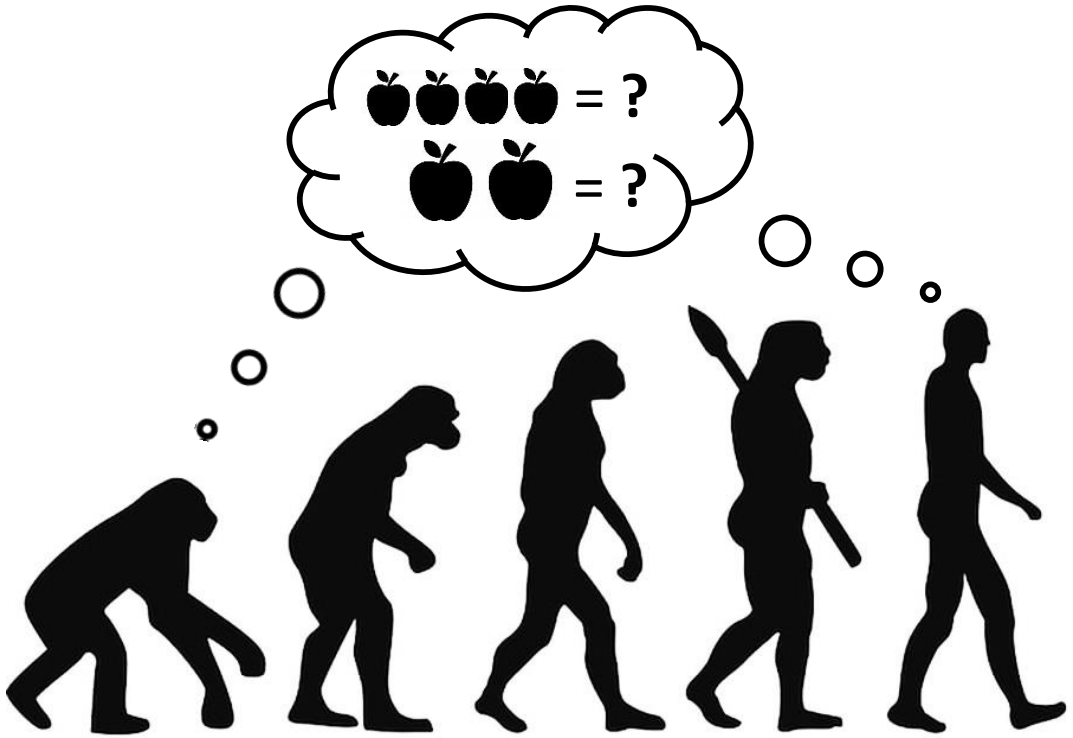
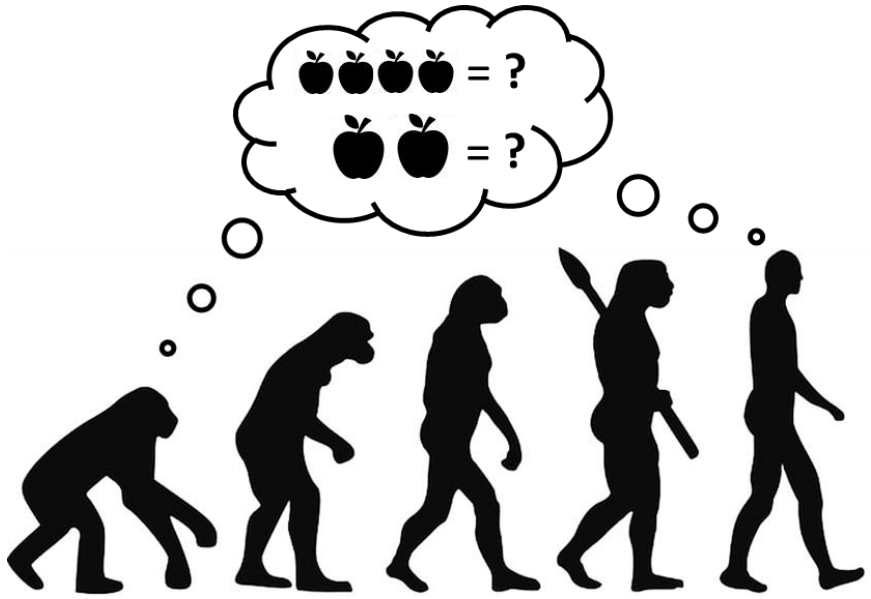


Spontaneous Numerical Cognition in human and non-human Primates

Guillermo Hidalgo Gadea and Gema Martin Ordas

#PSGBspring19



Agenda

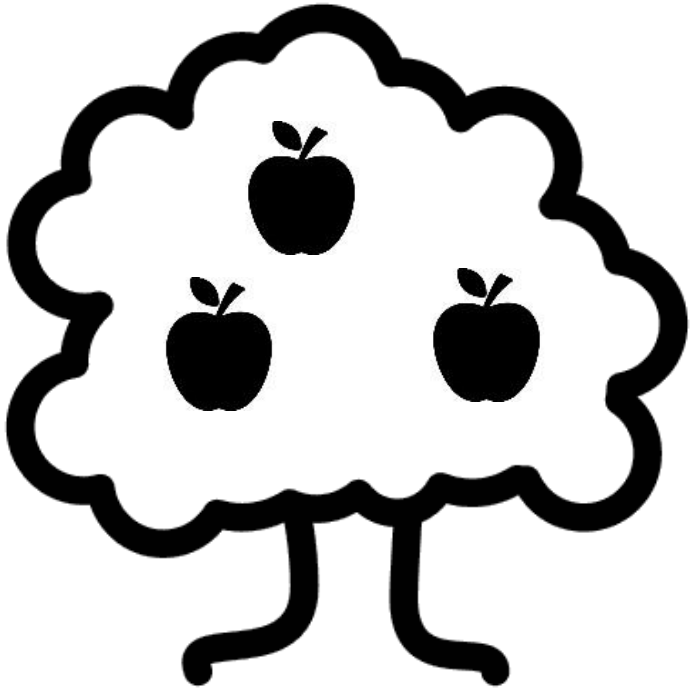
Introduction
Quantity Discrimination
Numerical Cognition

Methods
Task, Stimuli, Design
Subjects

Results
Chimpanzee
Human

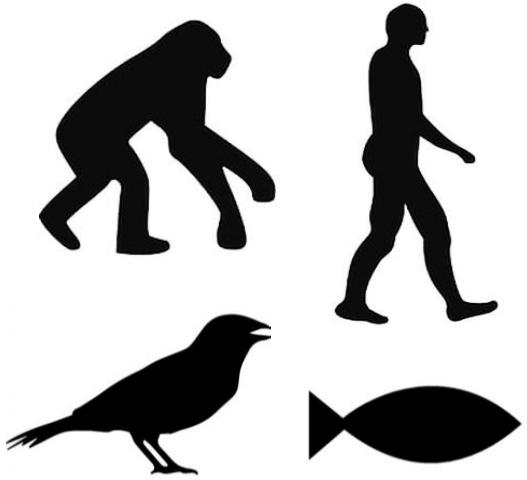
Research Question

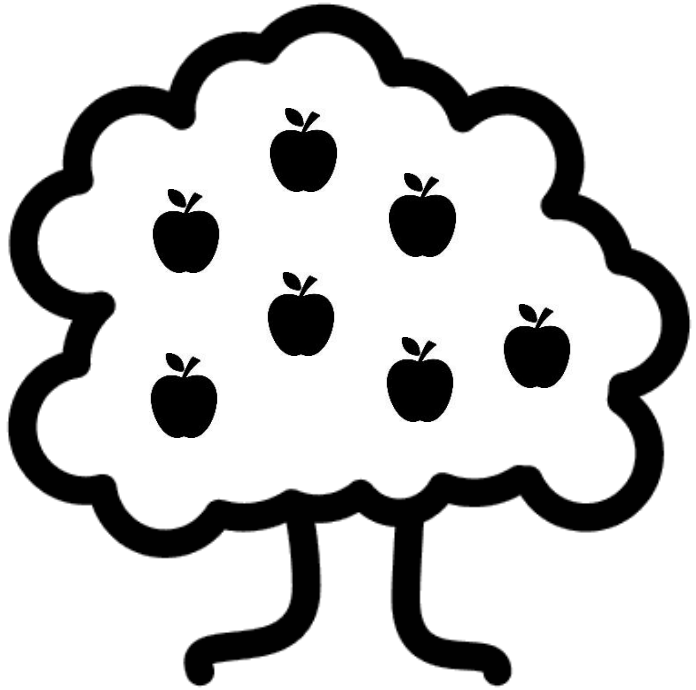
Introduction: Quantity Discrimination



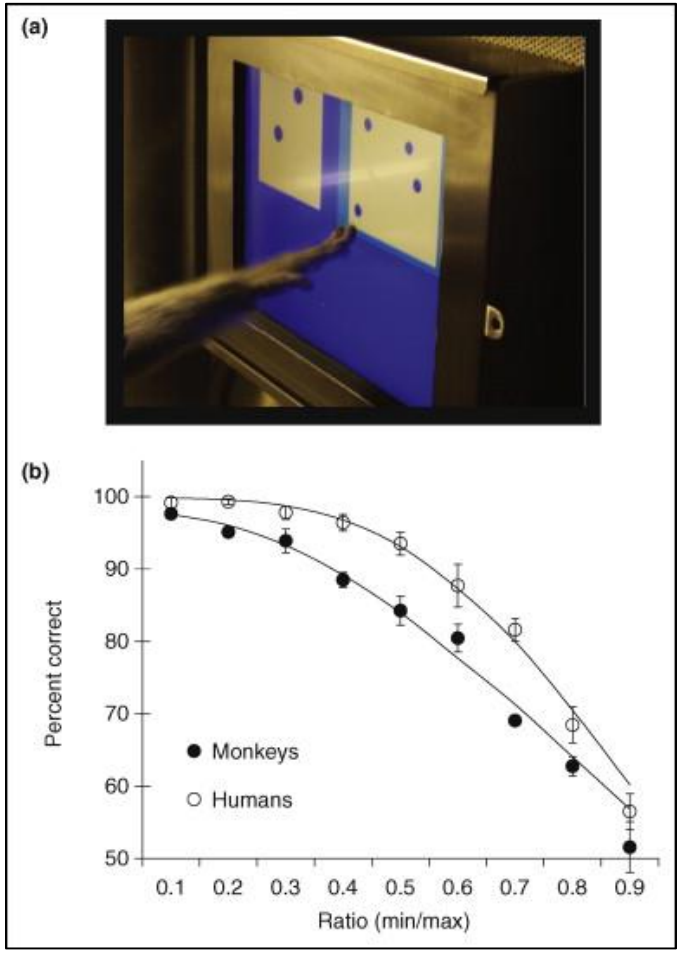
Multitude & Magnitude → **Quantity**

?

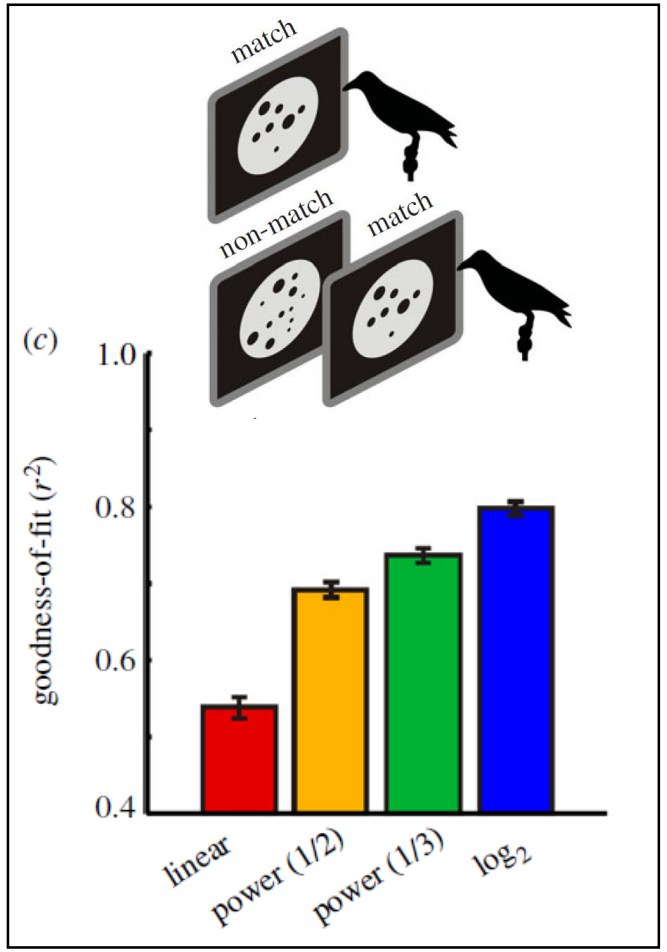




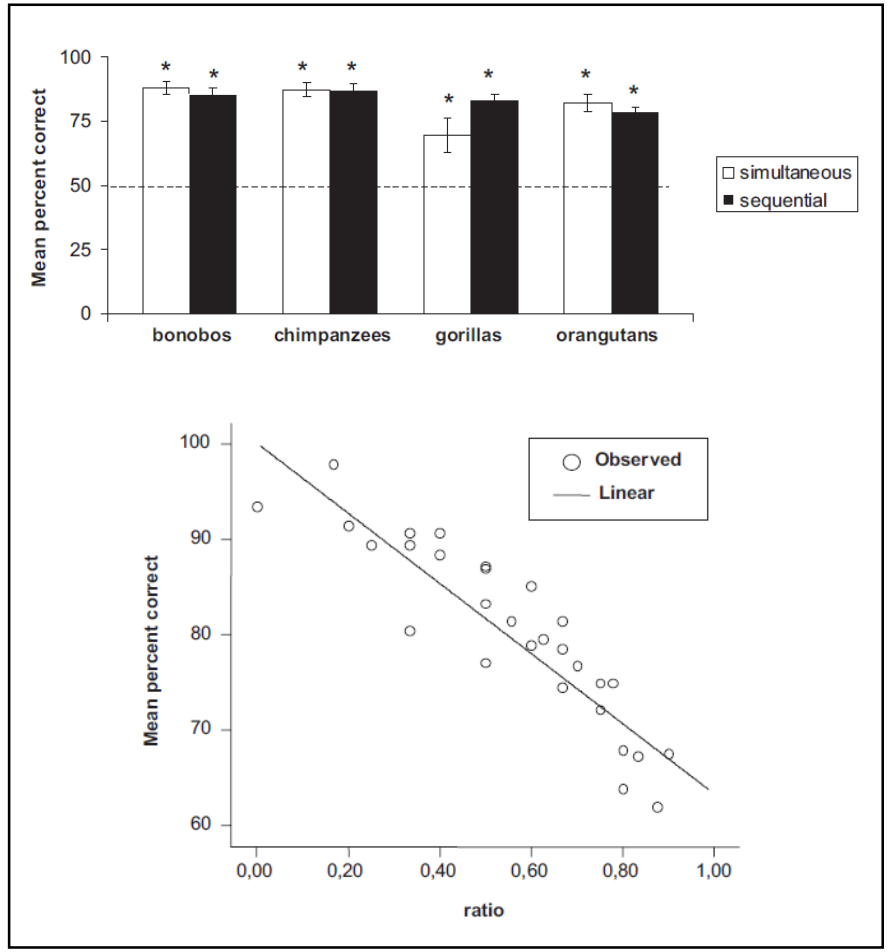
Introduction: Numerical cognition



Cantlon, Platt & Brannon (2009)



Ditz & Nieder (2016)



Hanus & Call (2007)

Methods: Task

Methods: Task

Methods: Stimuli

Methods: Design

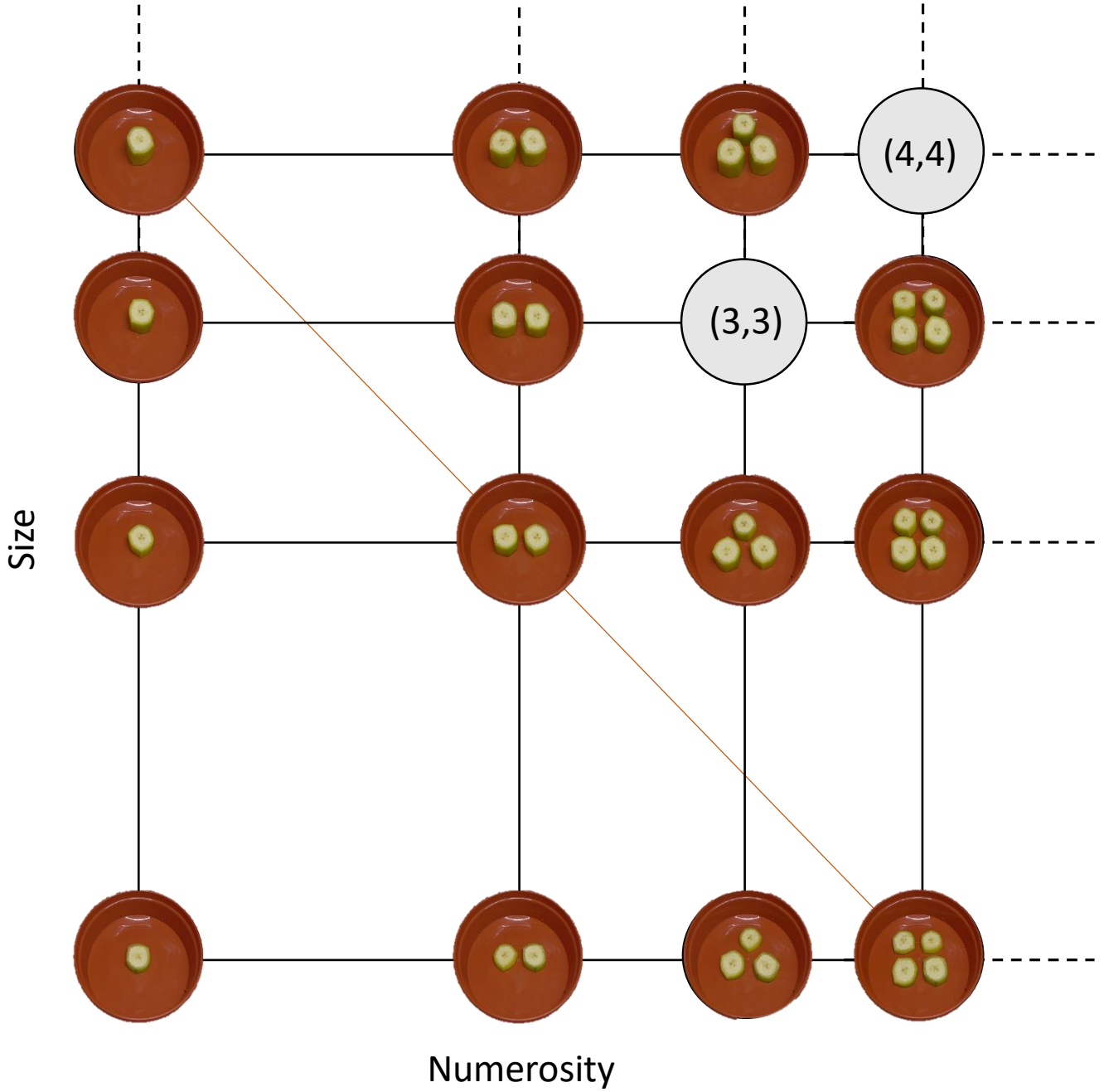
Presentation styles

- Visible plates
- Covered cups

Conditions

- Numerosity
- Size
- Critical Discriminations
- Equal Quantities

Natural Choice: Stimulus = Reward



Methods: Metrics

IV:

Quantity Ratio = Q_1/Q_2

Quantity Difference = $Q_2 - Q_1$

Number Ratio = N_1/N_2

Size Ratio = S_1/S_2

DV:

Highest quantity choice

e.g. (numerosity) **critical combination**

vs.

(1,4)

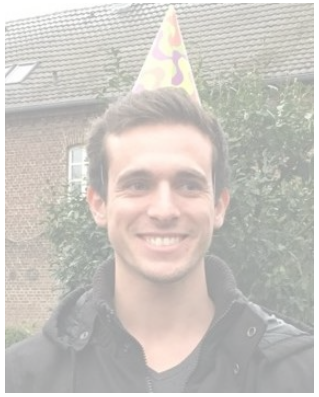
(3,2)

Methods: Subjects

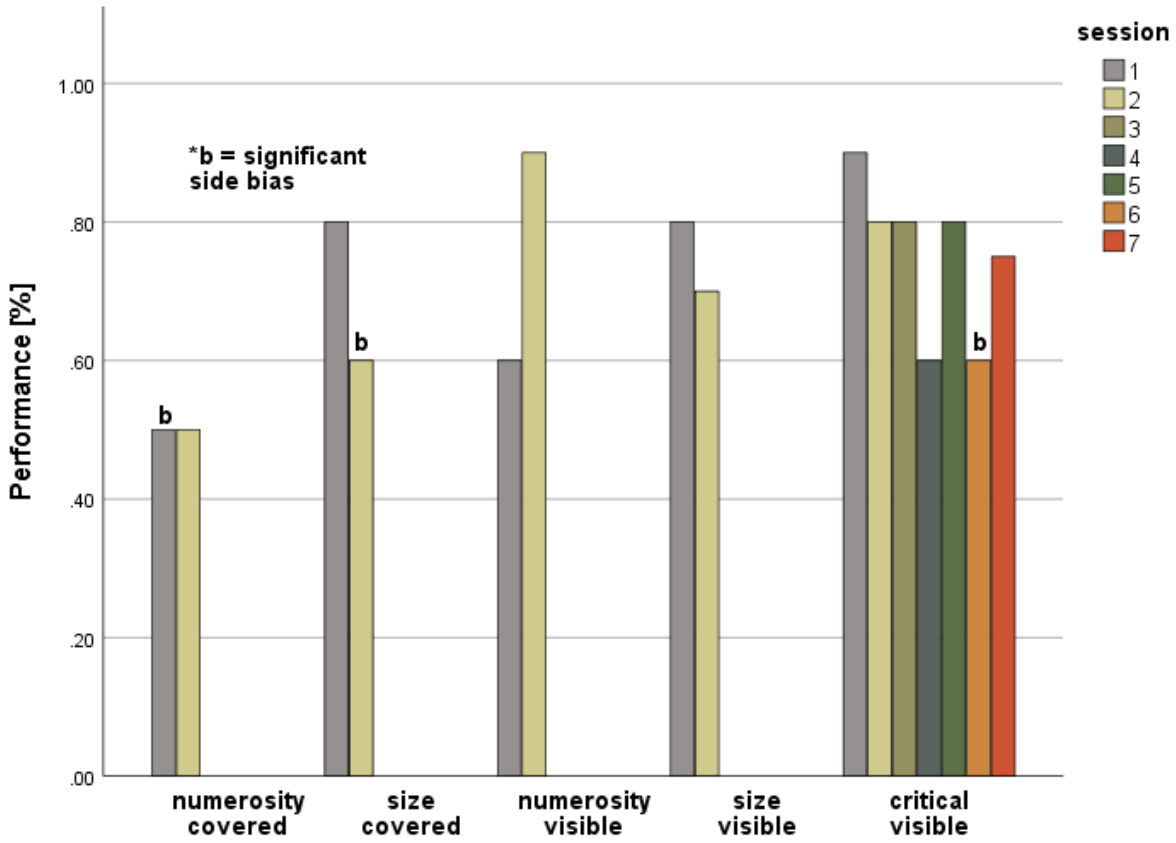
- **Undergraduate psychology students**
  N = 92 (78 f), age M = 22.15 years SD = 4.62
  tested in 4 groups at the University of Stirling.

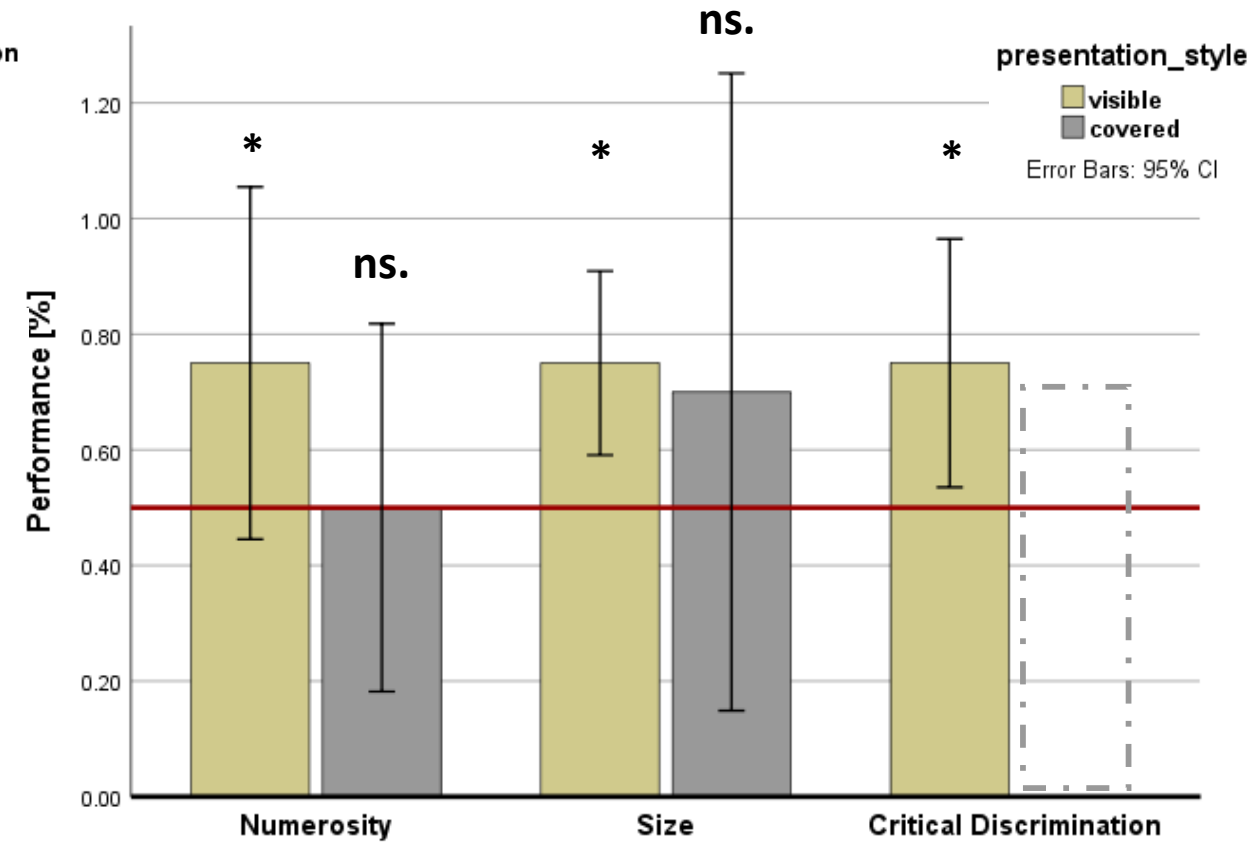
- **One chimpanzee** (f, 30 years) captive living group of four at Blair Drummond Safari Park not deprived from food or water, not separated

- Expected: **Four Ring-Tailed Lemurs** (2 f) and **two Brown Lemurs** (2 m) from a captive living group at the Blair Drummond Safari park



Results: Chimpanzee (*Pan troglodytes)*

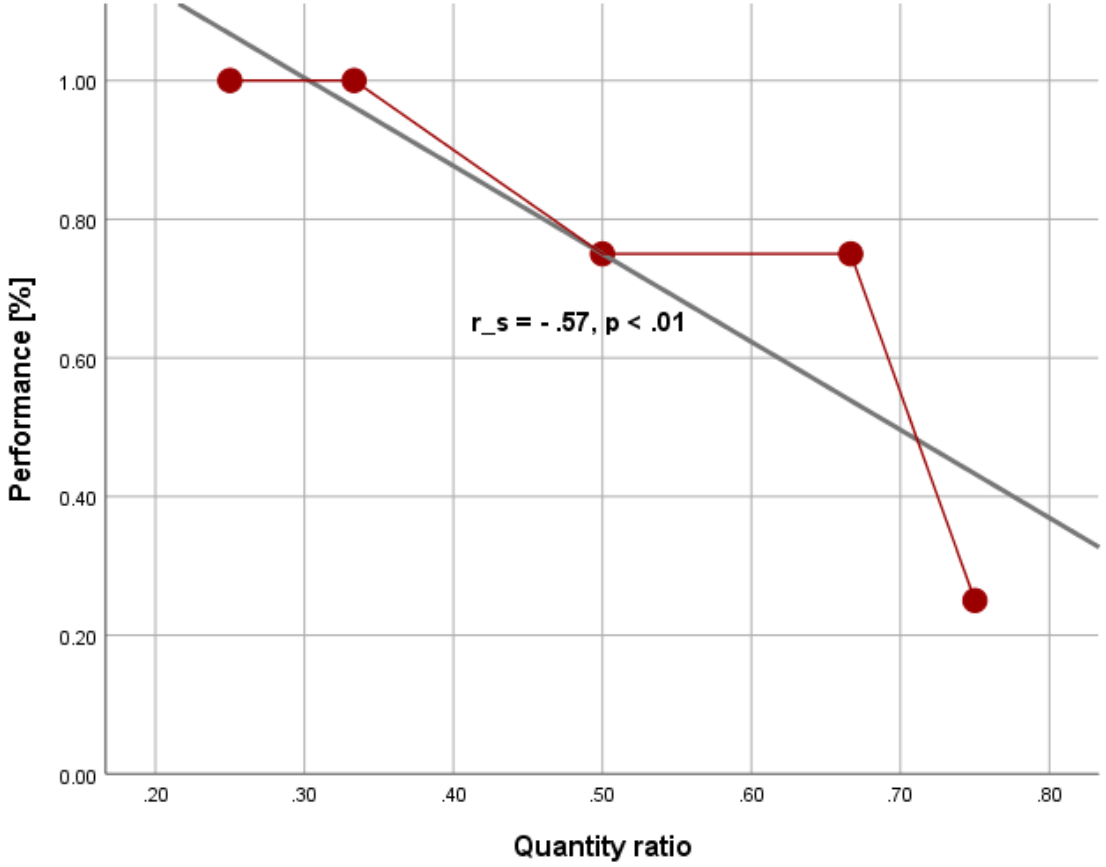


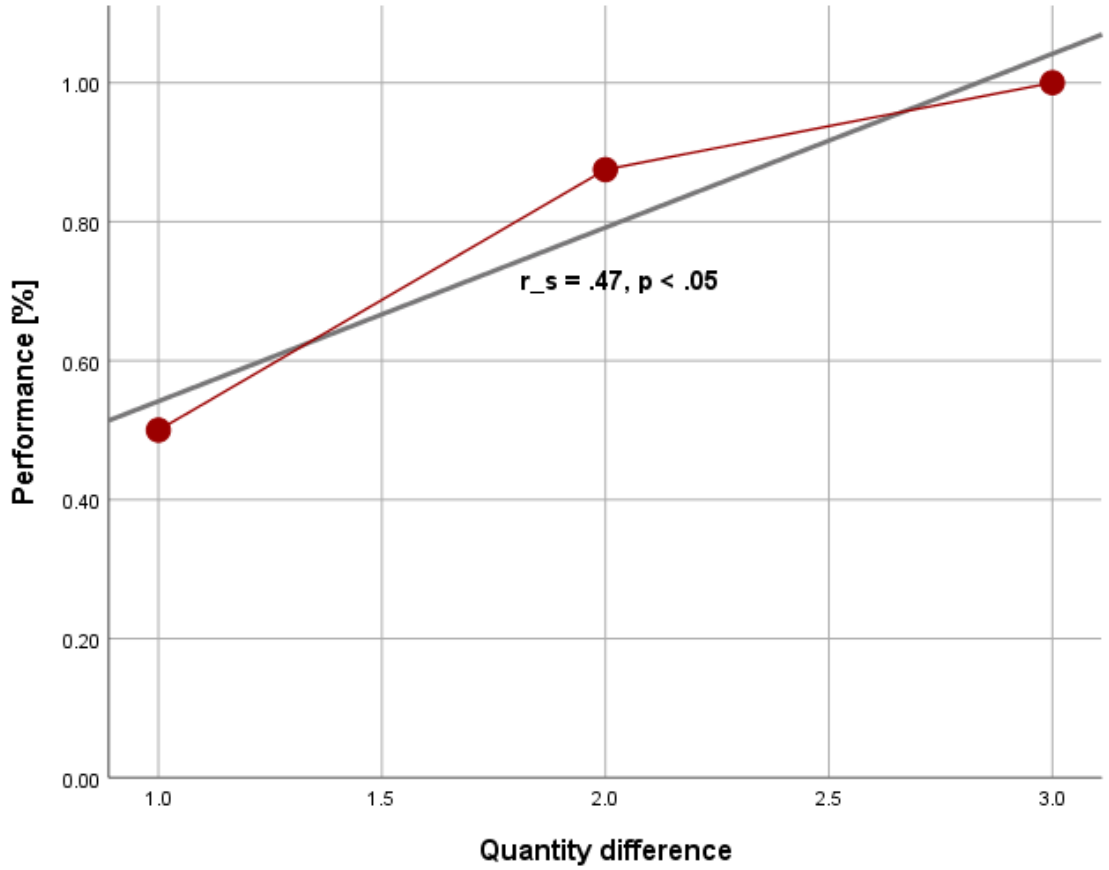


Significant <u>side bias</u> (Binomial test, $p < .05$) on single sessions in covered conditions and critical discrimination.

Performance in covered conditions not significantly different from <u>chance level</u> (Binomial test, $p < .05$).

Results: Chimpanzee (*Pan troglodytes)*

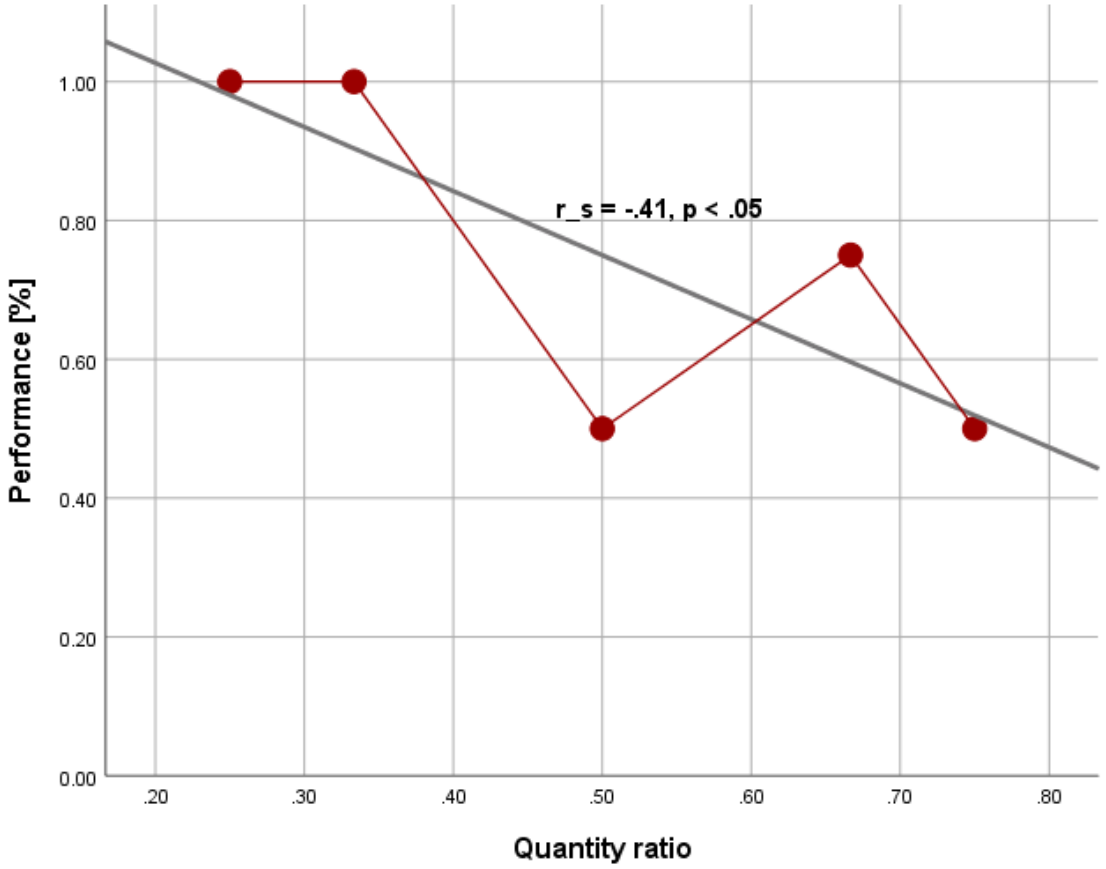


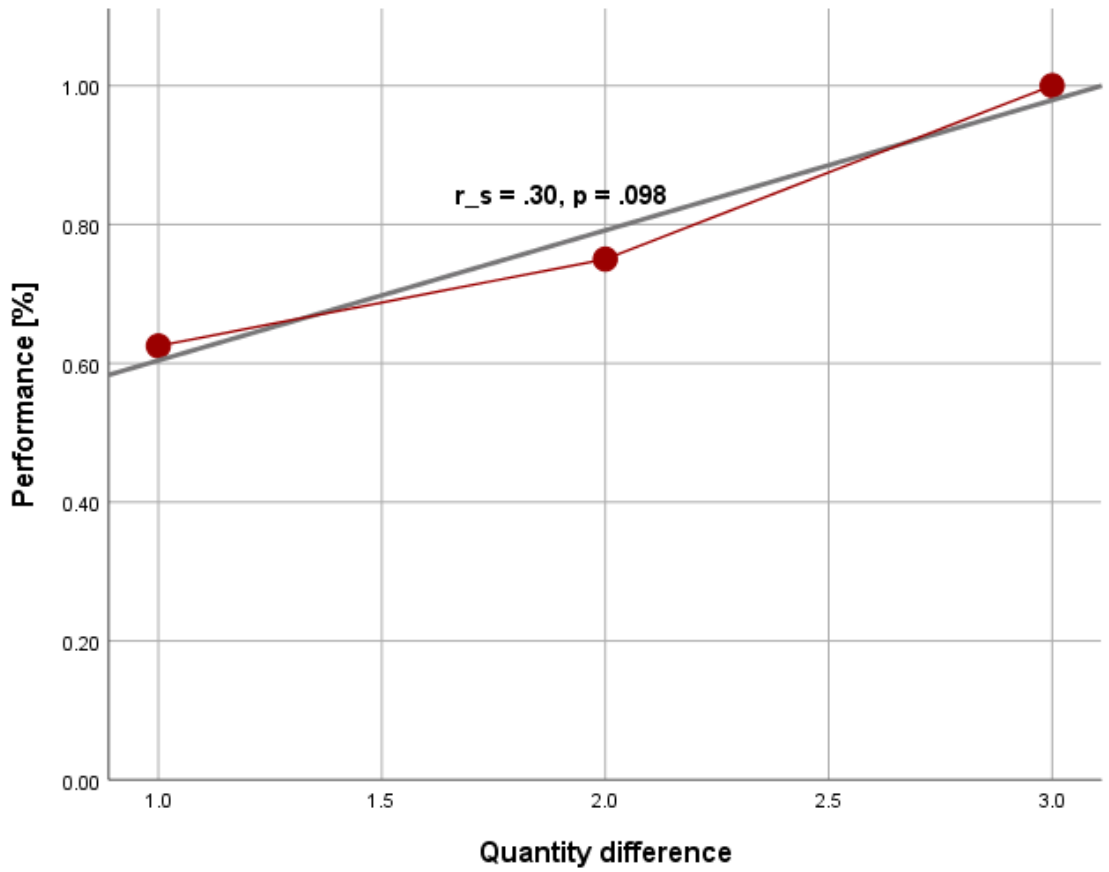


Quantity ratio has a stronger influence on performance than quantity difference (see Weber‘s Law).

T_ r_S difference difference ns. for **numerosity**.

Results: Chimpanzee (*Pan troglodytes)*

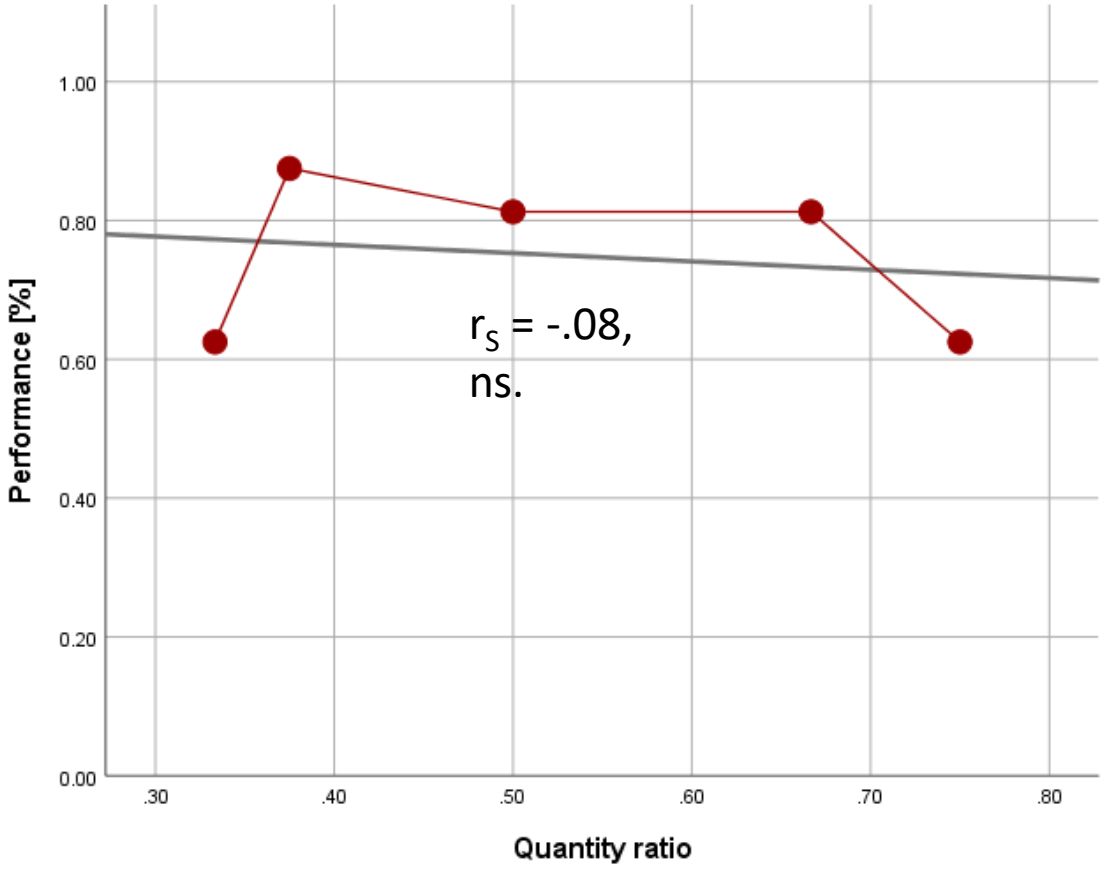


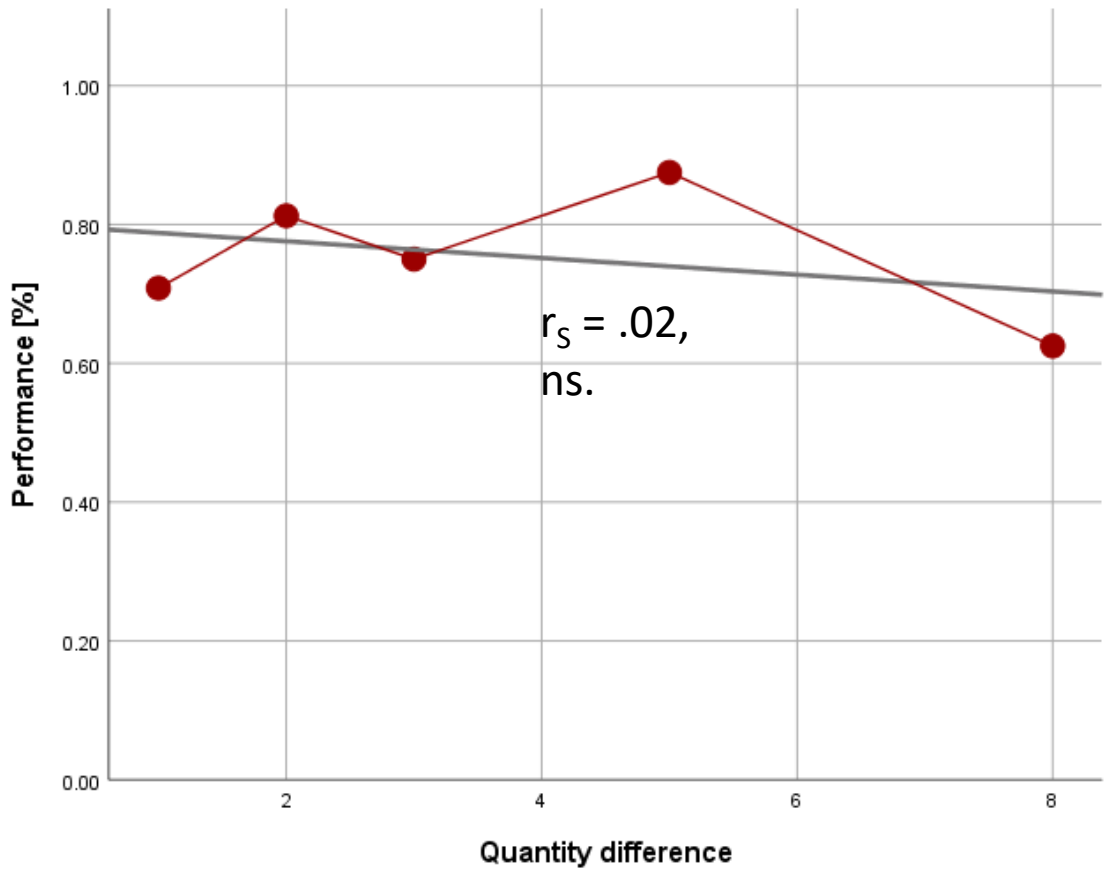


Quantity ratio has a stronger influence on performance than quantity difference (see Weber's Law).

T_ r_S difference difference $p < .05$ for size.

Results: Chimpanzee (*Pan troglodytes)*

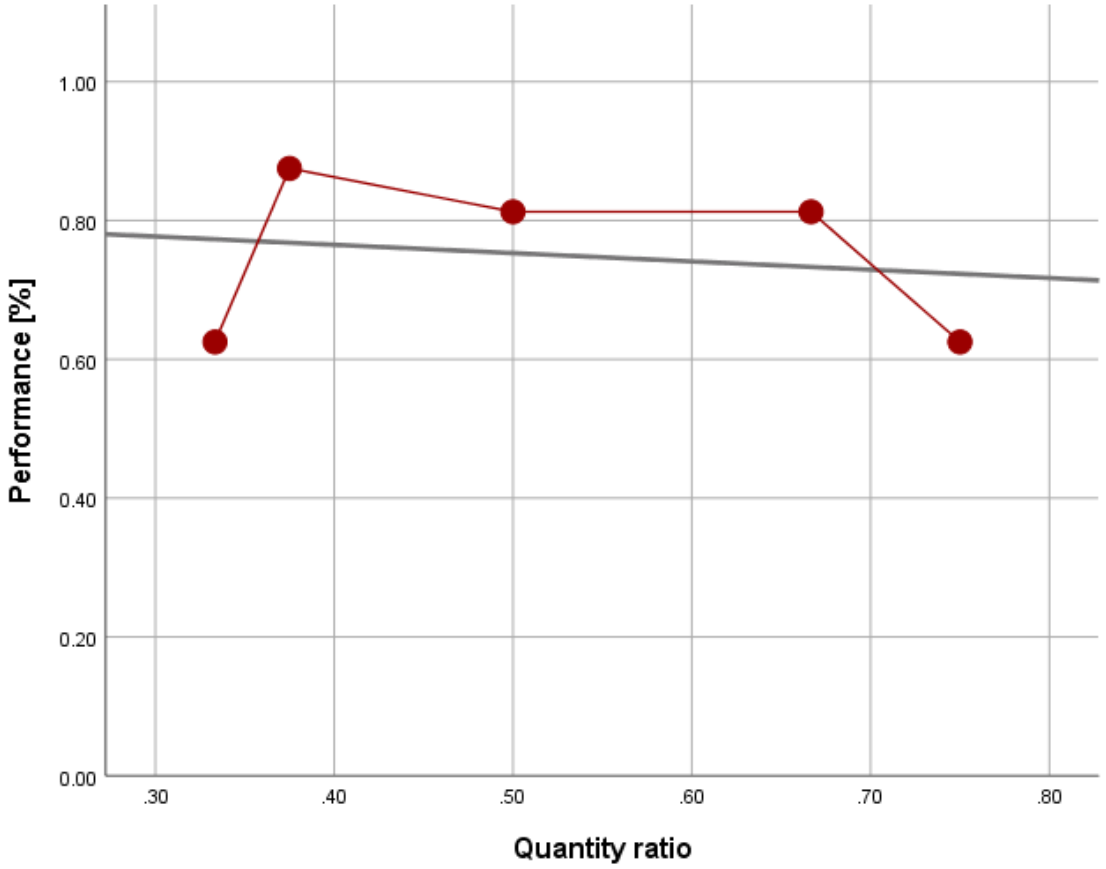


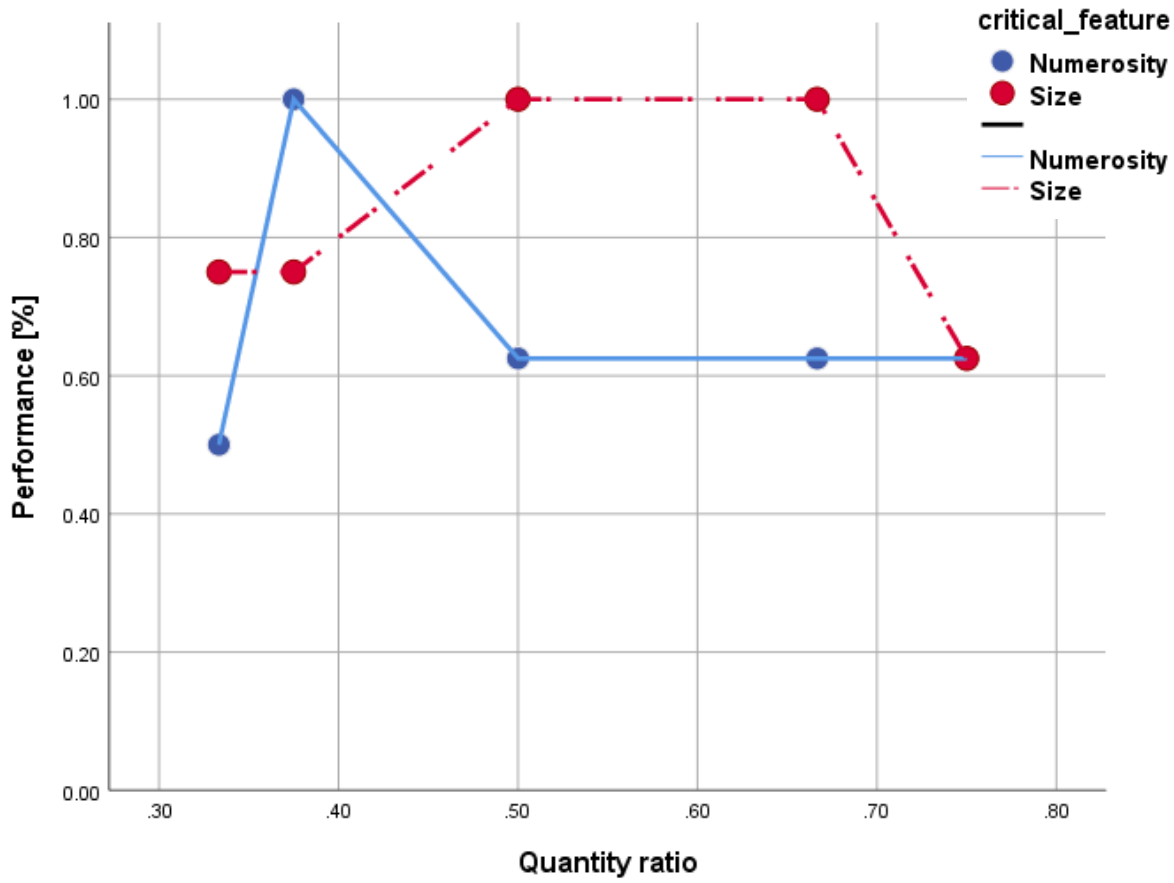


Performance in critical condition is not influenced by neither quantity ratio nor quantity difference.

Performance can be explained by size ratio (r_S = -.24), indicating feature preference.

Results: Chimpanzee (*Pan troglodytes)*

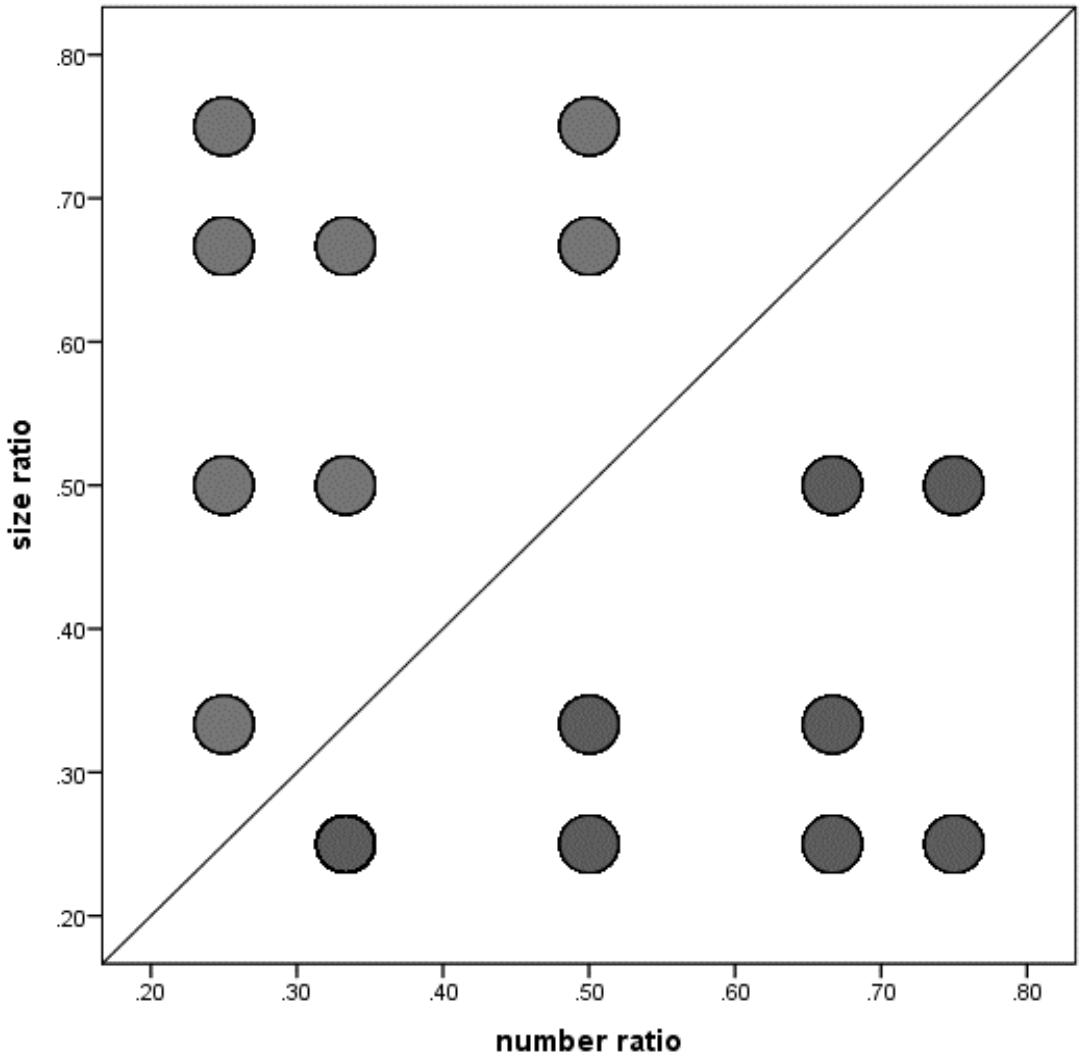


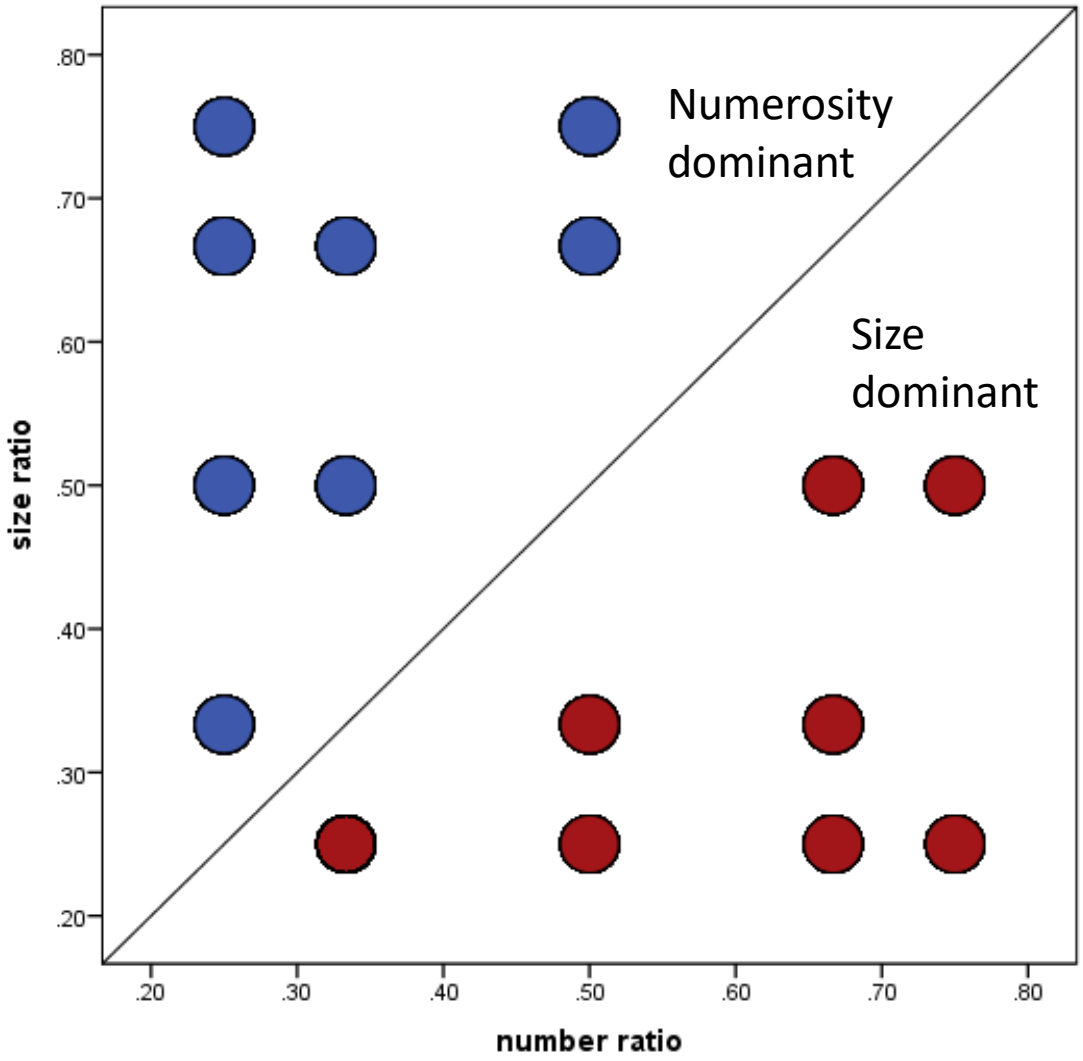


Separate analysis for dominant feature in critical condition indicates preference for size critical trials.

No significant difference in performance between dominant features (Wilcoxon T = 75, p = .109).

Flashback: Critical condition





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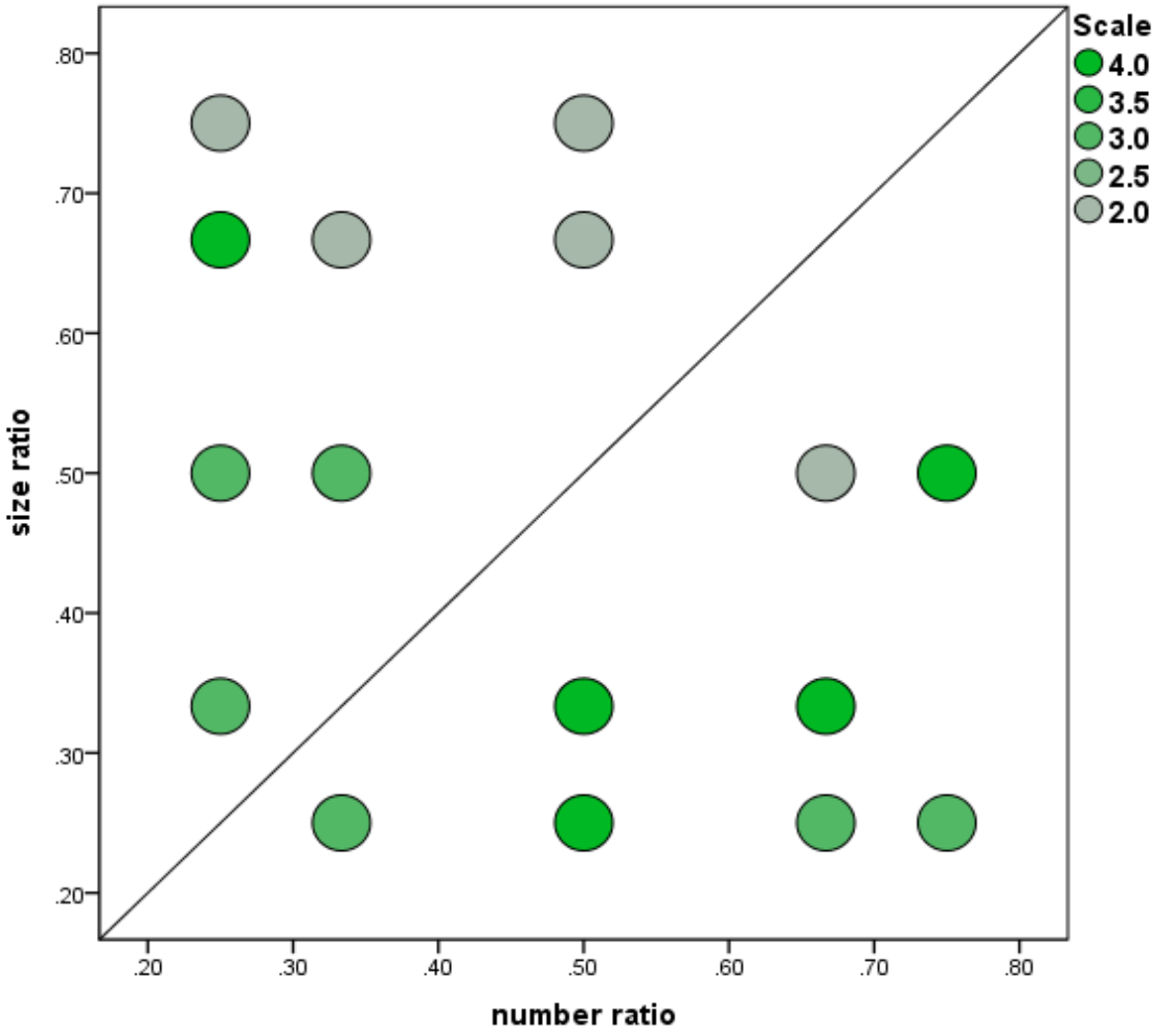

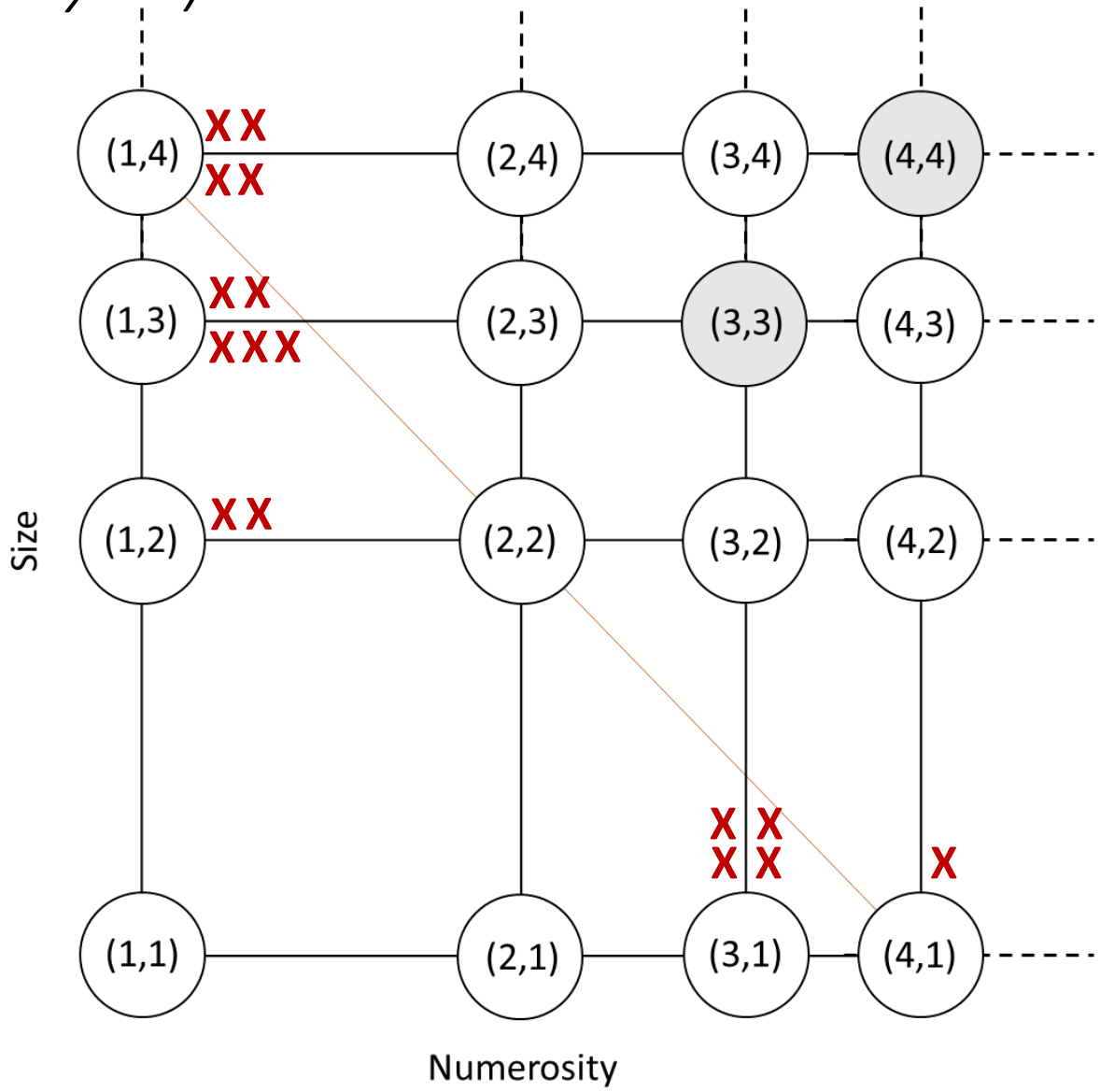

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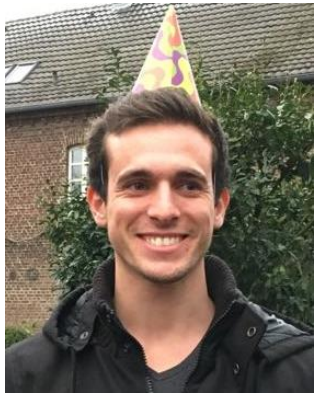
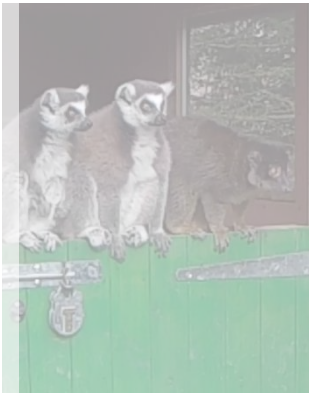
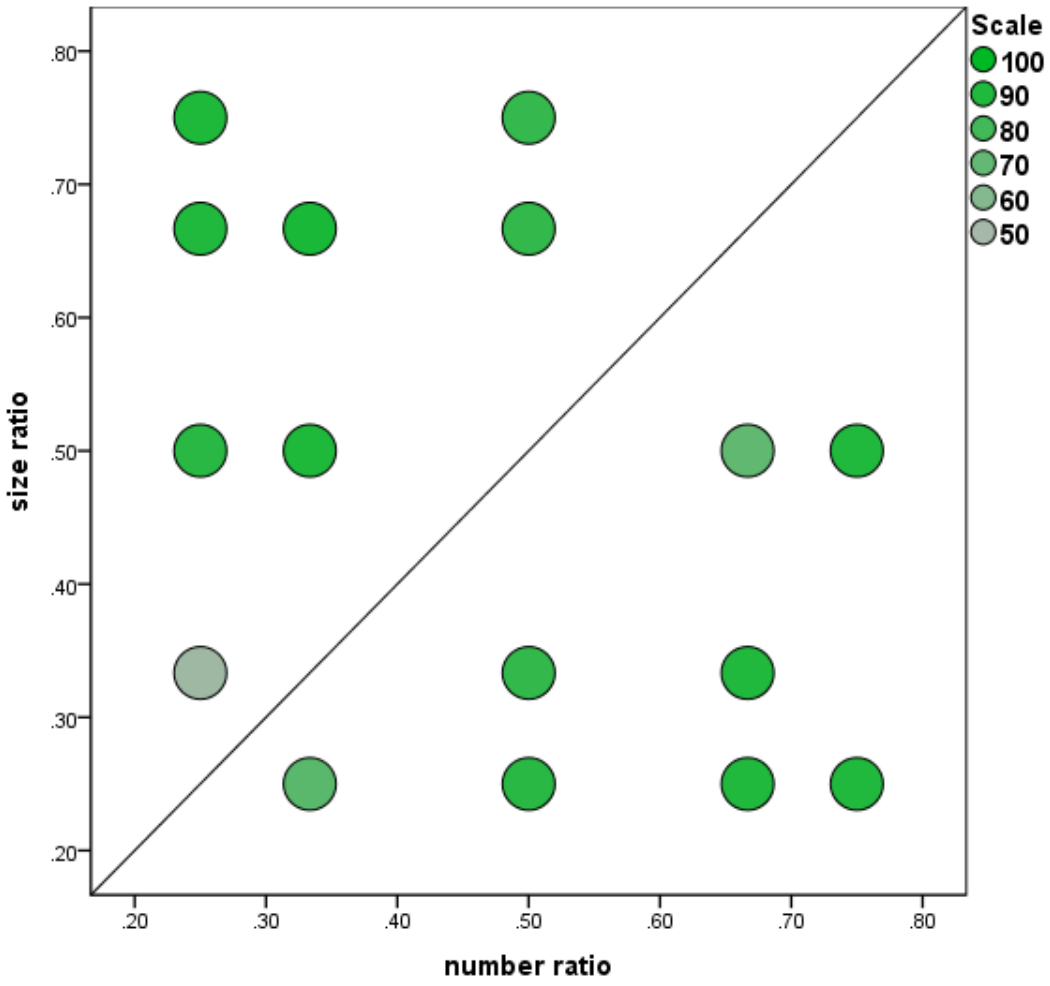
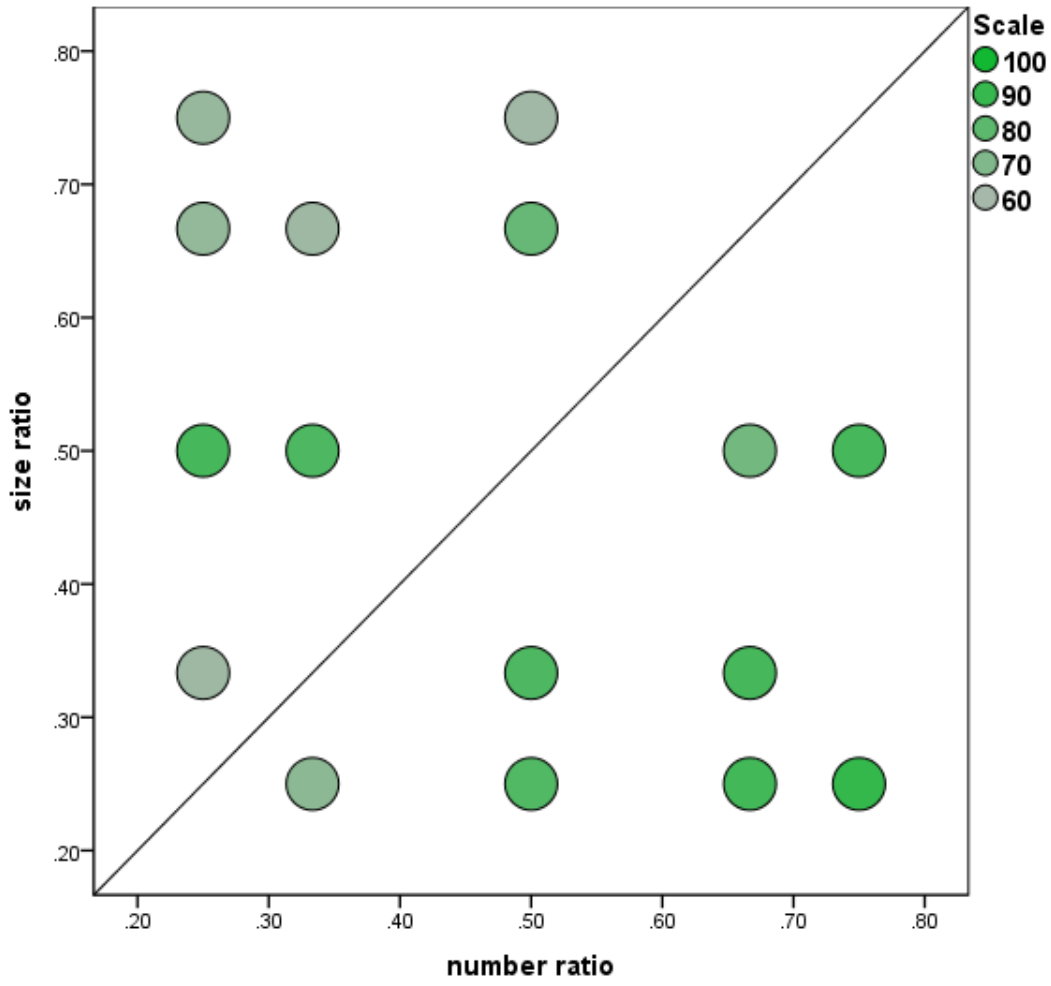




Results: Undergraduates (*Homo sapiens*)

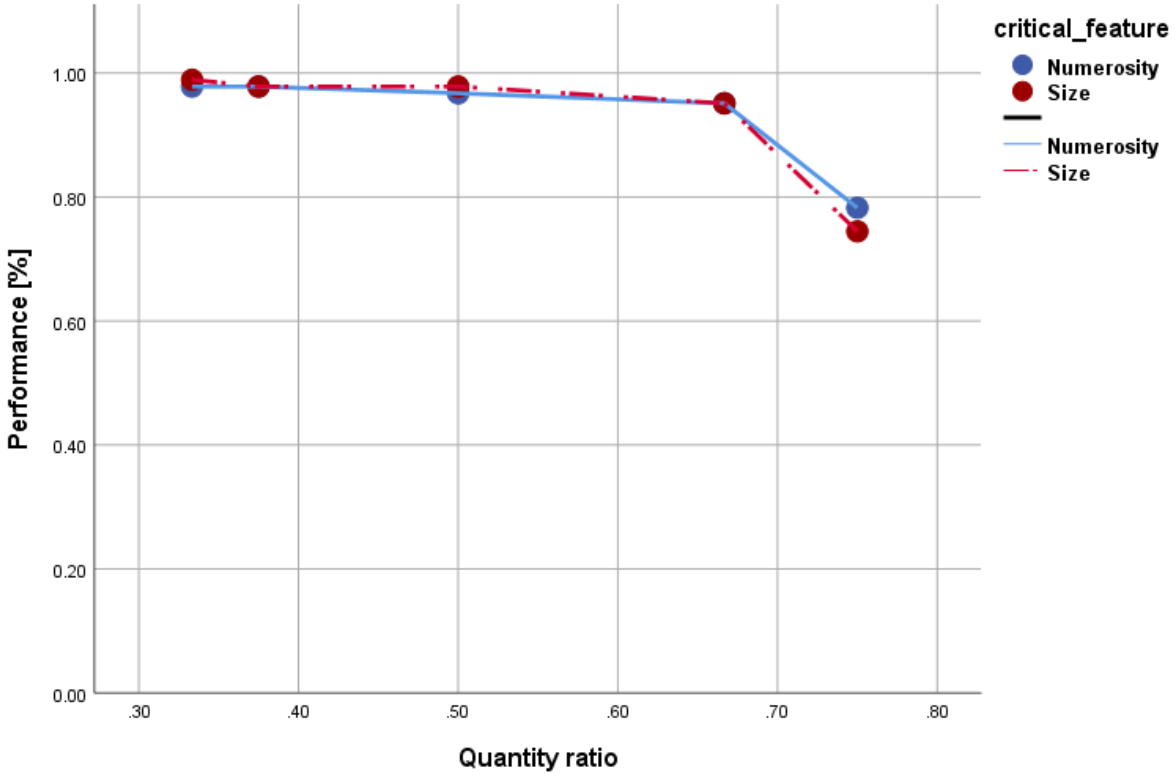


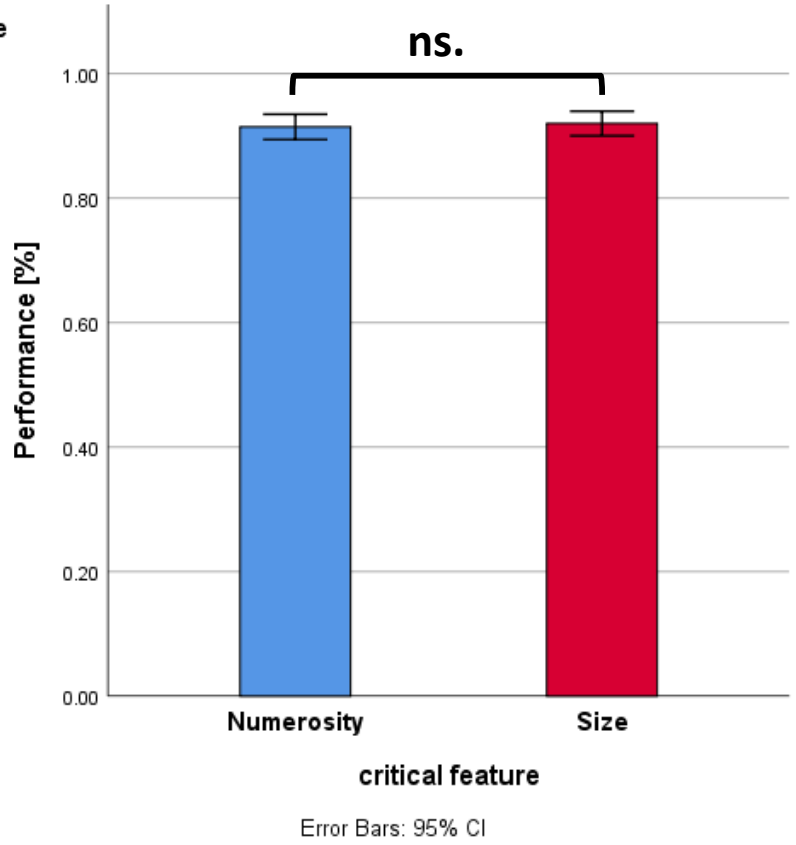
Visible



Covered

Results: Undergraduates (*Homo sapiens*)



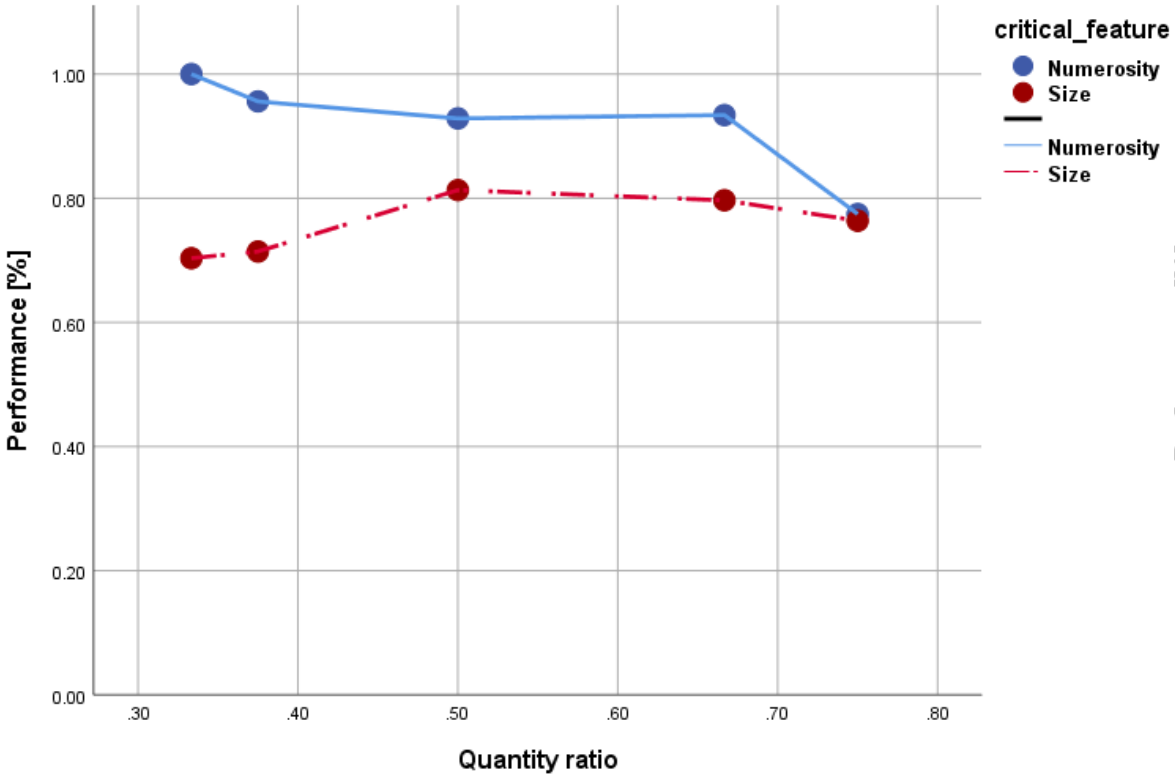


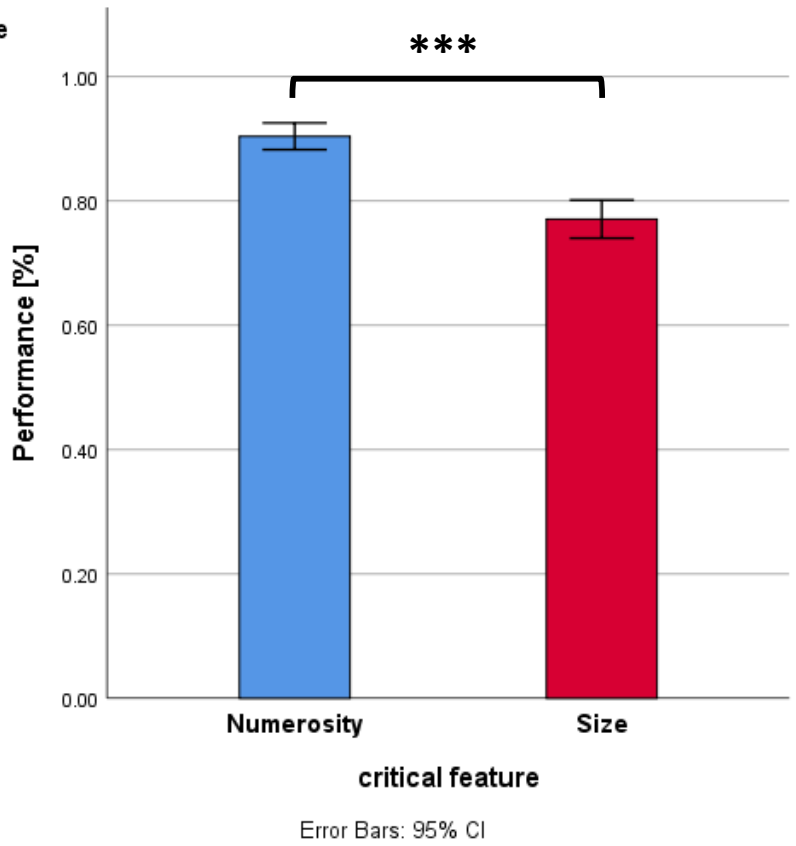
Wilcoxon signed-rank
T = 3277 ns., r = .01

Visible numerosity critical trials correlated to quantity (r_S = -.30) and size ratio (r_S = .26), least to numerosity (r_S = .11).

Visible size critical trials correlated to quantity (r_S = -.25) and numerosity ratio (r_S = .15), least to size (r_S = -.06).

Results: Undergraduates (*Homo sapiens*)



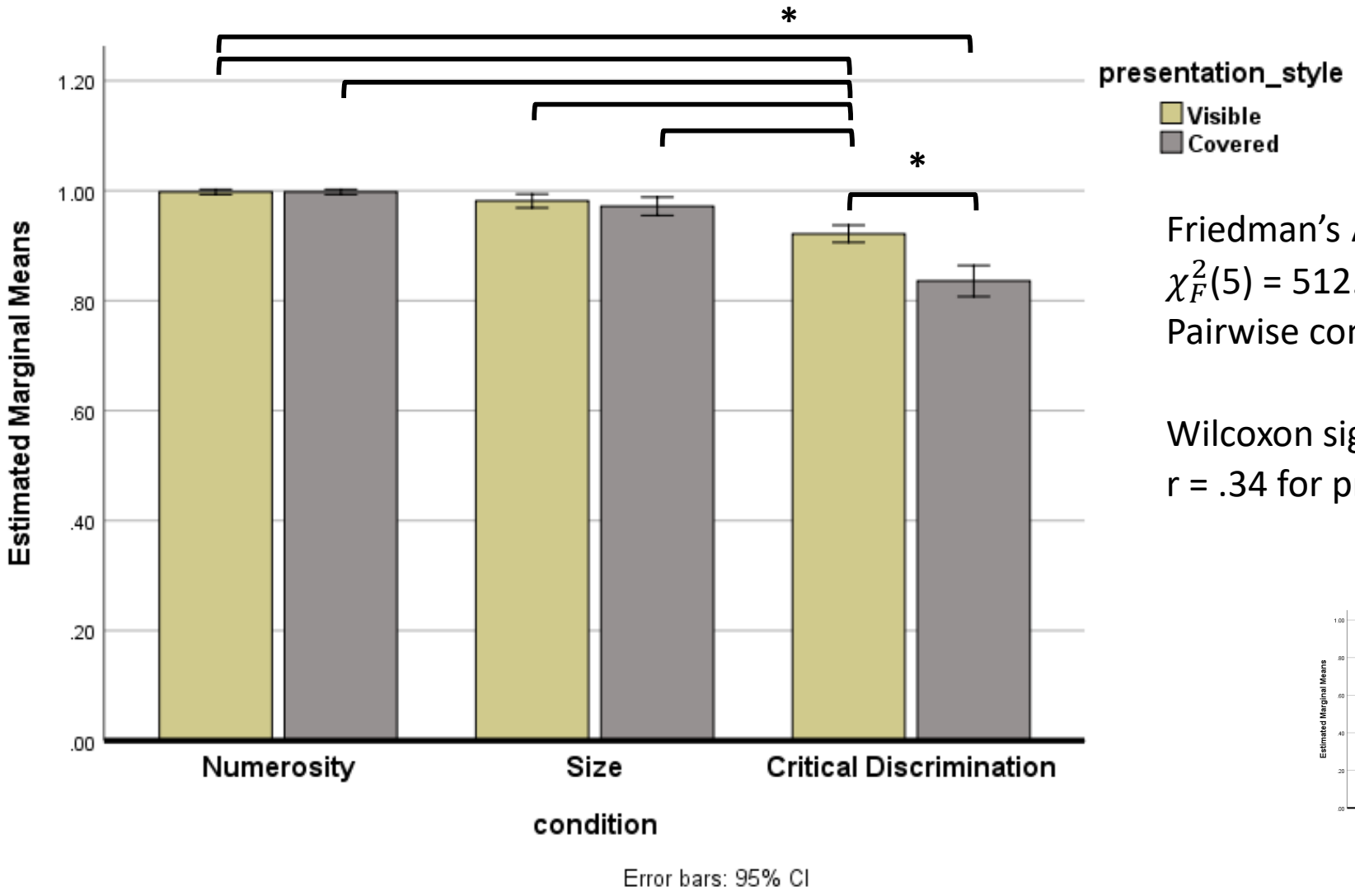


Wilcoxon signed-rank
T = 6372 p < .001, r = -.17

Covered numerosity critical trials correlated to size ratio (r_S = -.12), not to quantity nor numerosity.

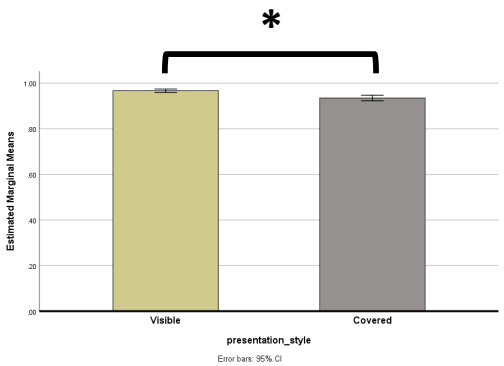
Covered size critical trials correlated to quantity (r_S = -.23) and numerosity ratio (r_S = .18), least to size (r_S = -.01).

Results: Undergraduates (*Homo sapiens*)



Friedman's ANOVA by ranks;
$\chi_F^2(5) = 512.29$, $p < .001$.
Pairwise comparisons at $p < .05$

Wilcoxon signed-rank T = 2130 $p < .001$,
$r = .34$ for presentation style



Research Question: Quantity Discrimination Strategies

Rational Model:
Volume $_{total}$ = Volume$_{piece}$ x Number$_{pieces}$
(feature combination)

Rational Model + Bias:
Feature salience bias on quantity proxy
(weighted combination)

Take-the-Best Model:
Single dominant feature as proxy
(feature reduction)

Take-the-Best Model + Bias:
Feature salience bias on feature dominance
(feature preference)

			Q. ratio	N. ratio	S. ratio
Human	**Visible**		**-.27**	**.09**	**.08**
		N. critical	**-.30**	**.11**	**.26**
		S. critical	**-.25**	**.15**	ns.
	Covered		**-.07**	**.19**	**-.18**
		N. critical	ns.	ns.	**-.12**
		S. critical	**-.23**	**.18**	ns.
Chimp.	**Visible**		ns.	ns.	**-.24**
		N. critical	ns.	ns.	ns.
		S. critical	ns.	ns.	ns.

Note. All Spearman (Rank-) Correlations different from 0 at a $p < .01$ level.

Outlook: Data collection Lemurs (*Eulemur fulvus, Lemur catta*)

Eulemur fulvus

Lemur catta

UNIVERSITY of STIRLING

Thank you for listening

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(University of Stirling)

Research Coordinator:
Alasdair Gillies
(Blair Drummond Safari Park)