructions, sequential)

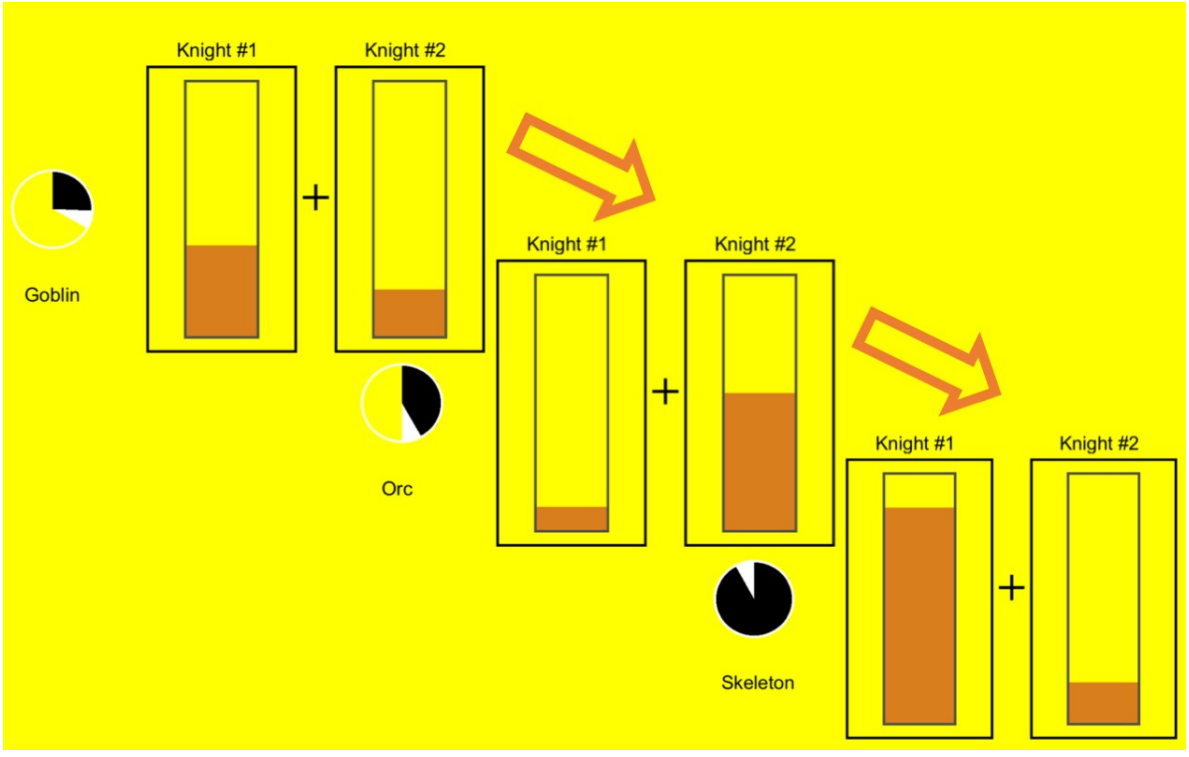
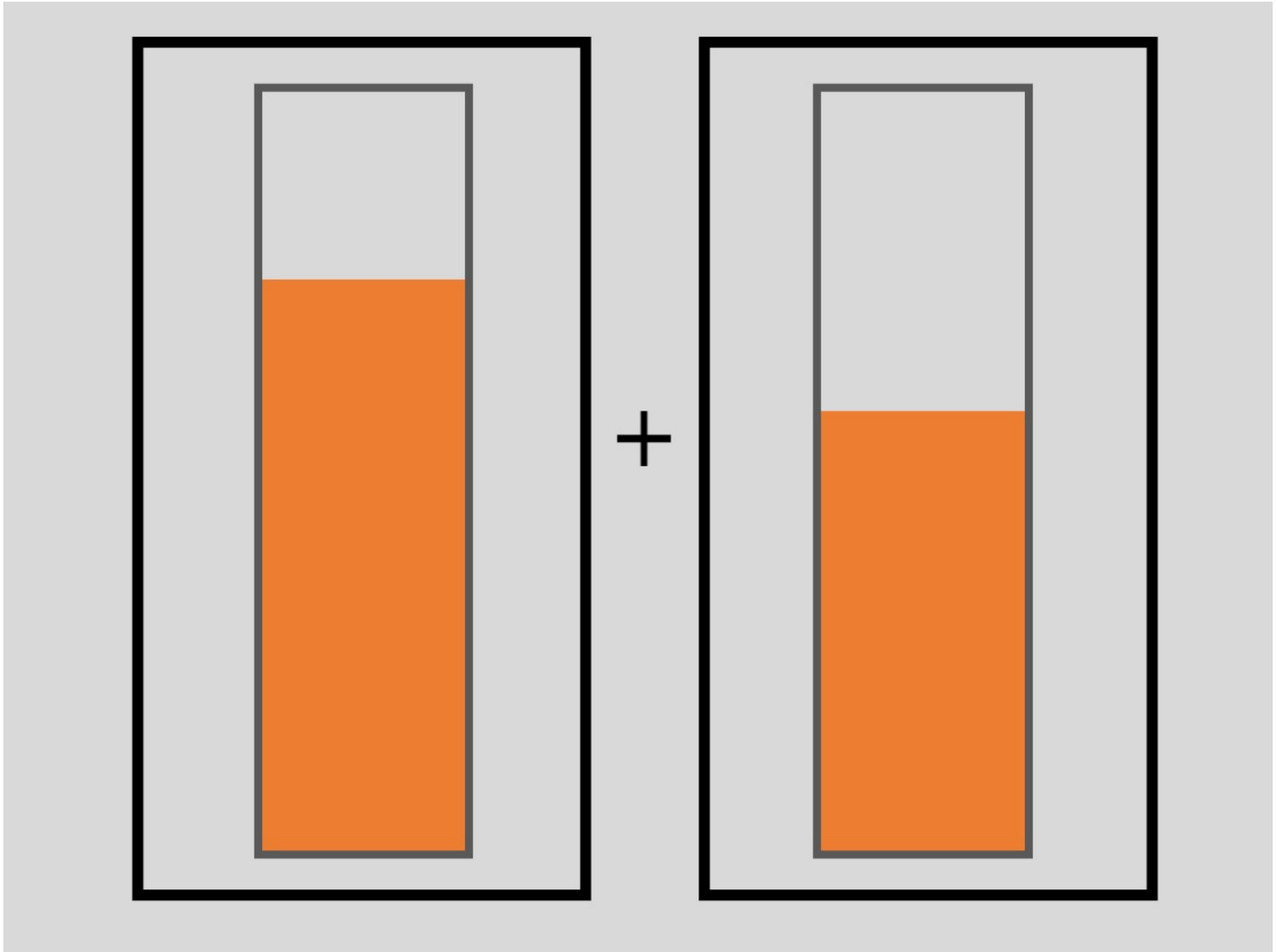


Figure 2: In the main task the lotteries are displayed sequentially

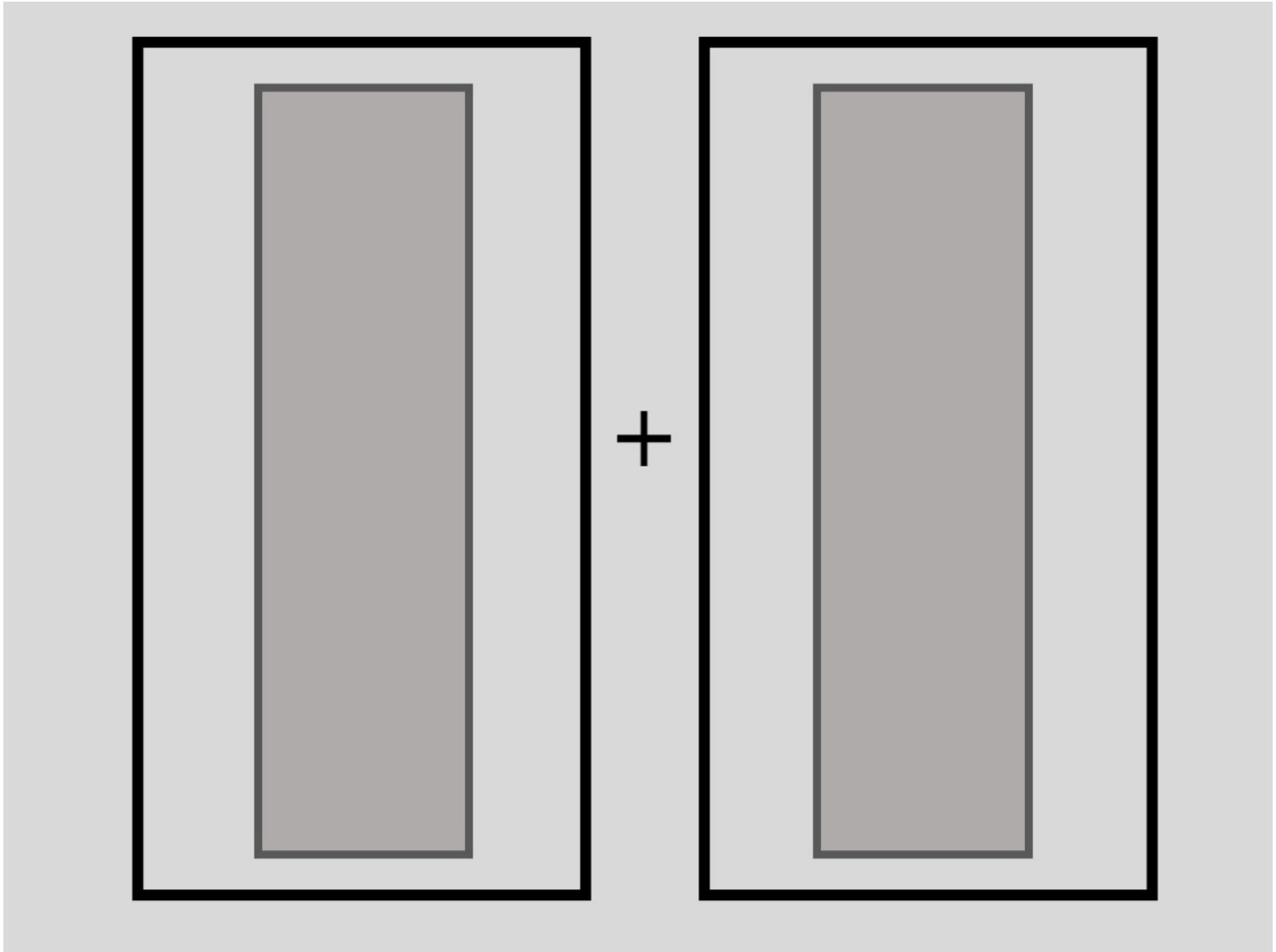
- Instructions, free sampling, and practice trials
- 300 trials divided into 4 blocks

Experimental Design (t=5, bars)



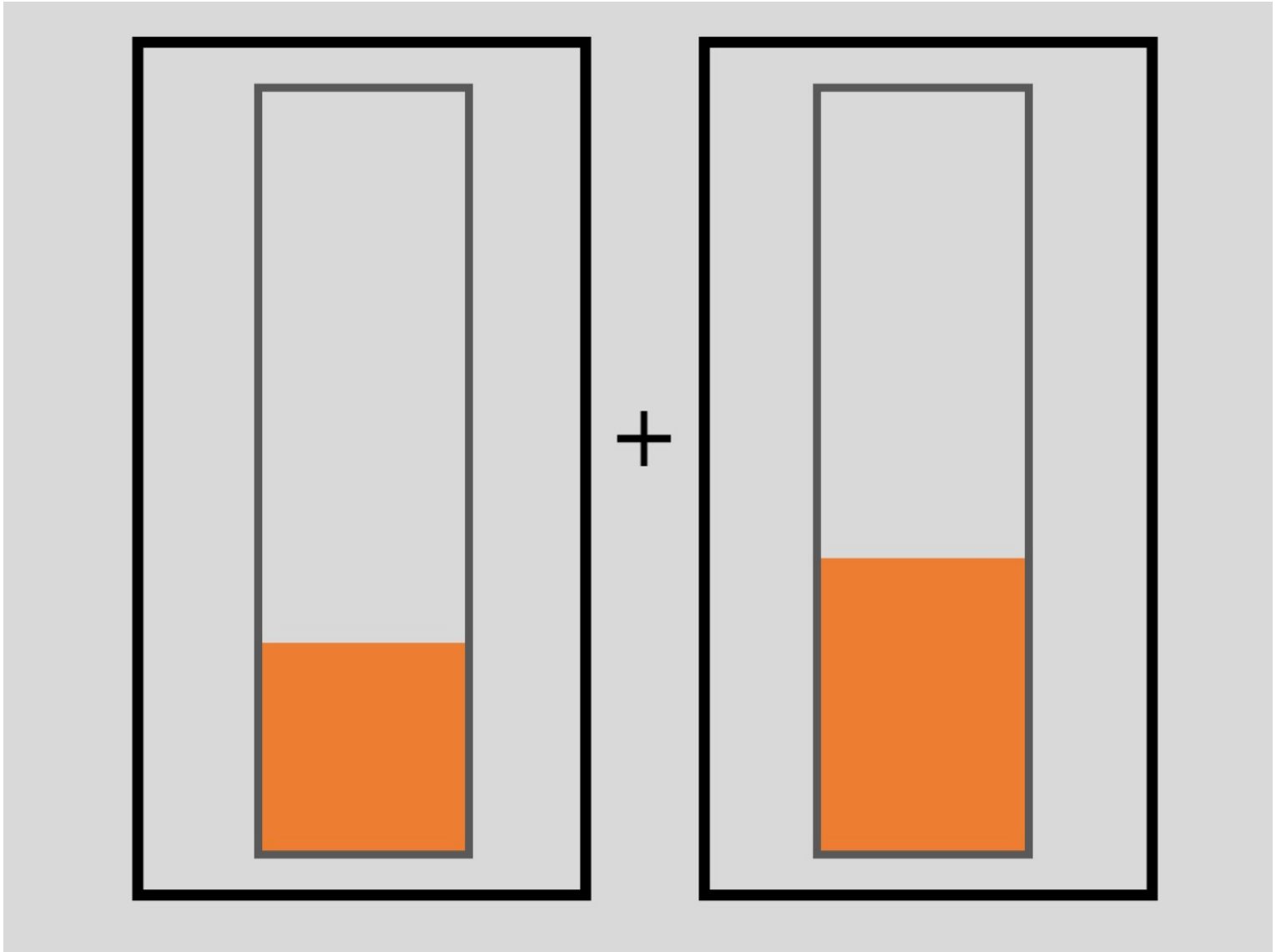
Lotteries L_5 and R_5 (200 ms)

Experimental Design (t=5, blank bars)



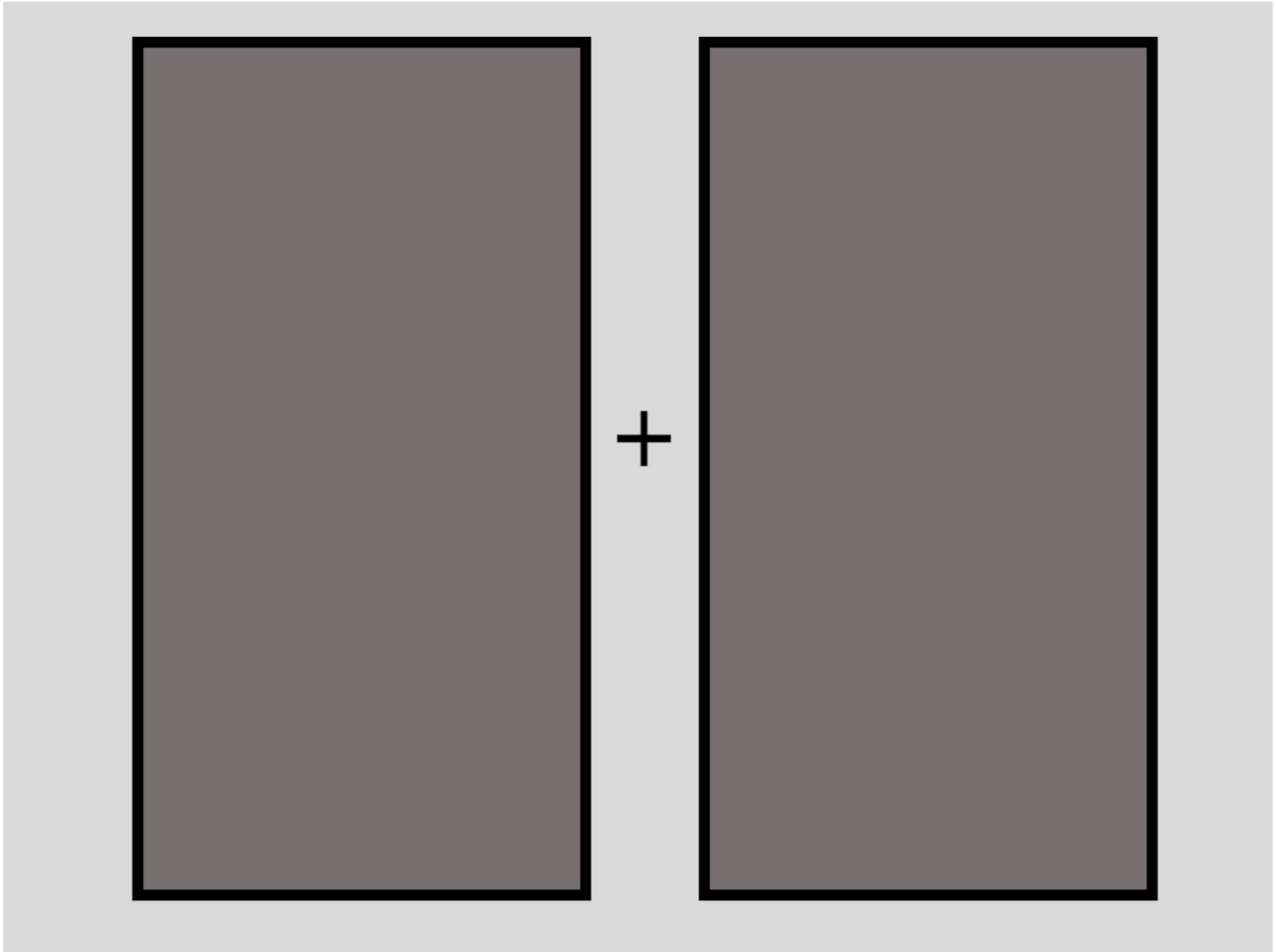
Placeholders and blank bars (200 ms)

Experimental Design (t=6, bars)



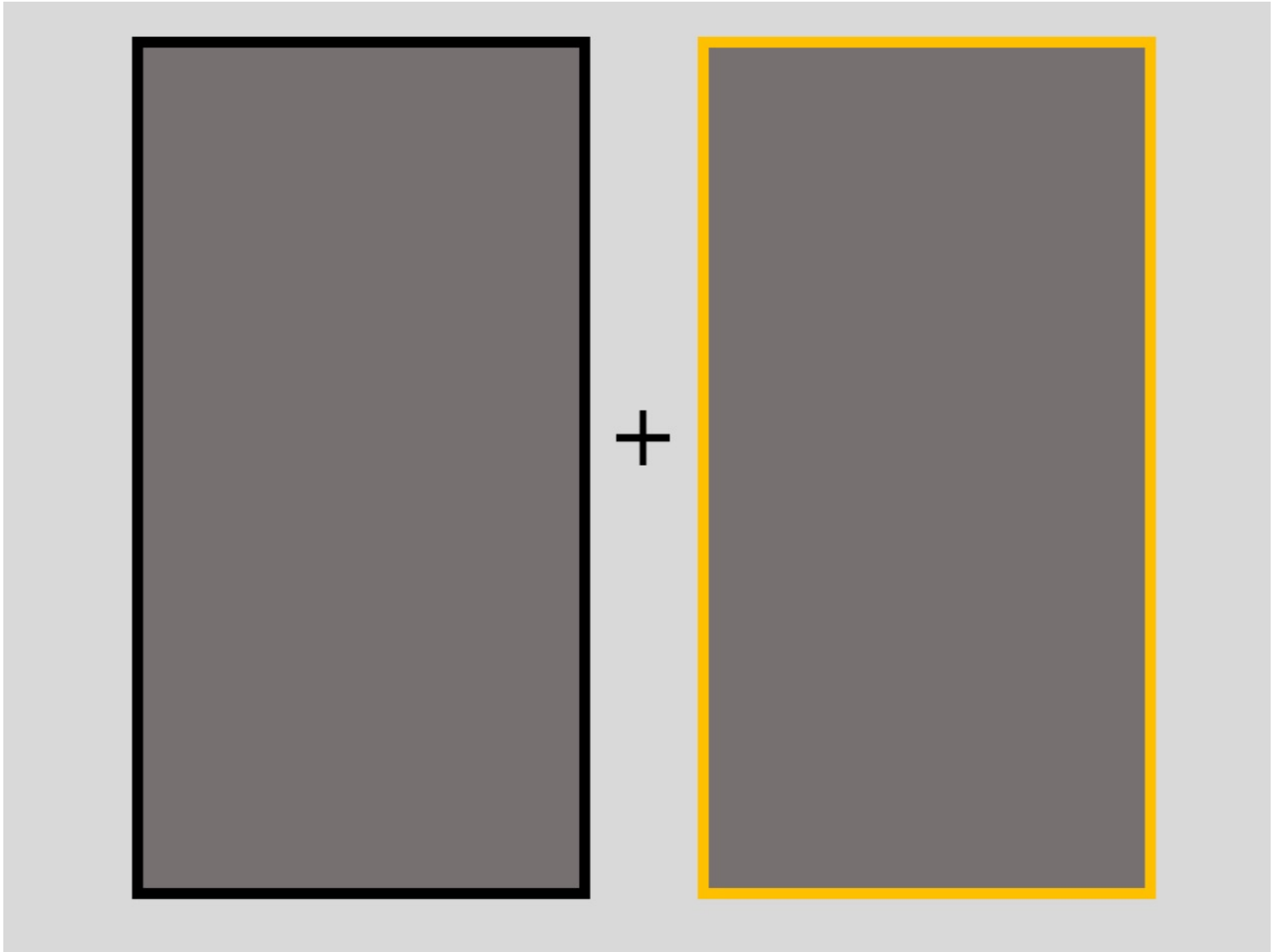
Lotteries L_6 and R_6 (200 ms)

Experimental Design (t=7, Choice screen)



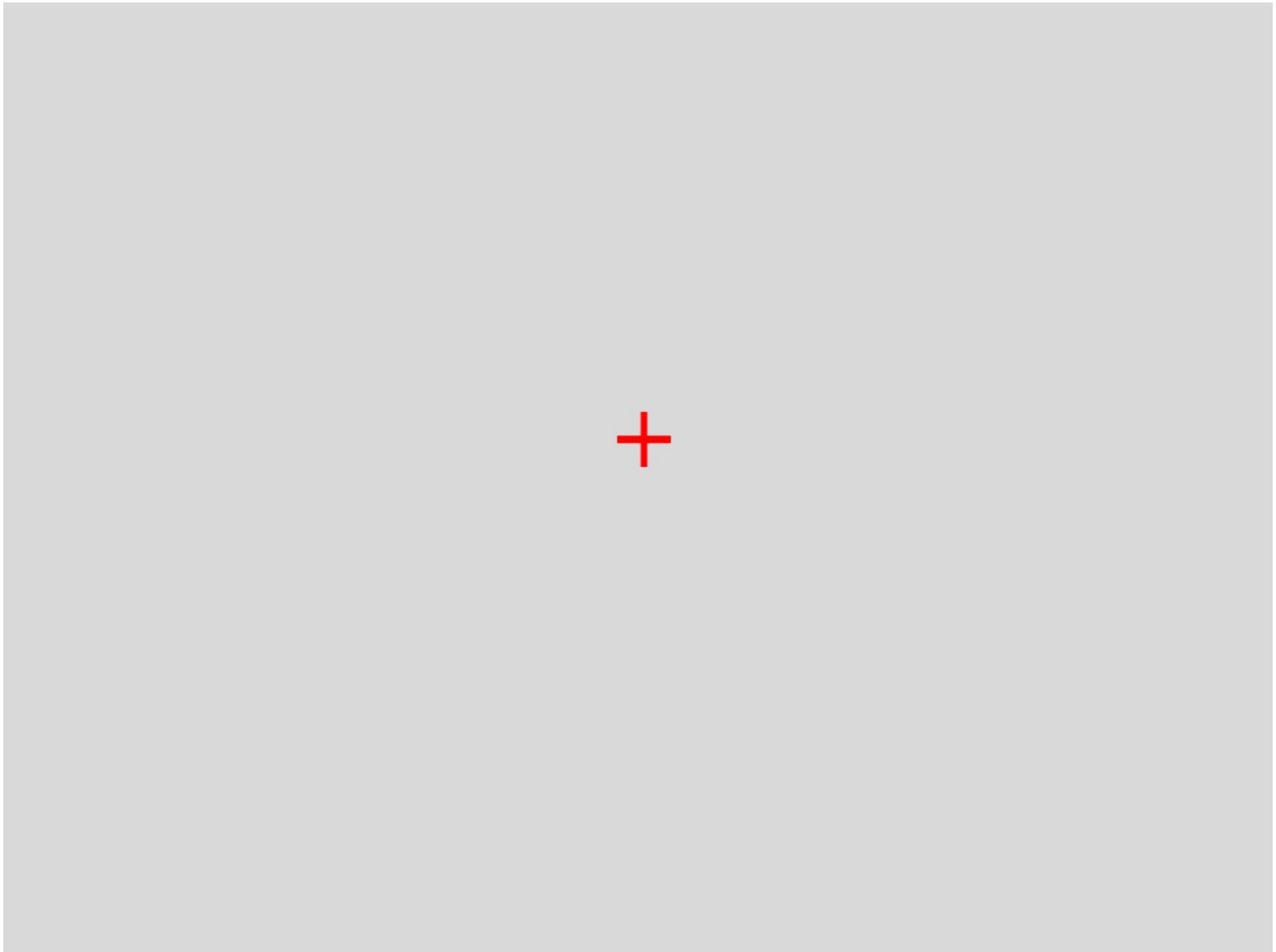
Choice screen (press F or J to select the option)

Experimental Design (t=7, Choice)



The subject chooses option R(ight).

Experimental Design (t=8, Outcome)



Green/red fixation cross indicates the outcome.

Two treatments - Upward/Downward distributions

- Upward and Downward triangular distributions
  - Same range (60 pts), same mean (50 pts),
    same distribution of **differences** between two random draws
  - Different distribution and range of values (10-70 vs 30-90)

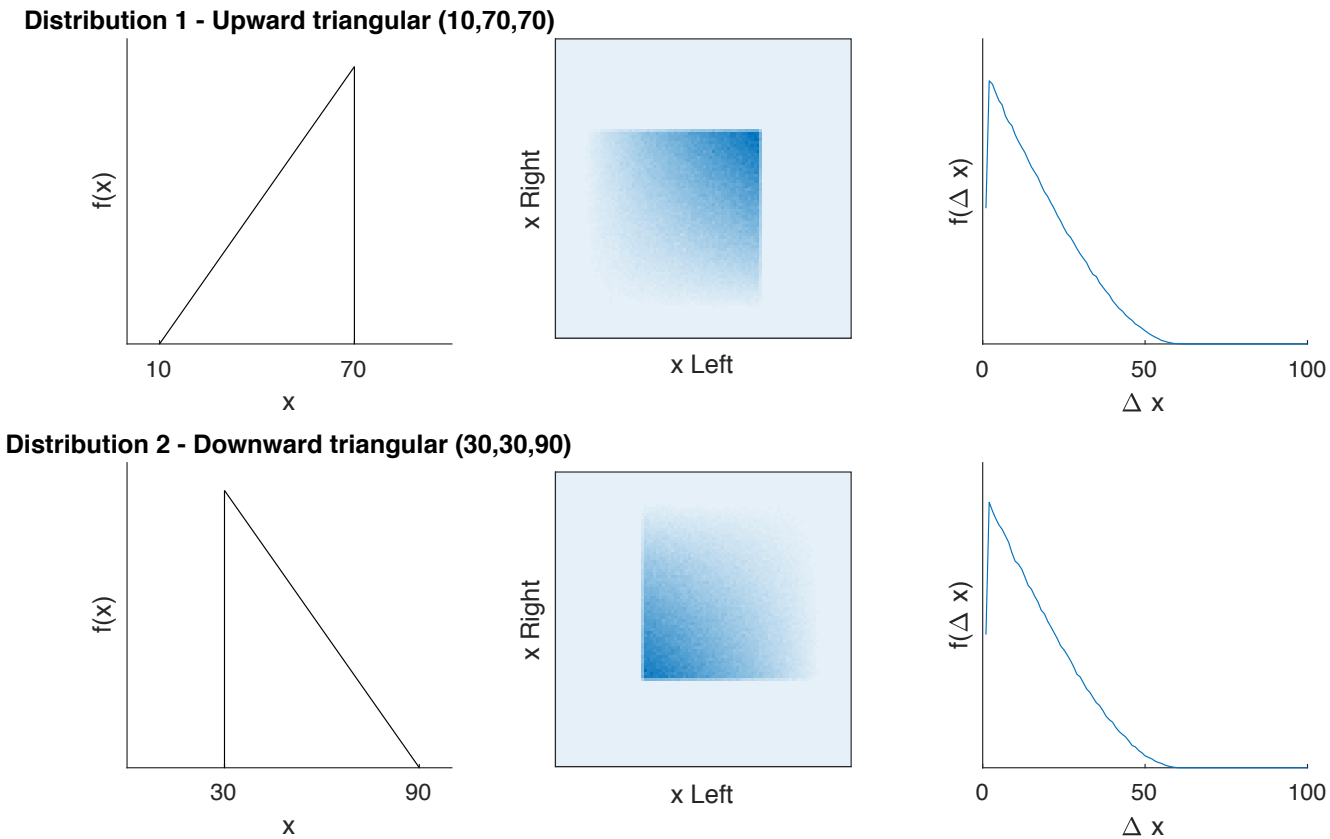


Figure 3: The distributions used to generate data in the two treatments

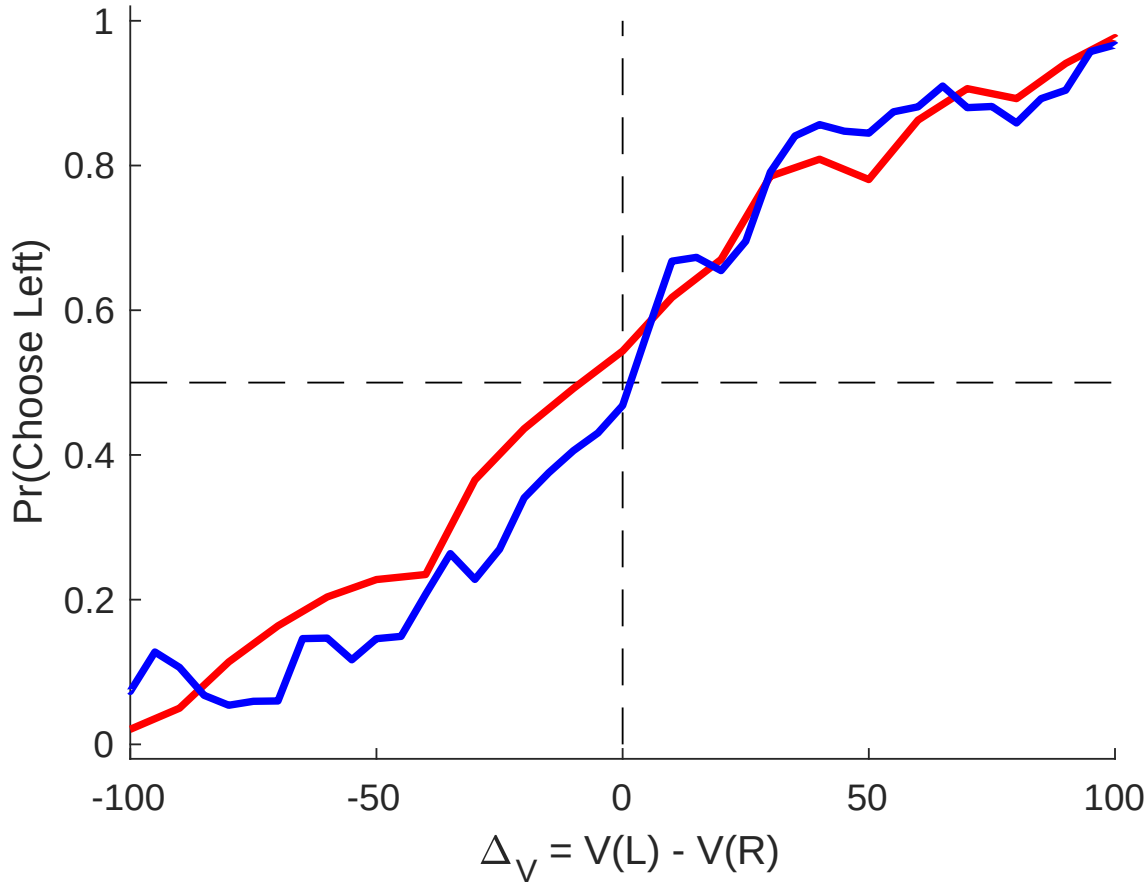
Models comparison (BIC)

Model	Merge t1+t2	Separate t1/t2
$N(x, s^2)$	7059	7039
$N(m(x), s^2)$	6986	7018
$N(m(\Delta x), s^2)$	7037	7074
$N(x, s(x)^2)$	7023	7065
$N(\Delta x, s(\Delta x)^2)$	6945	6982

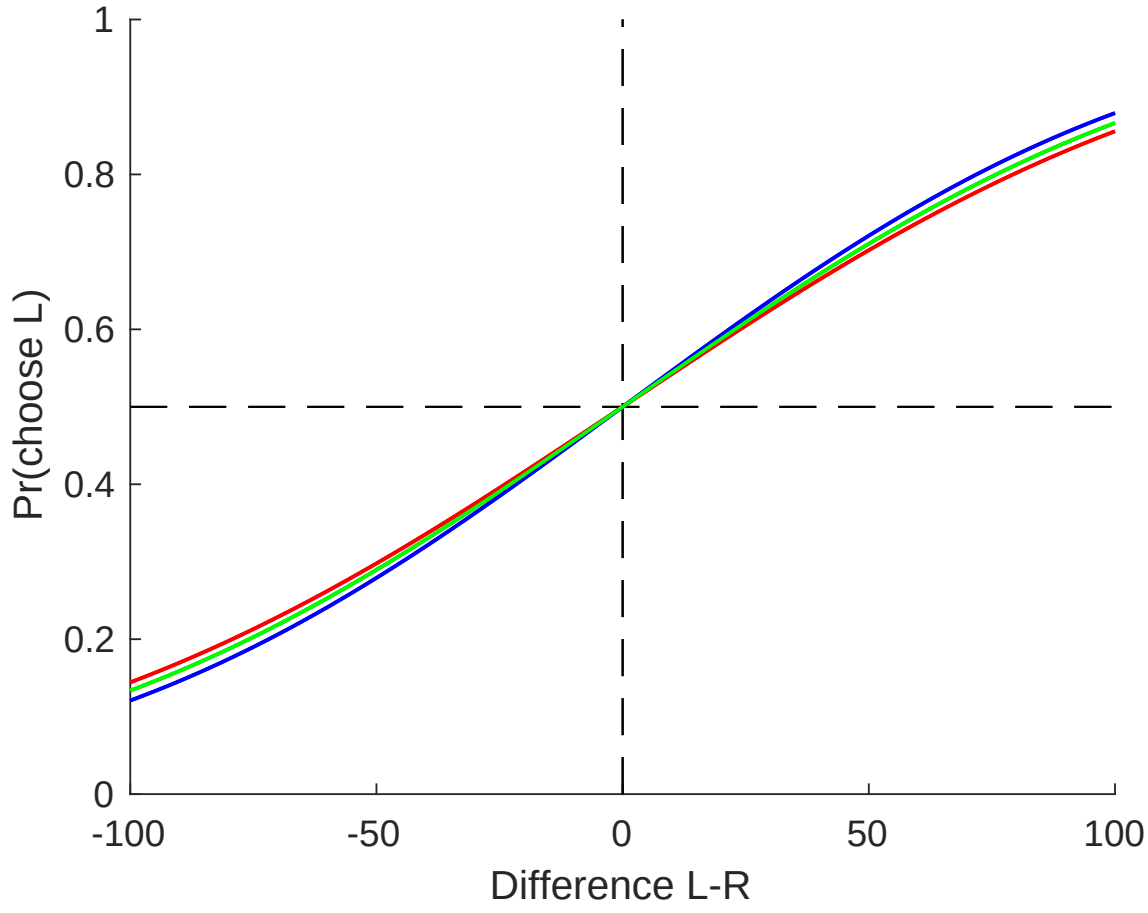
1. Vanilla noisy perception model
2. Transducer (of separate values)
3. Transducer (of difference)
4. Varying noise (of separate values)
5. Varying noise (of difference)

All the fit include recency effect (leaking memory $\delta \sim 0.8$)

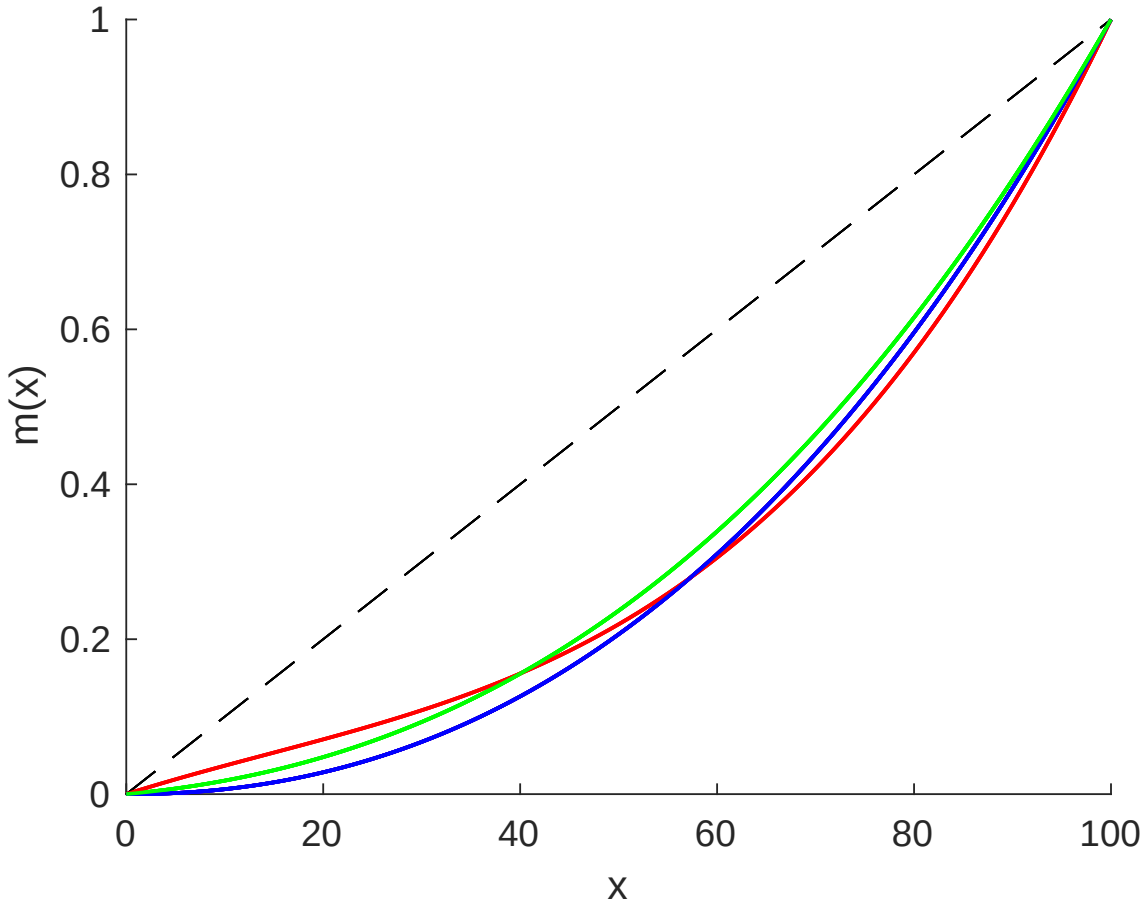
Accuracy over trials



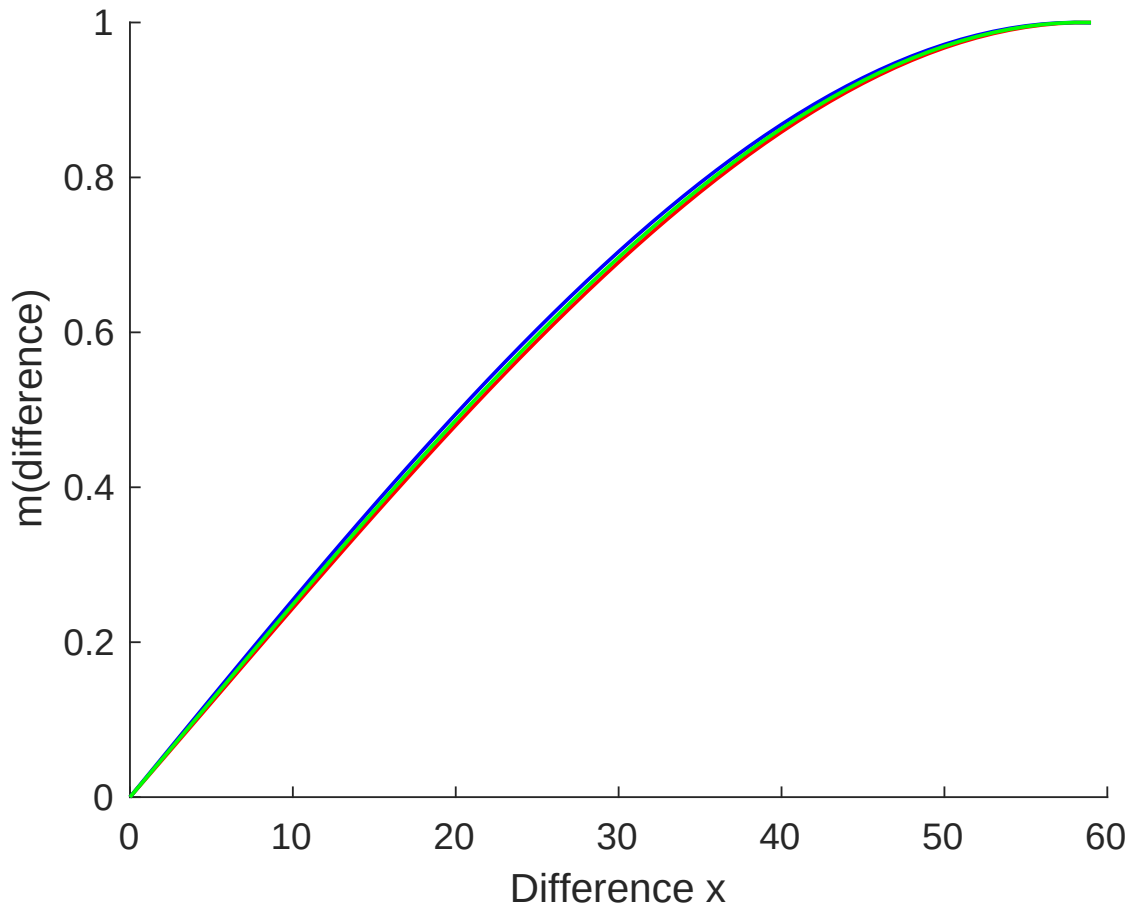
Fit vanilla noisy perception model



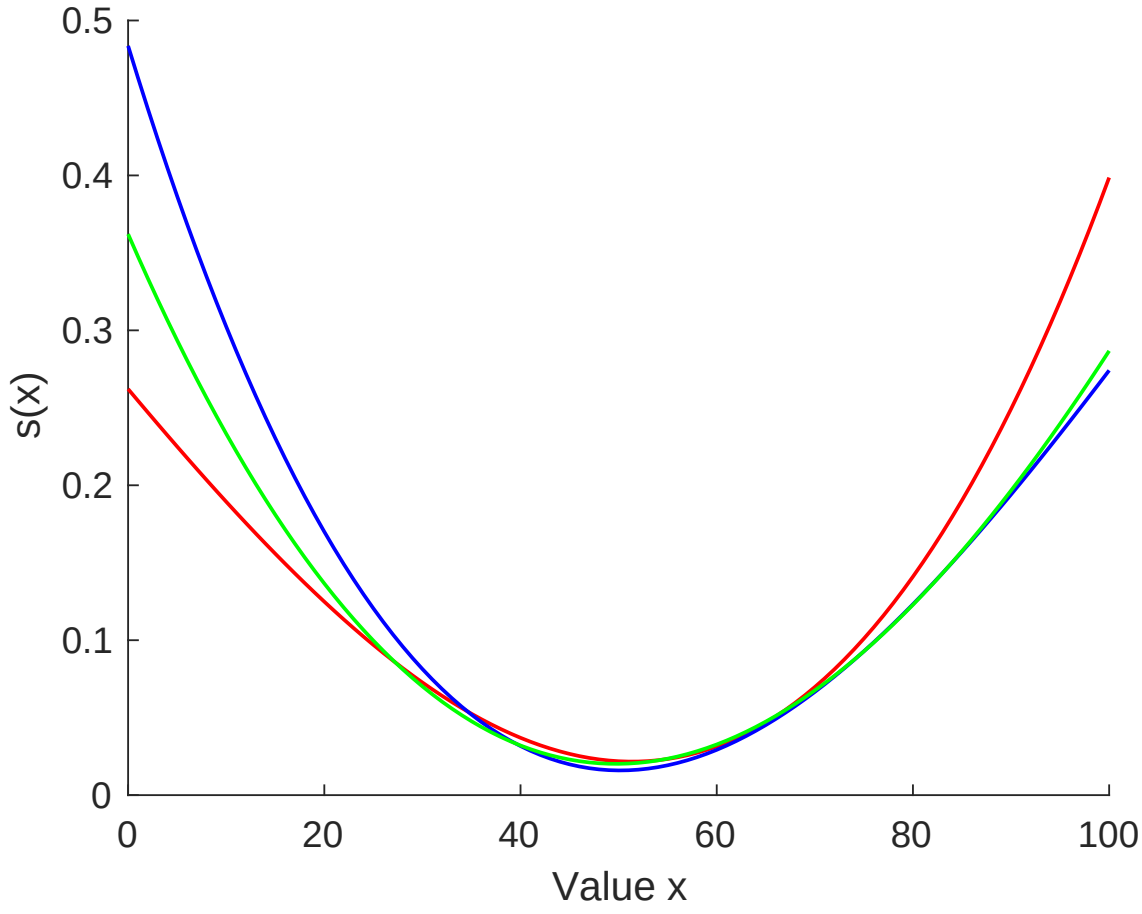
Transducer (of separate values)



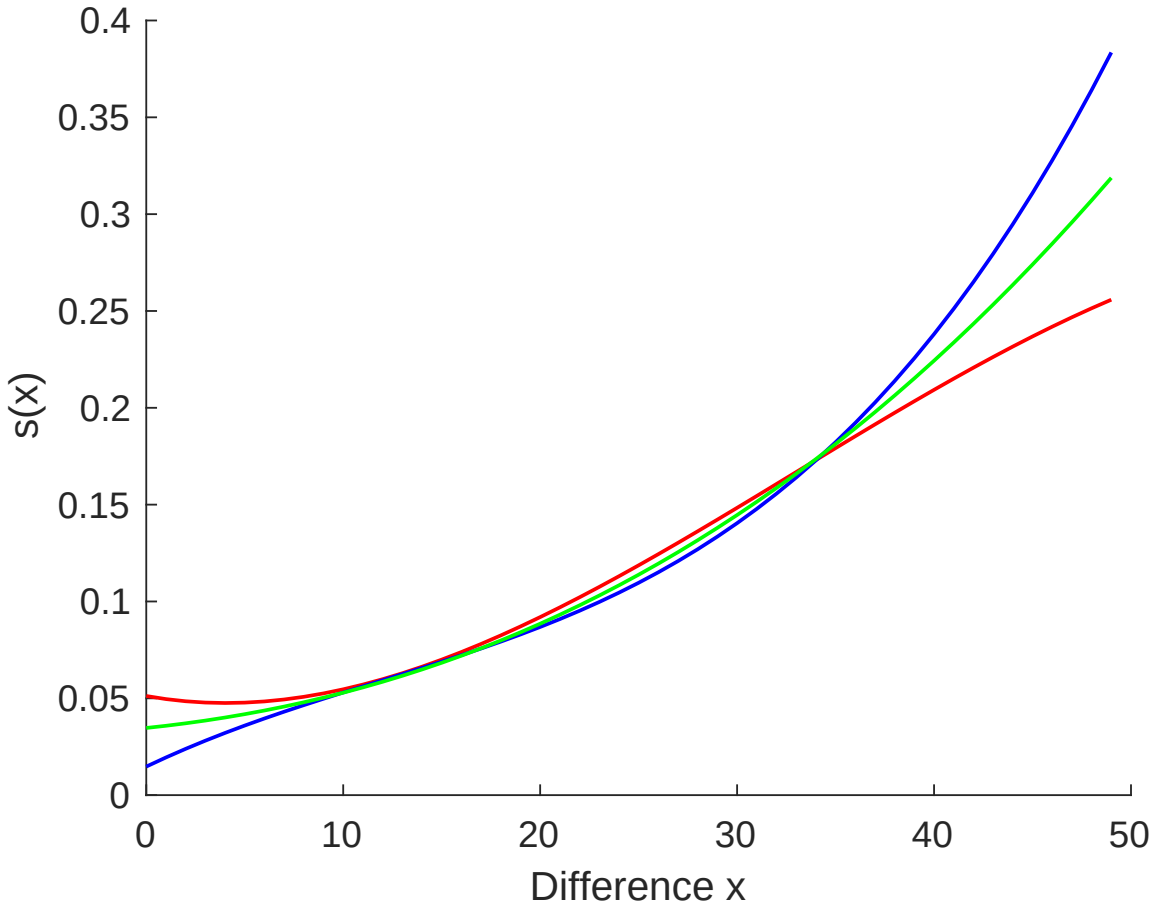
Transducer (of difference)



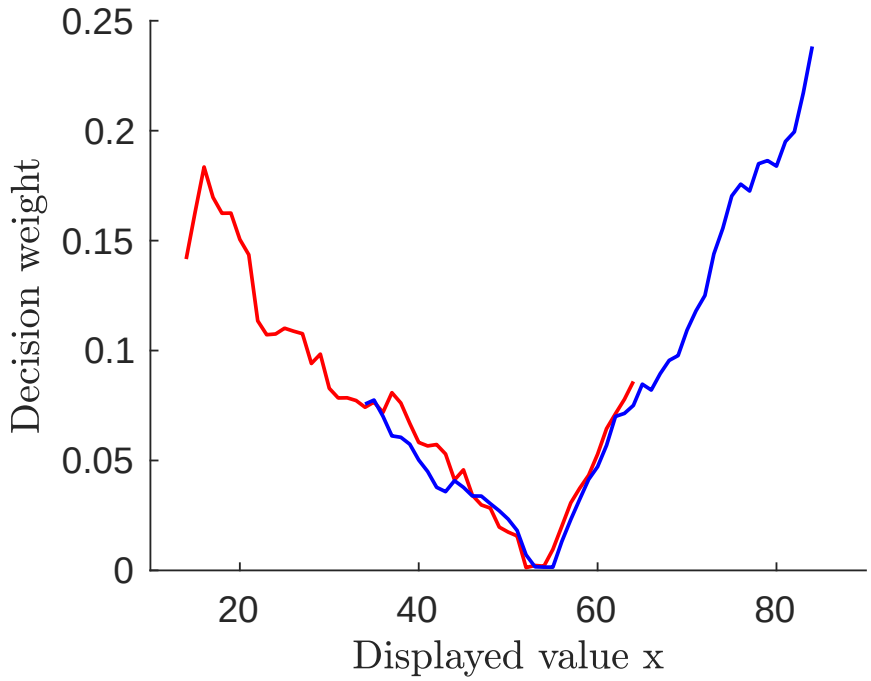
Varying noise (of separate values)



Varying noise (of difference)



Decision weight



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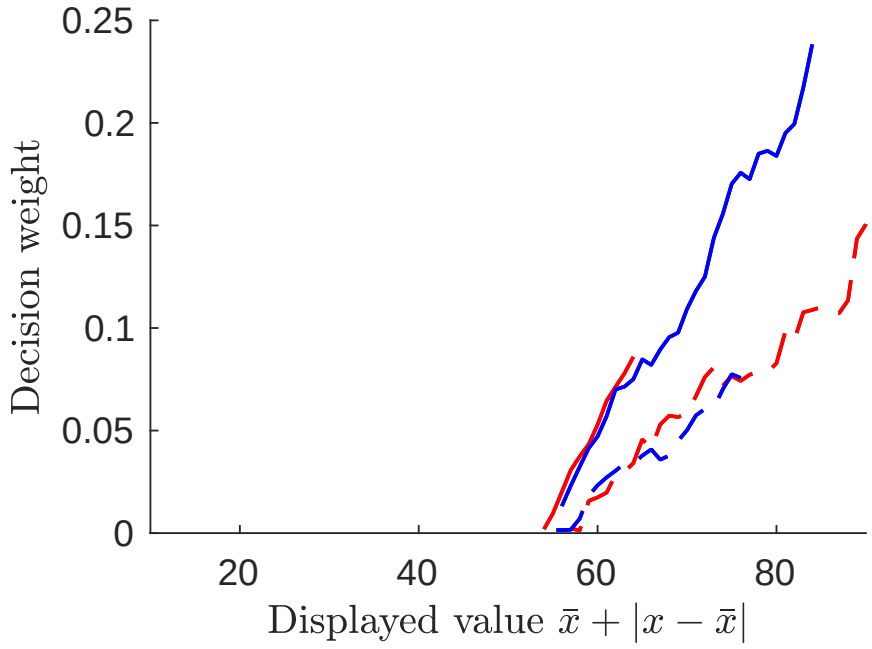
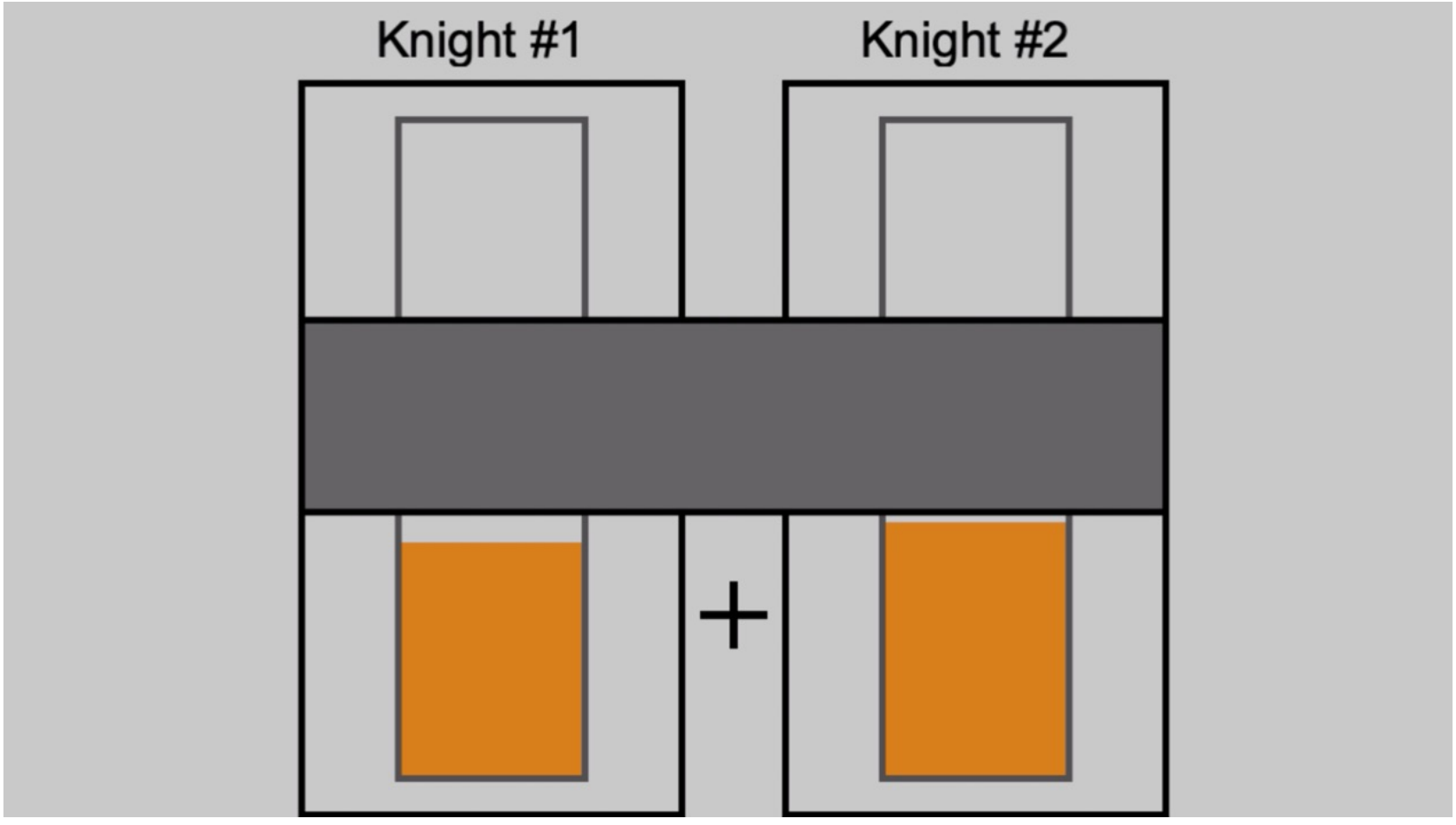


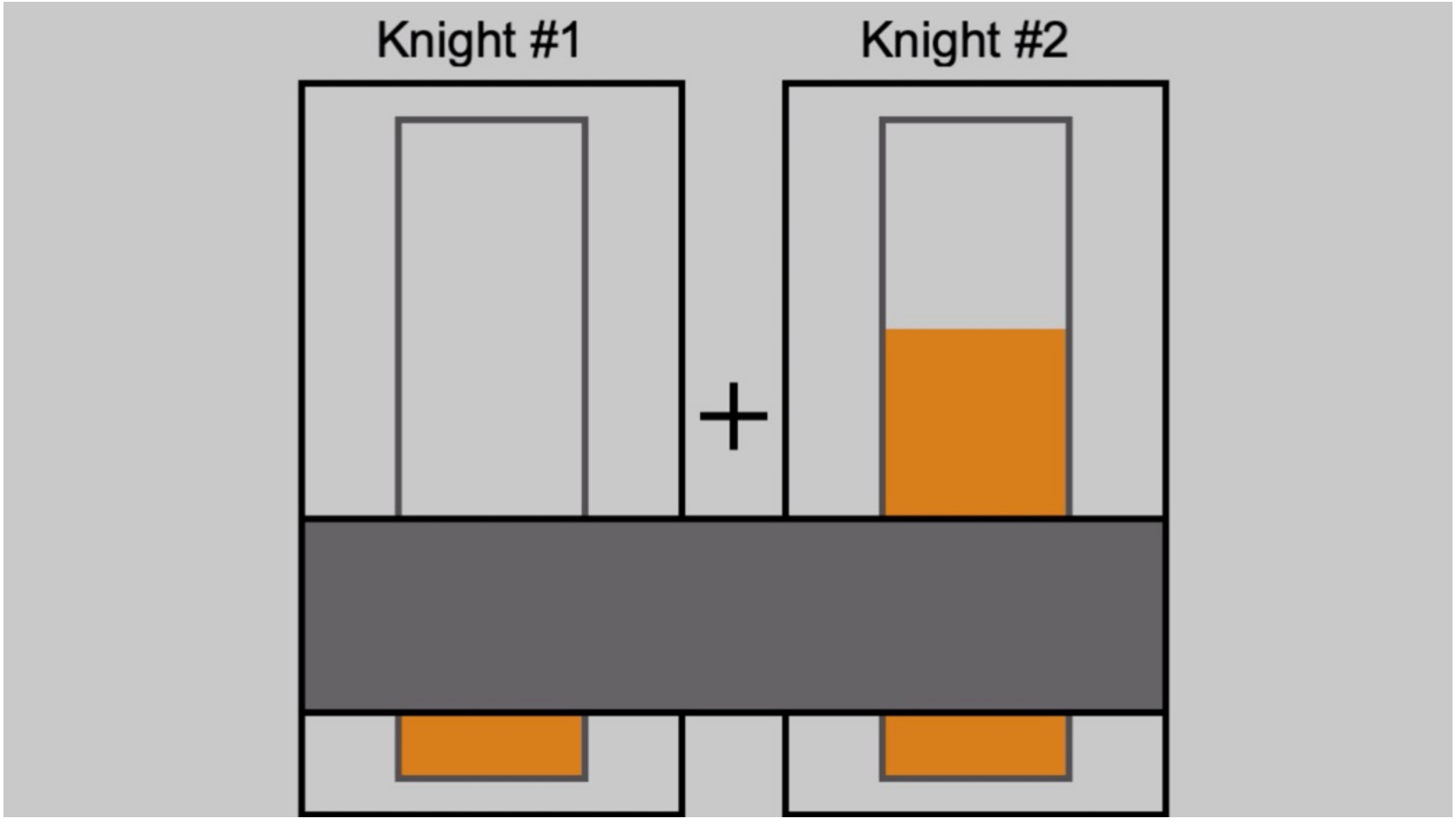
Additional tasks

Task 2 - Partial screen (top covered)



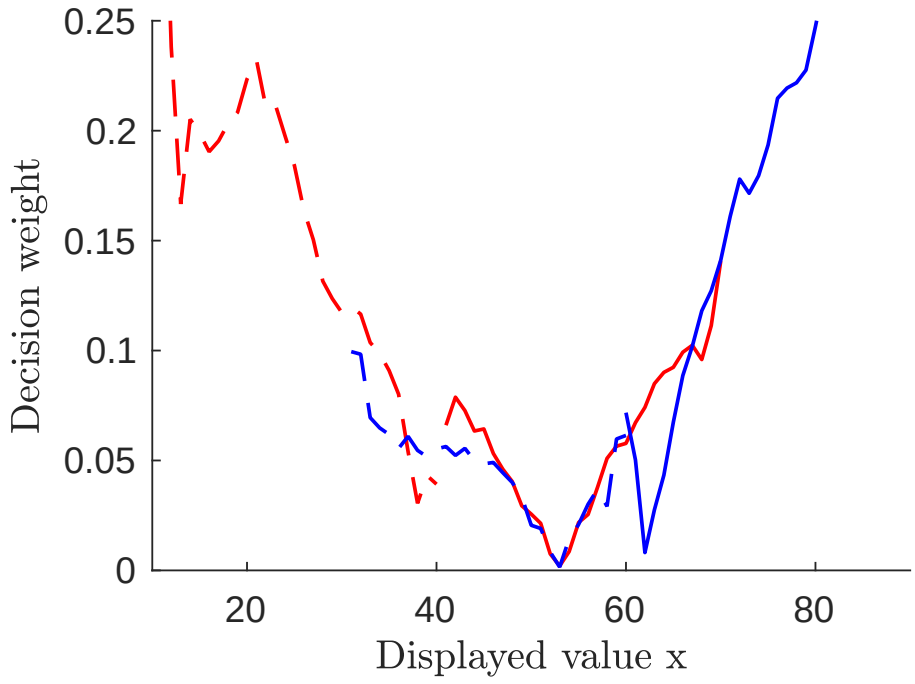
Only the values between 10 and 40 are visible (25%)

Task 2 - Partial screen (top visible)

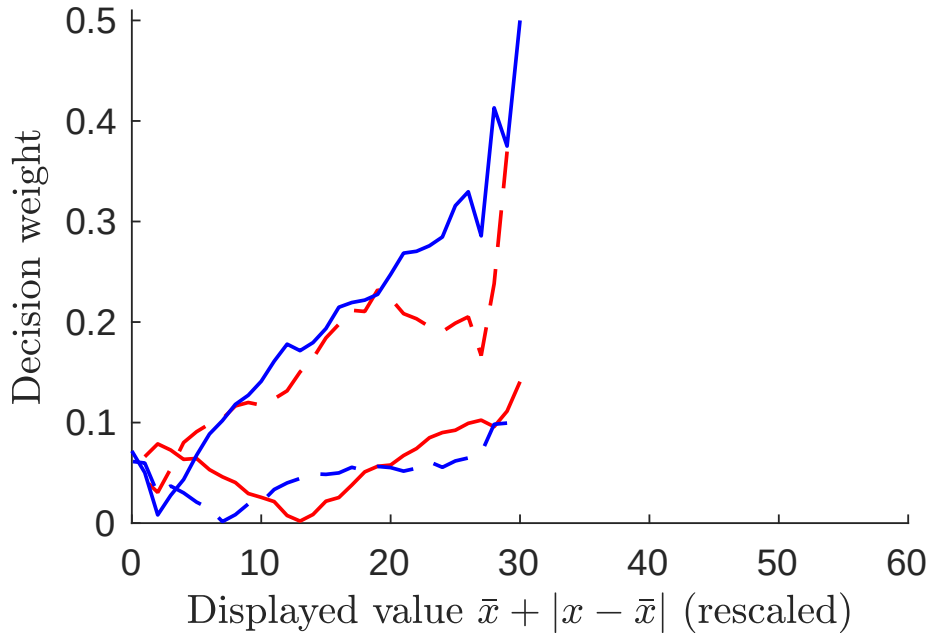


Only the values between 40 and 70 are visible(75%)

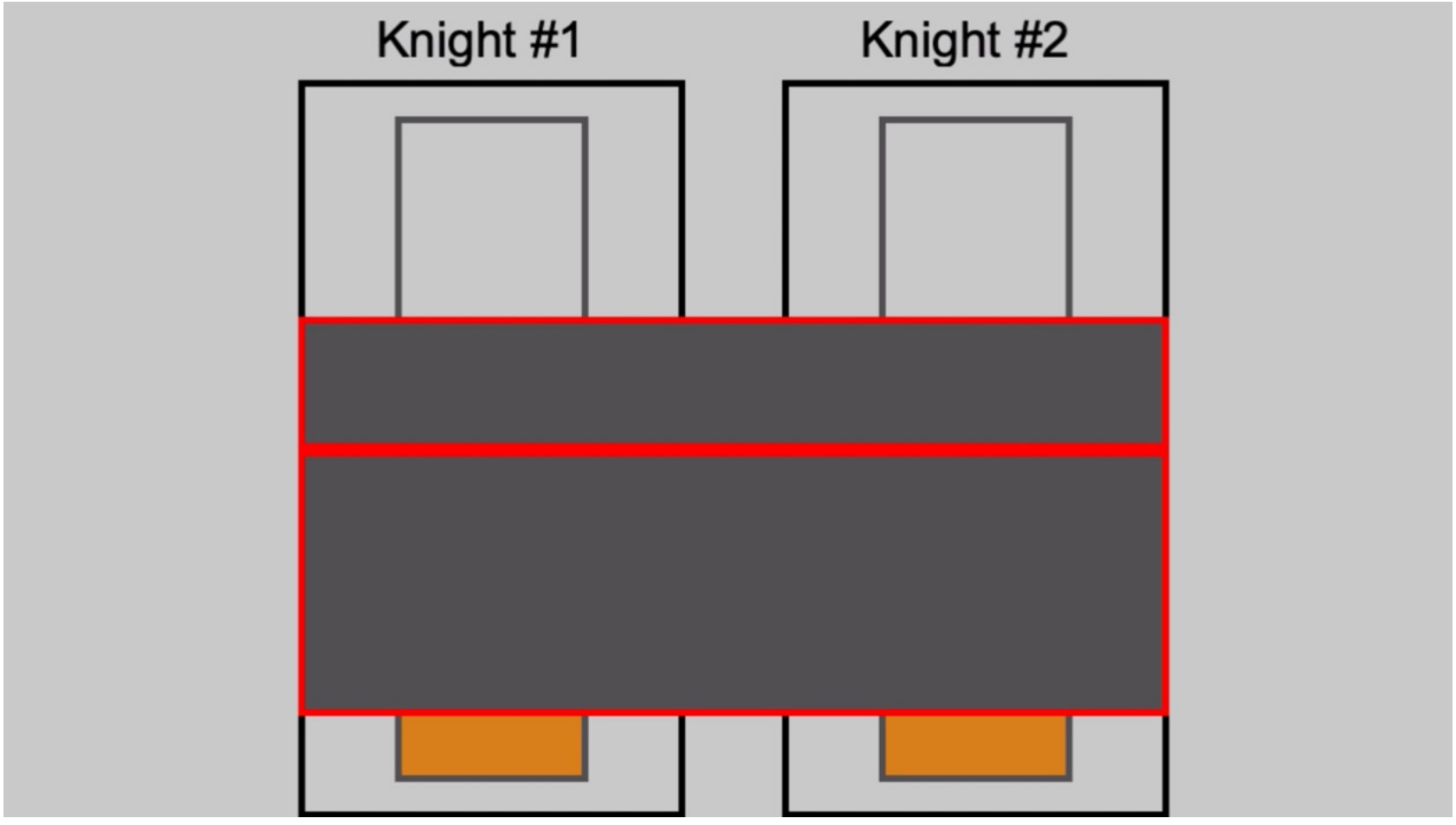
Decision weight



Decision weight

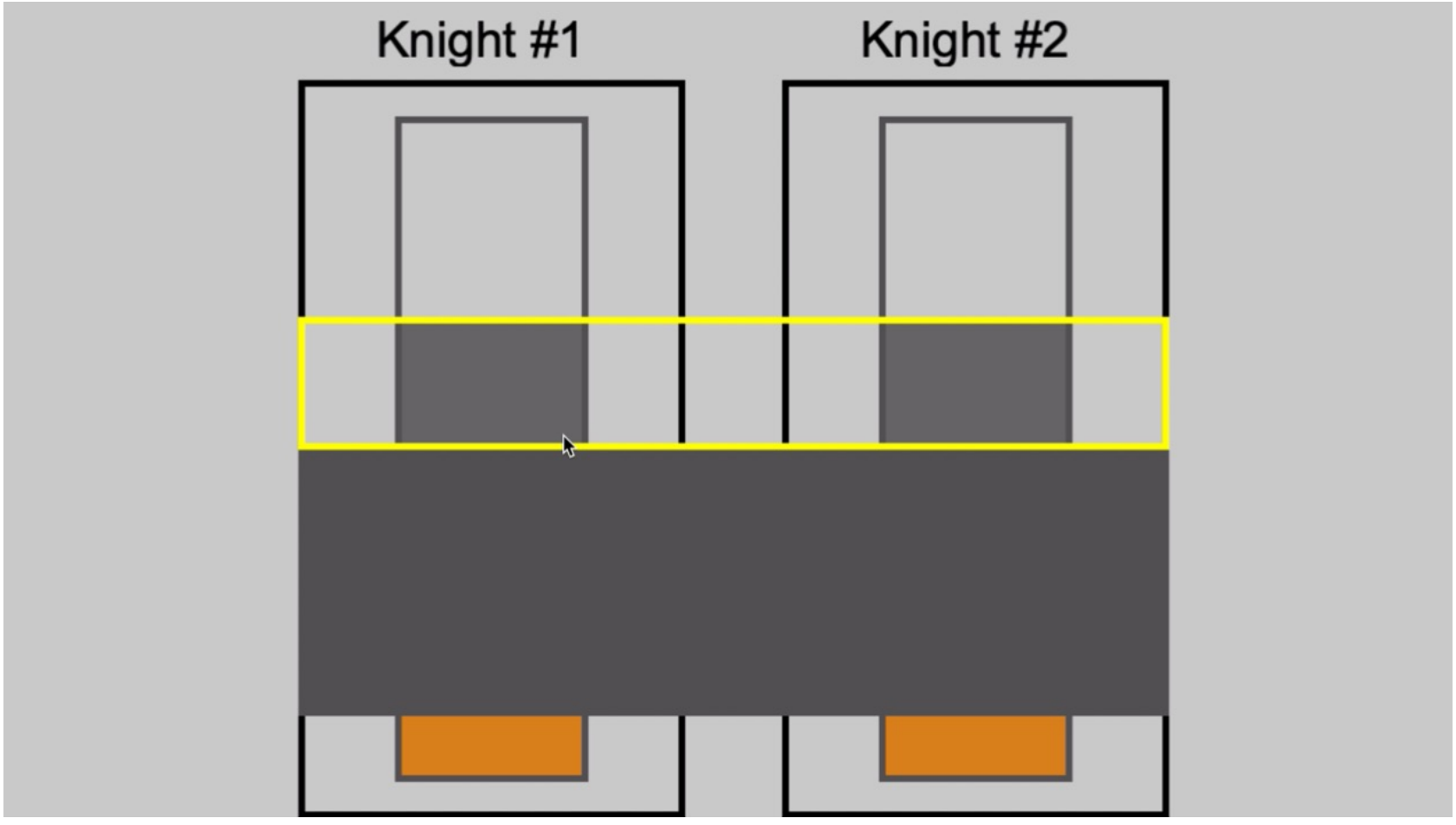


Task 3 - Reveal screen



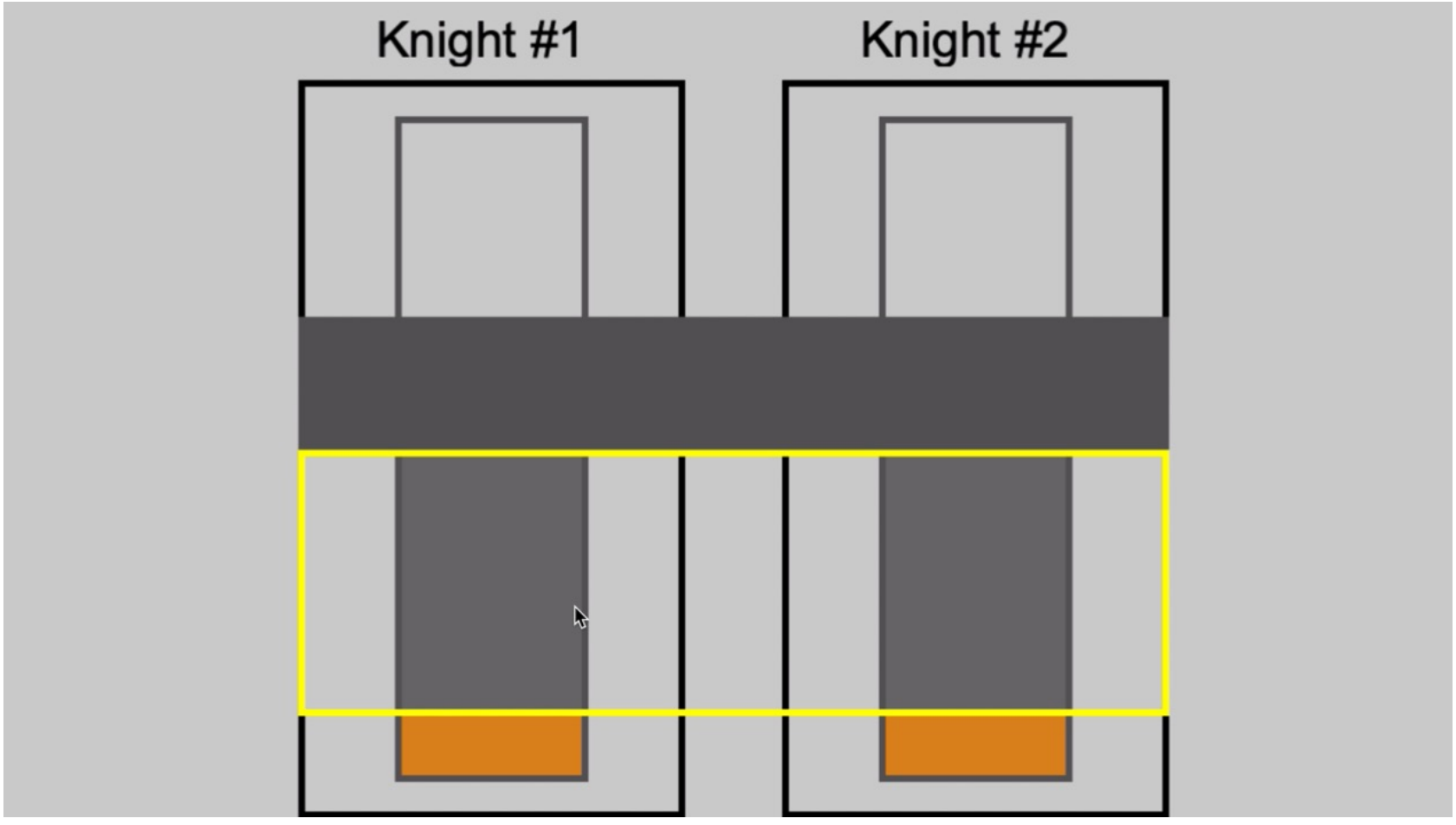
The range is divided in two (uneven) parts.

Task 3 - Reveal screen - Top



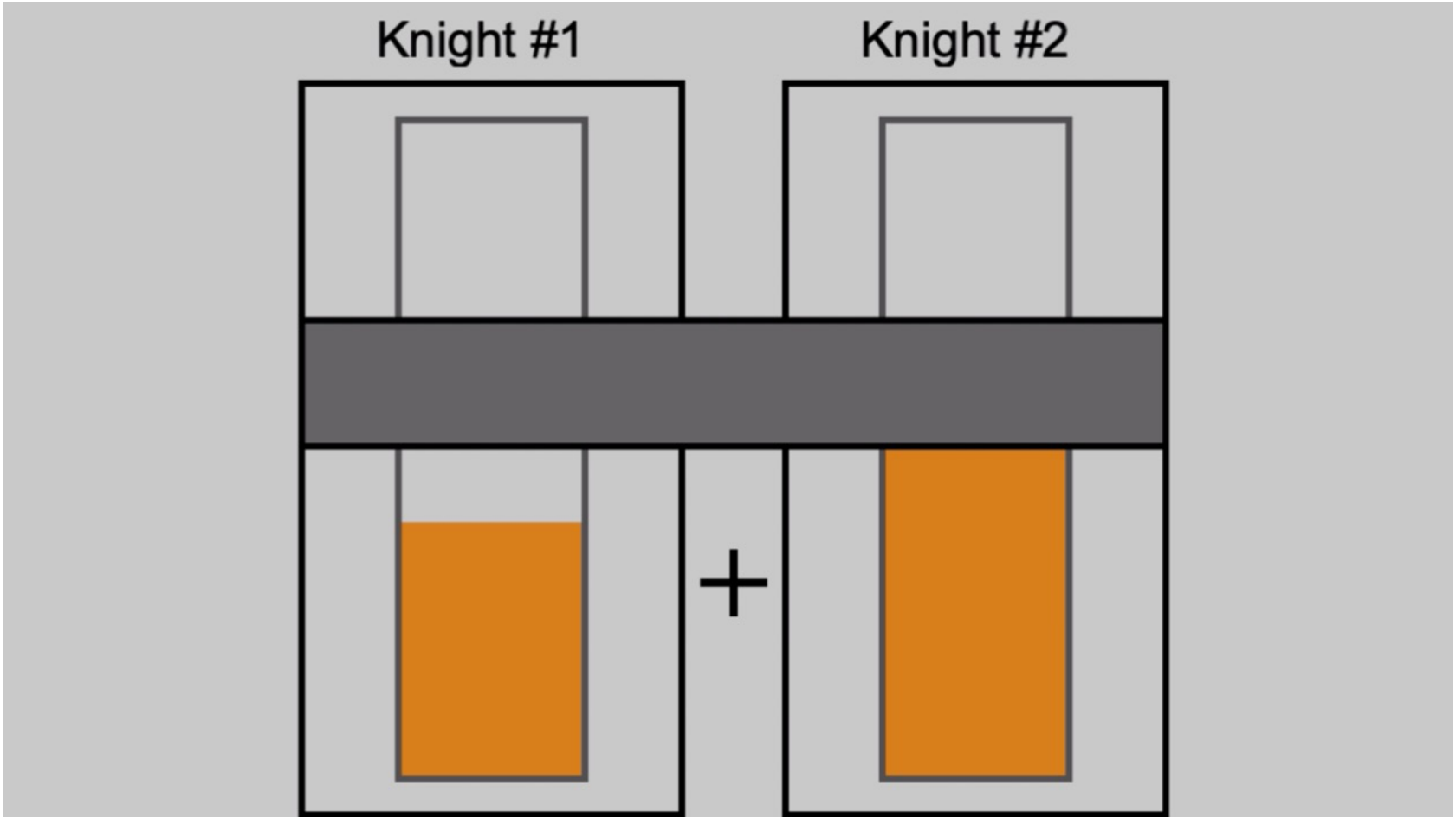
Move the mouse to have a preview of the range.

Task 3 - Reveal screen - Bottom



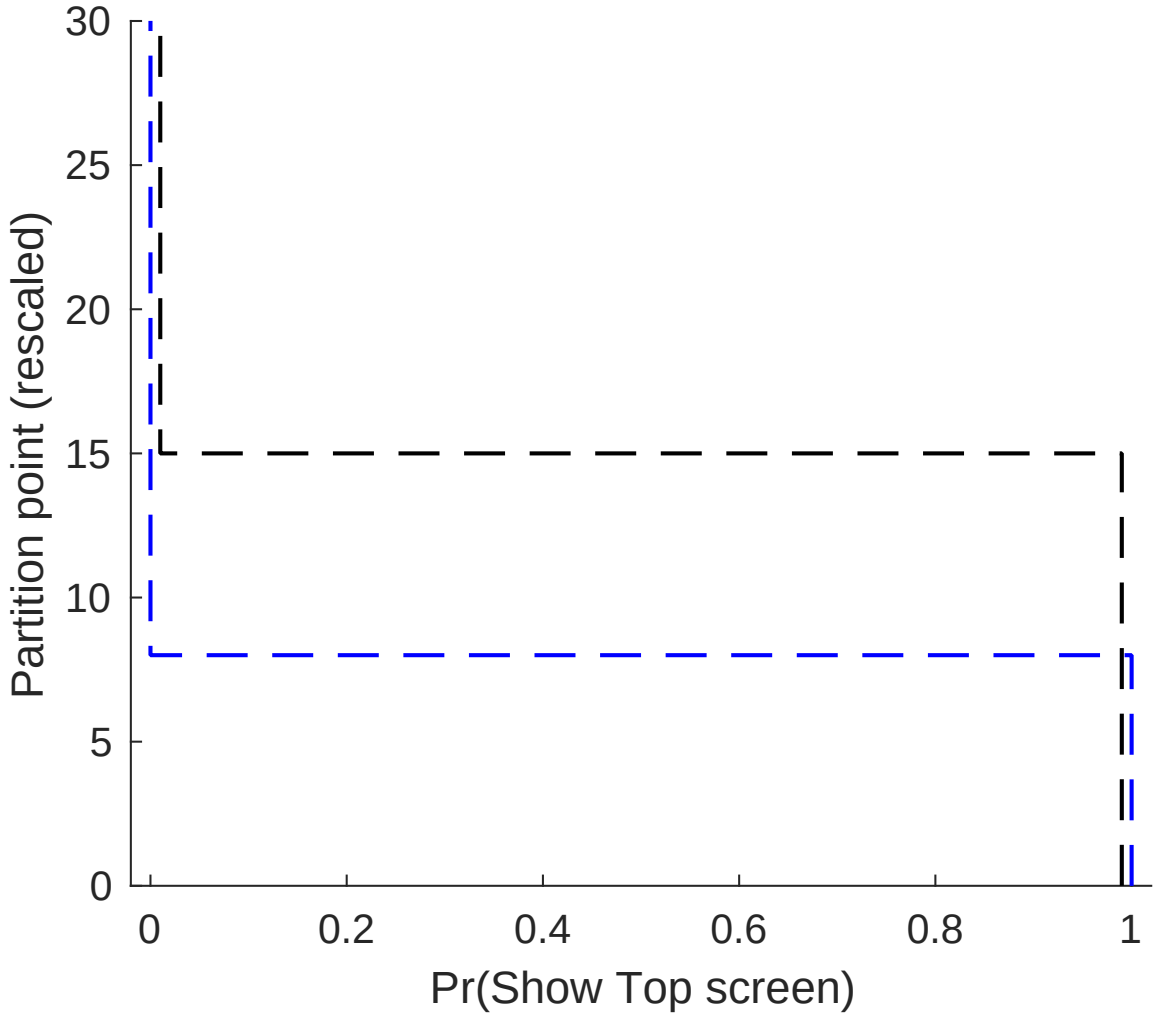
Click to confirm

Task 3 - Reveal screen (bottom visible)



Only the values in the selected range are visible

Screen partition



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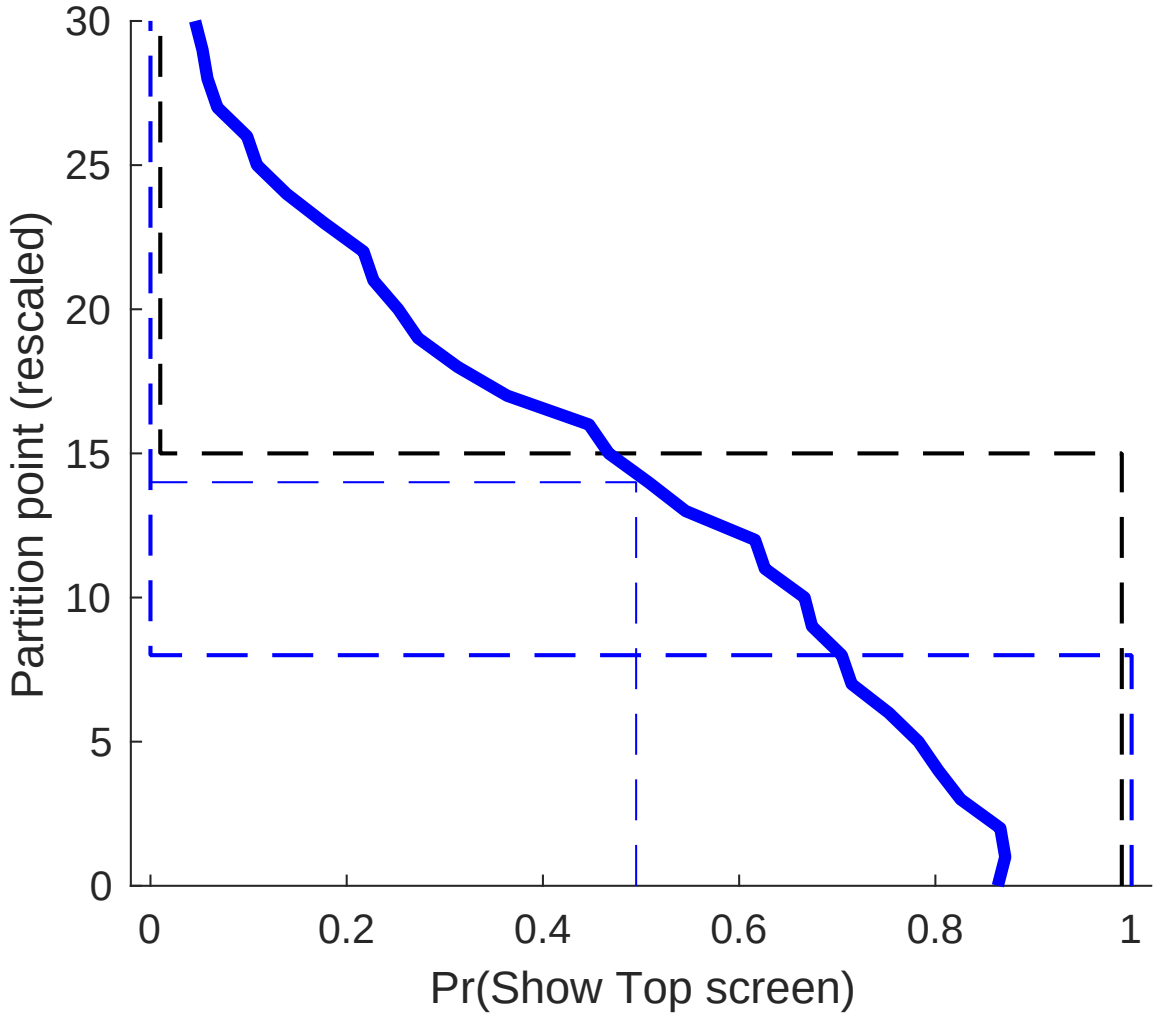

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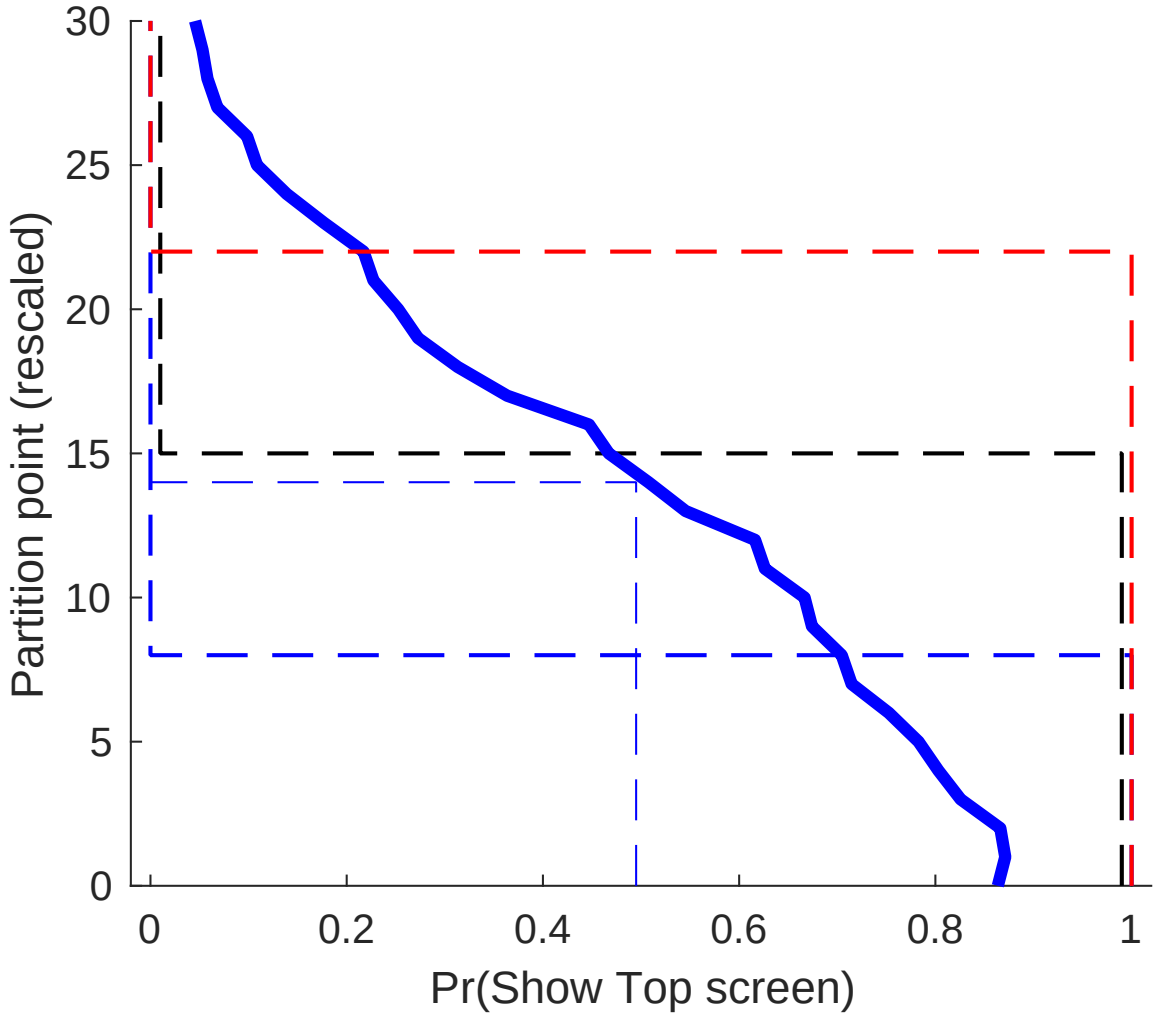

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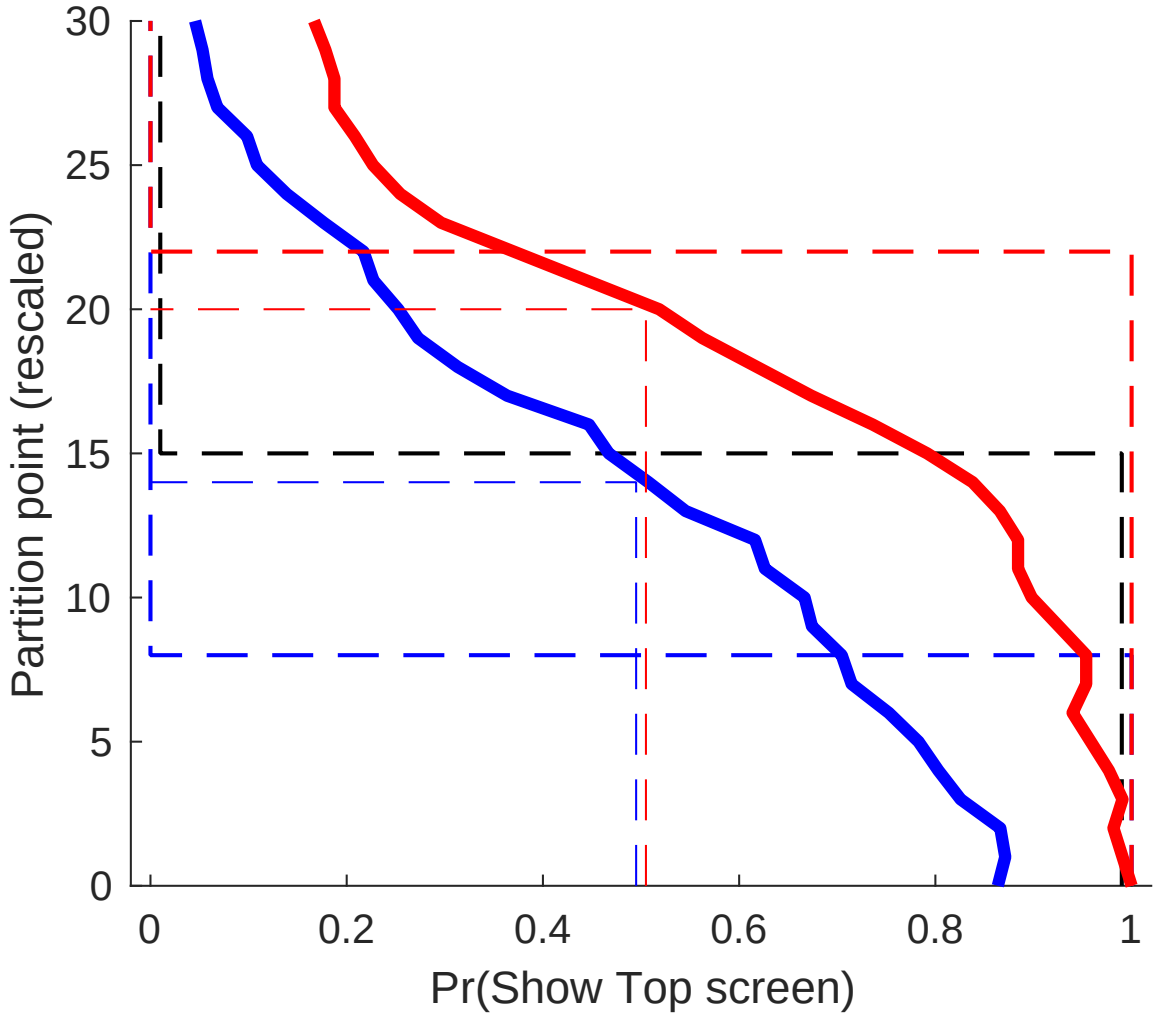

Summary

- Noisy encoding with comparison and information restriction

- **Encoding of differences**
- But absolute values also play a role
- Higher values have relatively higher value (task 1)
- And are systematically selected more (task 3)

Next steps

- Collect more data before the workshop!
- Model comparison (e.g. transducer + varying noise)
- Model endogenous allocation of attention over the range
- Show fewer, selected results
- Connect the results across tasks
- Explore individual heterogeneity
- Finish the slides on time