Factors influencing the ratio bias

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A Question

Which disease is more dangerous?

- A: Kills 1 out of 10 patients
- B: Out of 1000 patients, 100 will die

Ratio bias in context

- Framing effects: Different ways of presenting same information influence decisions (Kahnemann, 2012)
- Probabilities: Bayesian updates done more correctly if problem is described in absolute numbers (Gigerenzer /Hoffrage, 1995; Ohlert /Weissenberger, 2015)
- But: Presenting probabilities as ratios of large or small numbers makes a difference (Piaget/Inhalder, 1975; Miller et al., 1989; Kirkpatrick/Epstein, 1994)

Previous research on ratio bias

- Subjects chose lottery where probability is represented by larger numbers, even if it is objectively smaller (Piaget and Inhelder, 1975; Denes-Raj and Epstein, 1994; Kirkpatrick and Epstein, 1992; Miller et al., 1989)
- Holds mutatis mutandis also for undesirable outcomes (Bonner and Newell, 2008; Pinto-Prades et al., 2006; Yamagishi, 1997)
- Strong effects of context (phrasing of questions) (Denes-Raj et al., 1995; Passerini et al., 2012)
- Mixed evidence concerning incentives (Dale et al., 2007; Lefebvre et al., 2011)

Research gaps

- Choice between two alternatives forced, no indifference possible (Passerini et al., 2012)
- No comparison of ratio bias to opposite deviations (preference for low-number alternative),
  exceptions: Dale et al., 2007, Lefebvre et al., 2011
- Only low probabilities
- No systematic study of problem characteristics and individual characteristics

Research questions

- RQ1: Is there a systematic bias towards high-number alternatives when allowing for indifference?
- RQ2: Which characteristics of the choice problems and of subjects, lead to more or less frequent occurrence of the ratio bias?
- RQ3: Is there consistent behavior across decision problems, in which the objective relation of high-number and low-number alternatives is different?

Decision problems

universität wien

Probability	Low better		Equivalent		High better	
	Low	High	Low	High	Low	High
Low	1:9	9:90	1:9	10:90	1:9	11:90
	1:9	8:91	1:20	10:200	1:9	12:91
	1:9	7:92	1:12	100:1200	1:9	13:92
Medium	5:9	49:90	5:90	50:90	5:9	51:90
	5:9	48:91	11:20	110:200	5:9	51:91
	5:9	47:92	1:12	100:1200	5:9	53:92
High	8:9	79:90	8:9	80:90	8:9	81:90
	8:9	78:91	18:20	180:200	8:9	82:91
	8:9	77:92	11:12	1100:1200	8:9	83:92

Possible forms of deviation

Choice	Low better	Equivalent	High better
Low	Rational	Bias (reverse)	Strong (rev)
Indifferent	Weak bias	Rational	Weak (rev)
High	Strong bias	Bias (ratio)	Rational

Experiment

- Paper and pencil
- 136 undergraduate subjects (82 F, 54 M), mean age 22.1
- Incentive: All 27 lotteries played for points, 5 highest points received Amazon voucher for 50€ each

Descriptive results – deviations from objectively better alternative

	Low better		High better	
	Bias towards high		Bias towards low	
	N	%	N	%
Rational	720	59.36%	865	71.78%
Weak bias	120	9.89%	86	7.14%
Strong bias	373	30.75%	254	21.08%

$\chi^2 = 41.44$; $p < 0.1\%$

Choice	Low better	Equivalent	High better
Low	Rational	Bias (rev)	Strong (rev)
Indifferent	Weak bias	Rational	Weak (rev)
High	Strong bias	Bias (ratio)	Rational

Statistical test

- Ranking:
  No bias – weak bias (indifference) – strong bias (preference)
  Ordered multinomial regression
- Multiple observations per subject, possibly unobserved characteristics:
  Intercept as random effect, dependent on subject

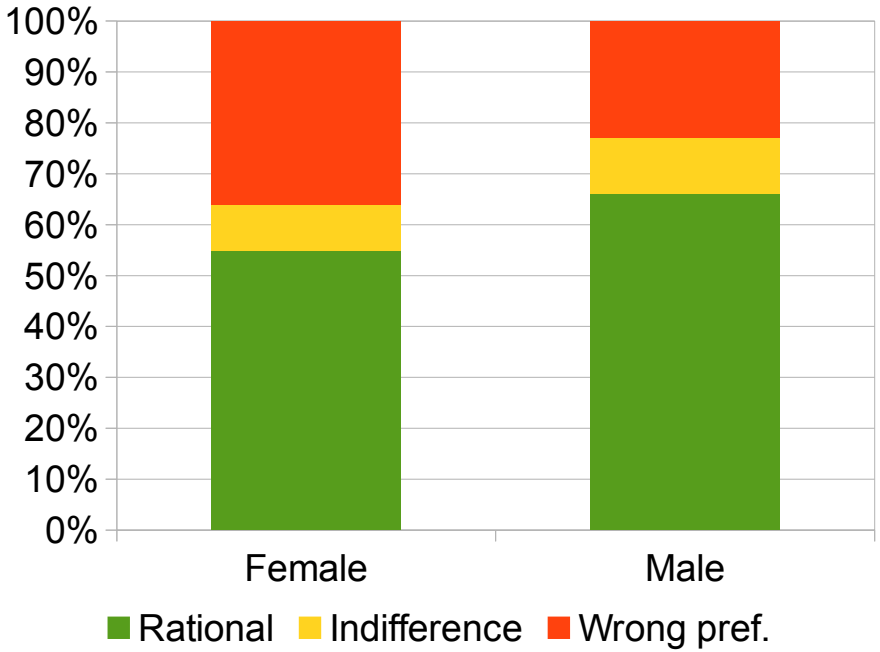
Regression results

	Both low and high		Bias towards high		Bias towards low	
	Parameter	Std. Error	Parameter	Std. Error	Parameter	Std. Error
Type	*** -0.7329	0.2145				
Prob. diff.	-1.9366	4.4301	-3.6920	5.0635	11.4717	15.5548
Low prob.	** 0.3469	0.1162	*** 0.5992	0.1710	0.2531	0.1999
High prob.	* 0.2715	0.1161	0.2086	0.1720	* 0.4439	0.1936
Gender	*** -0.7791	0.2235	* -0.8340	0.3587	** -0.9941	0.3709
Age	0.0439	0.0294	° 0.0892	0.0471	-0.0074	0.0491
LR stat.	*** 89.4530		*** 23.4160		* 14.6800	

***: p< 0.1%, **: p< 1%, *: p< 5%, °: p< 10%

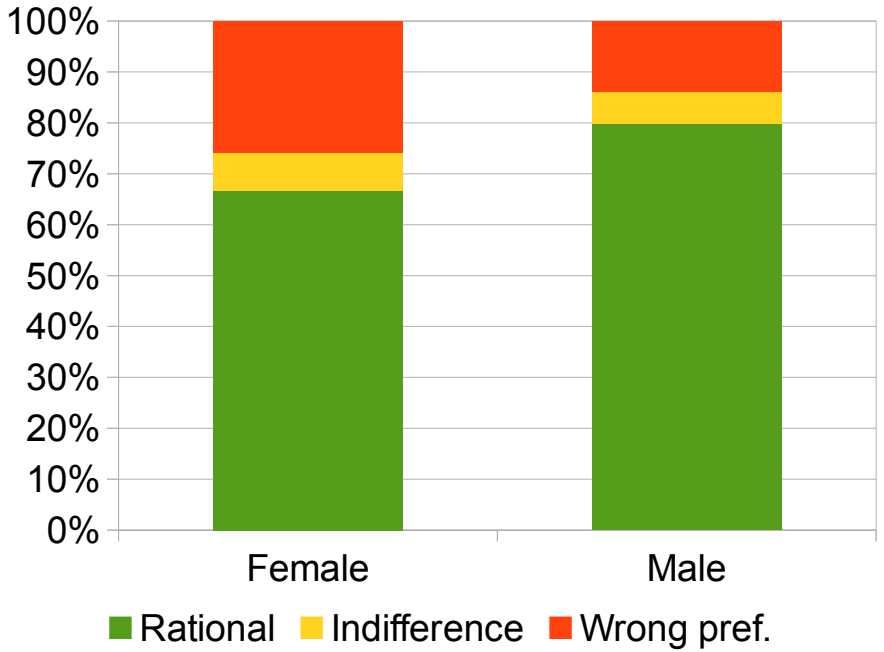
Gender effect

Low better – bias towards high



	Rational	Indifference	Wrong pref.
Female	54.88%	9.08%	36.04%
Male	66.05%	11.11%	22.84%

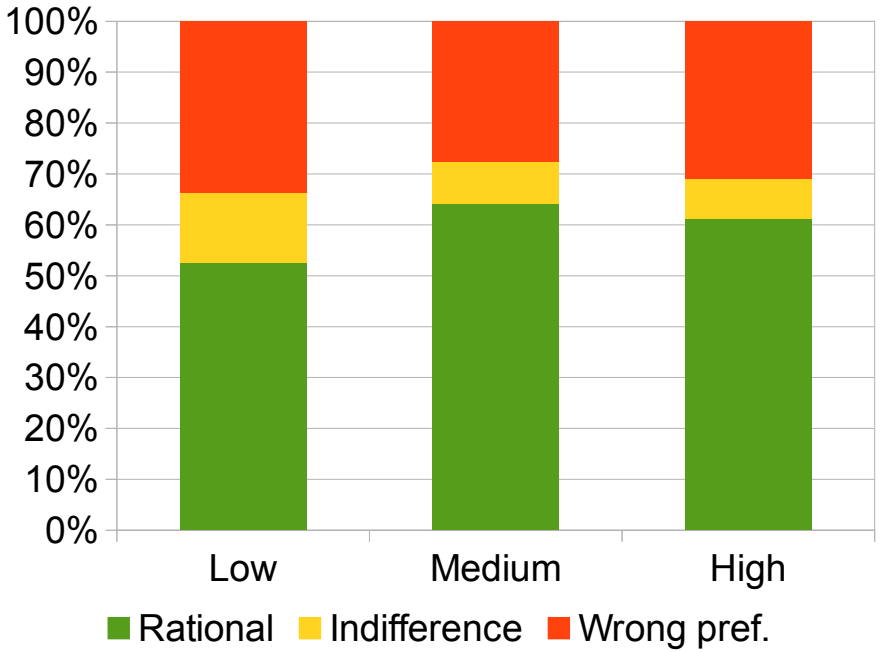
High better – bias towards low



	Rational	Indifference	Wrong pref.
Female	66.57%	7.57%	25.86%
Male	79.71%	6.49%	13.81%

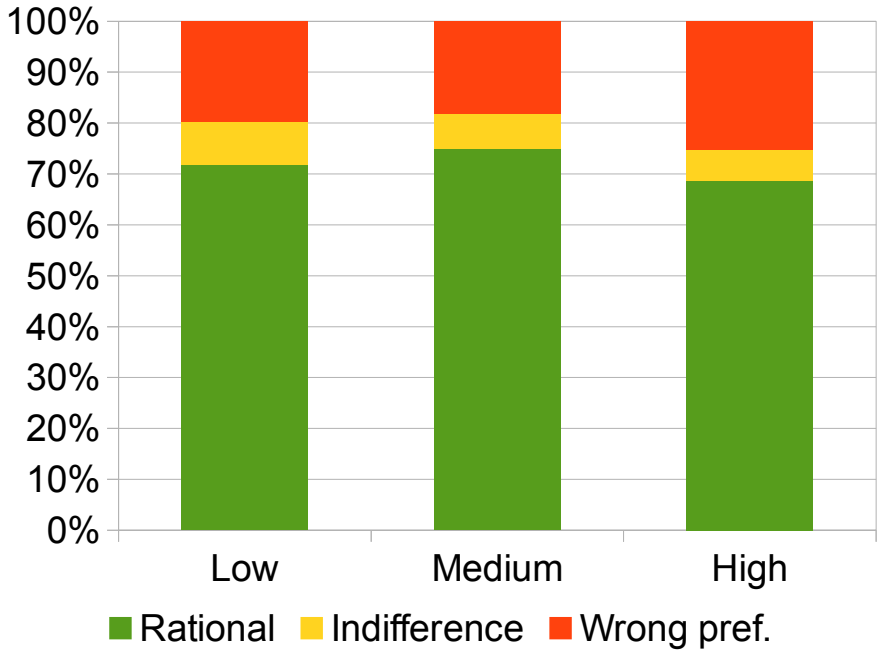
Probability effect

Low better – bias towards high



	Rational	Indifference	Wrong pref.
Low	52,61%	13,65%	33,75%
Medium	64,20%	8,15%	27,65%
High	61,23%	7,90%	30,86%

High better – bias towards low



	Rational	Indifference	Wrong pref.
Low	71,82%	8,48%	19,70%
Medium	75,00%	6,75%	18,25%
High	68,56%	6,19%	25,25%

Deviation from indifference – descriptive results

	N	%
Indifference (rational)	631	52.06%
Devation towards high	331	27.31%
Deviation towards low	250	20.63%

$\chi^2 = 1449$; $p < 0.1\%$

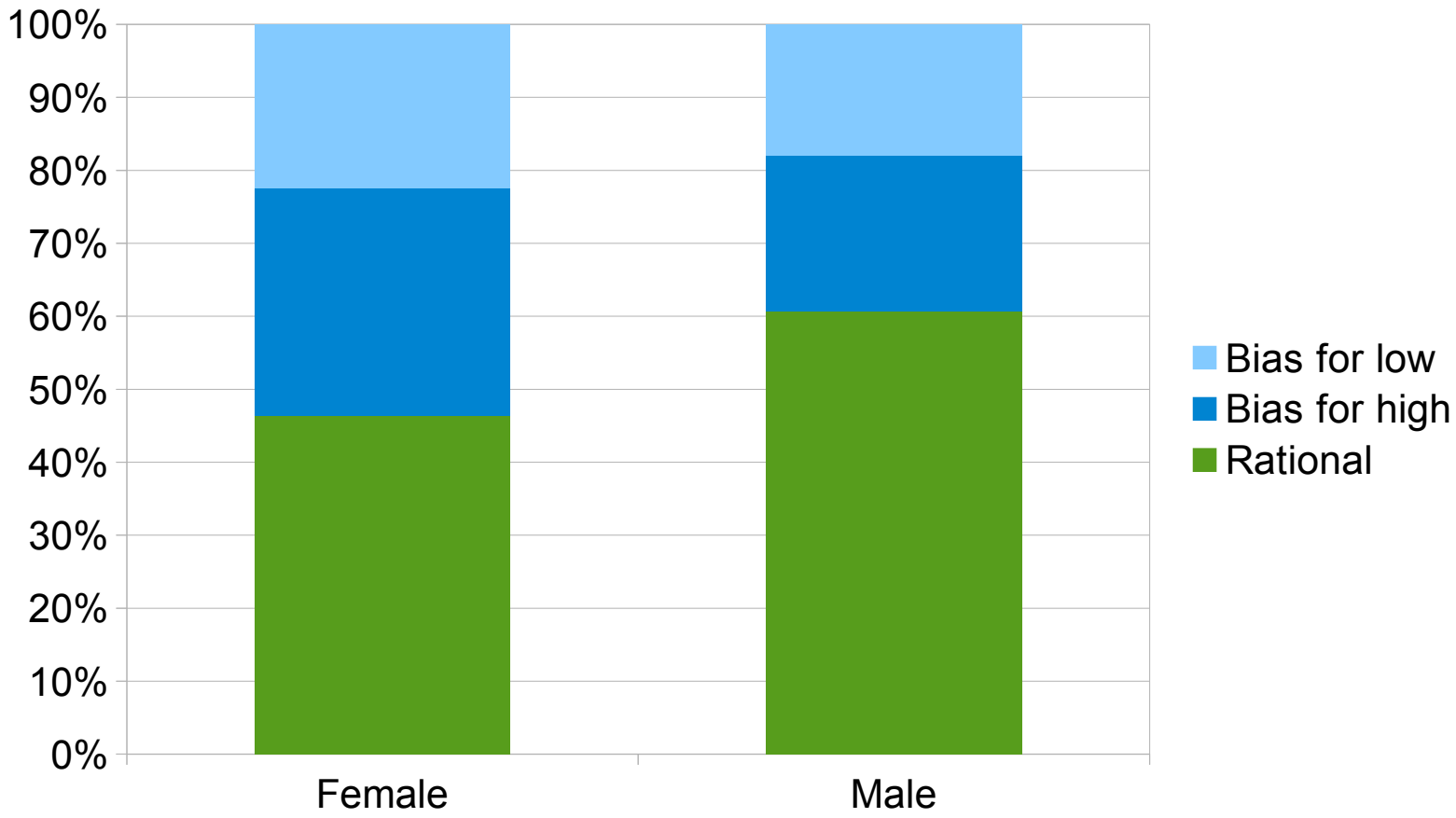
Choice	Low better	Equivalent	High better
Low	Rational	Bias (rev)	Strong (rev)
Indifferent	Weak bias	Rational	Weak (rev)
High	Strong bias	Bias (ratio)	Rational

Deviations from indifference - regressions

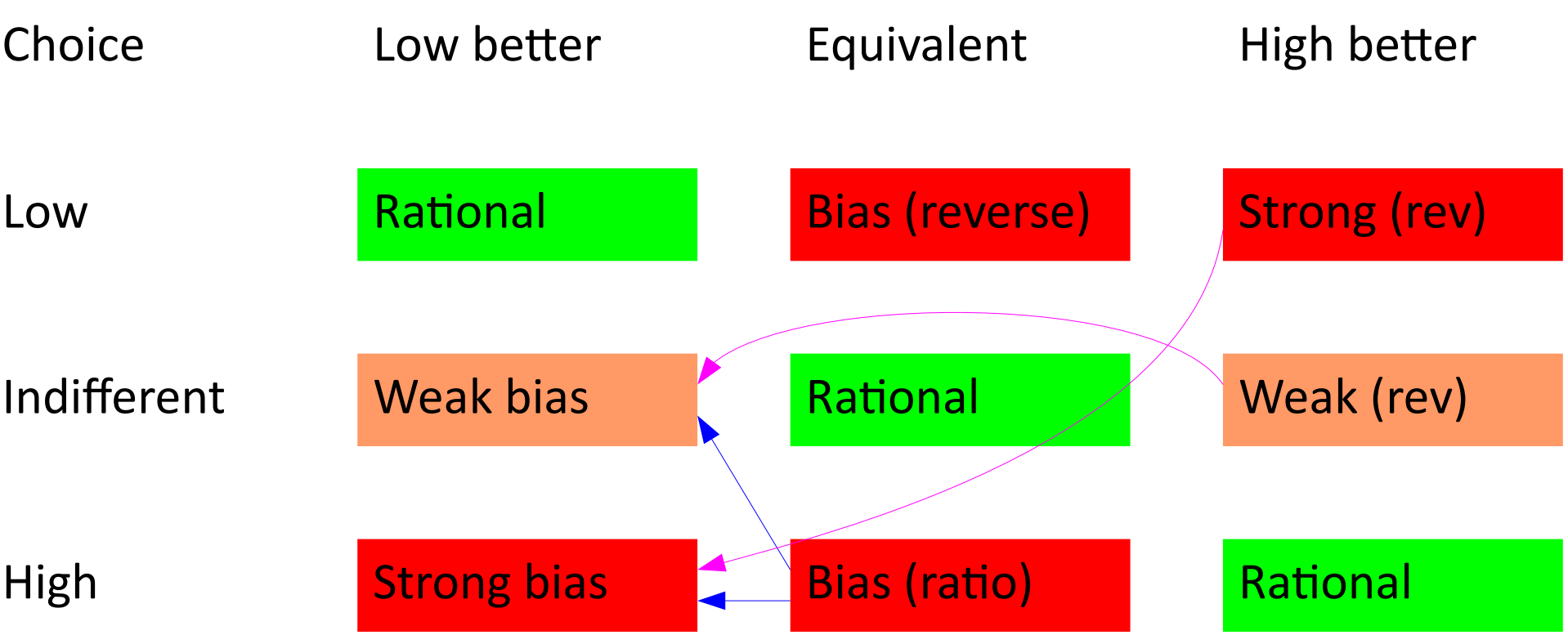
	Any bias		If bias then high	
	Parameter	Std. Error	Parameter	Std. Error
Intercept	0.9185	2.4213	-0.1506	1.3042
Low prob.	0.3184	0.2413	* 0.5122	0.2555
High prob.	0.0863	0.2399	-0.1633	0.2531
Gender	* -1.7661	0.8216	-0.2072	0.4557
Age	-0.0384	0.1067	0.0287	0.0572
Chi sq.	8.4352		* 13.8750	

Logistic regression, intercept as random effect

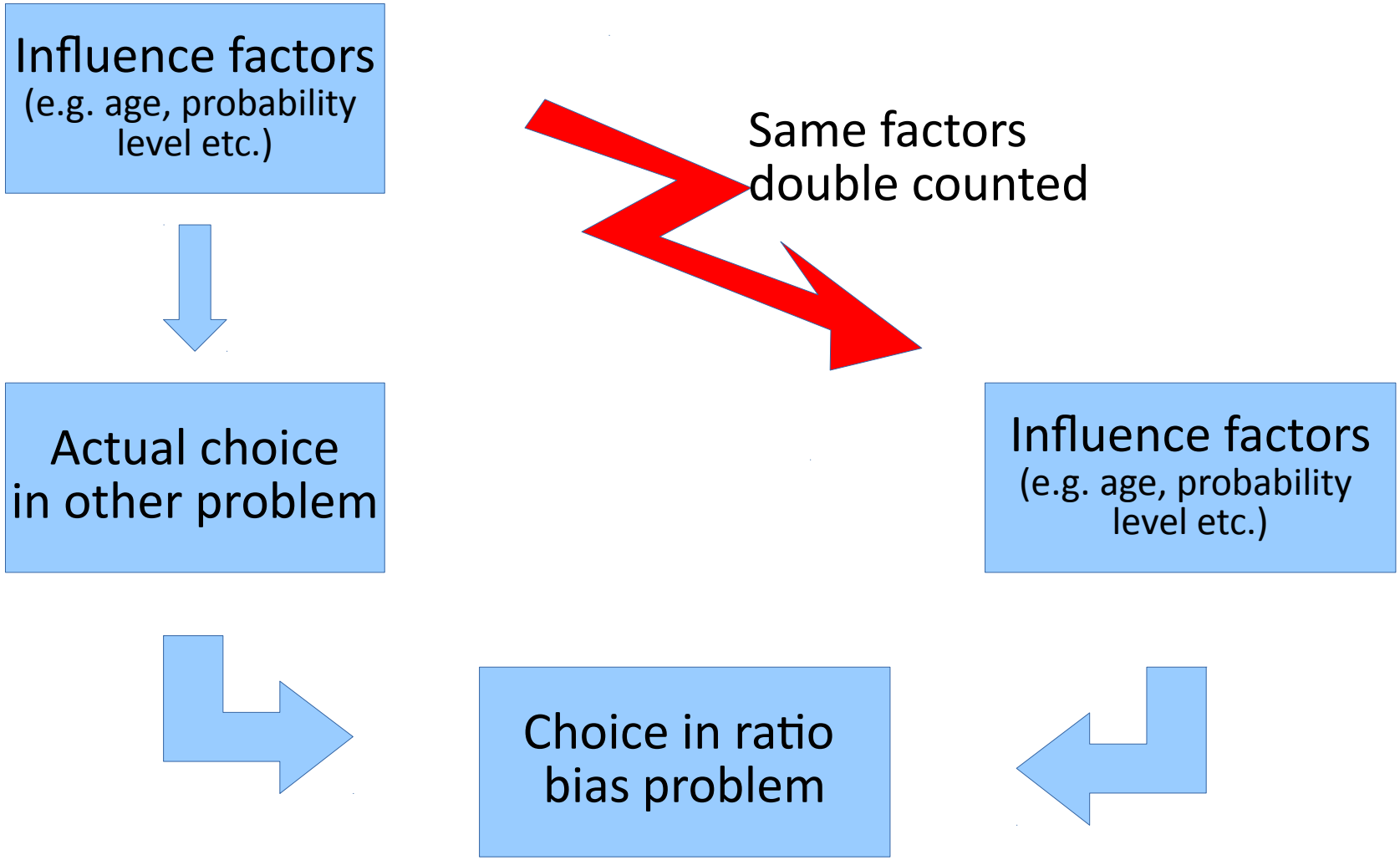
Deviations from indifference - gender



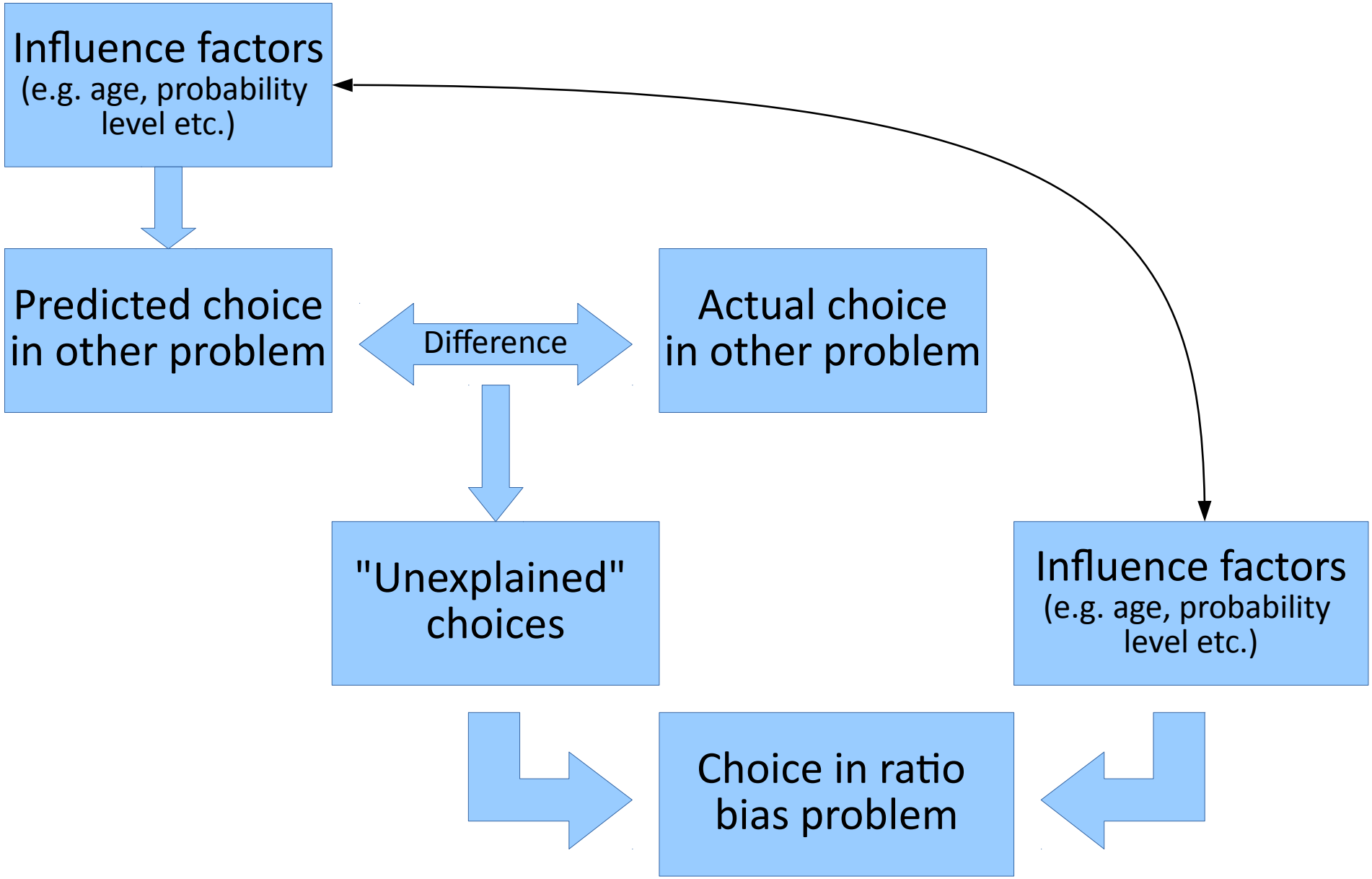
Interdependencies between behavior



Endogeneity problem



Identifying common factors



Ratio bias and behavior in other settings

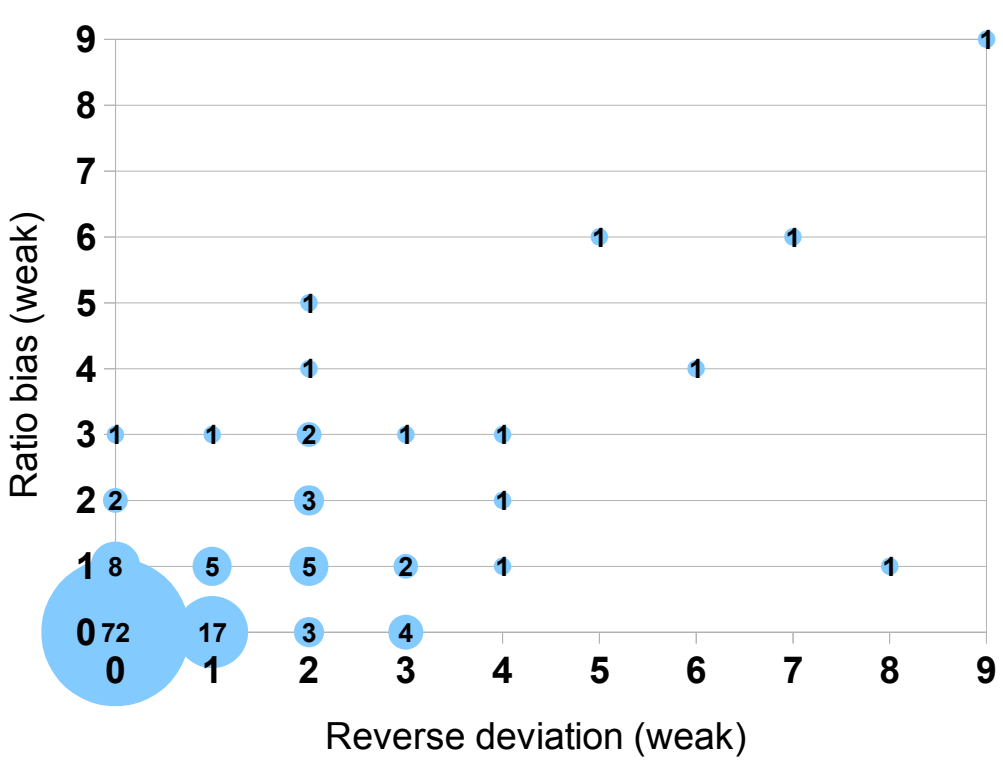
	Weak bias (Indifference)		Strong bias (preference)	
	Baseline	Full	Baseline	Full
Prob.diff	* -20.2232	* -20.7193	0.9818	0.9807
Low prob.	** 0.7188	** 0.7279	* 0.4952	* 0.4953
High prob.	0.0172	0.0167	0.2607	0.2607
Gender	0.3461	° 0.5967	** -1.0377	** -1.0362
Age	0.1528	0.1621	° 0.2970	0.2925
N weak reversals		*** 0.8825		-0.1336
N strong reversals		° 0.2228		0.0544
N ind pref high		-0.0145		° 0.3051
N ind pref low		0.0563		-0.0270
LR Statistic (between models)		*** 57.075		3.896

Conclusions

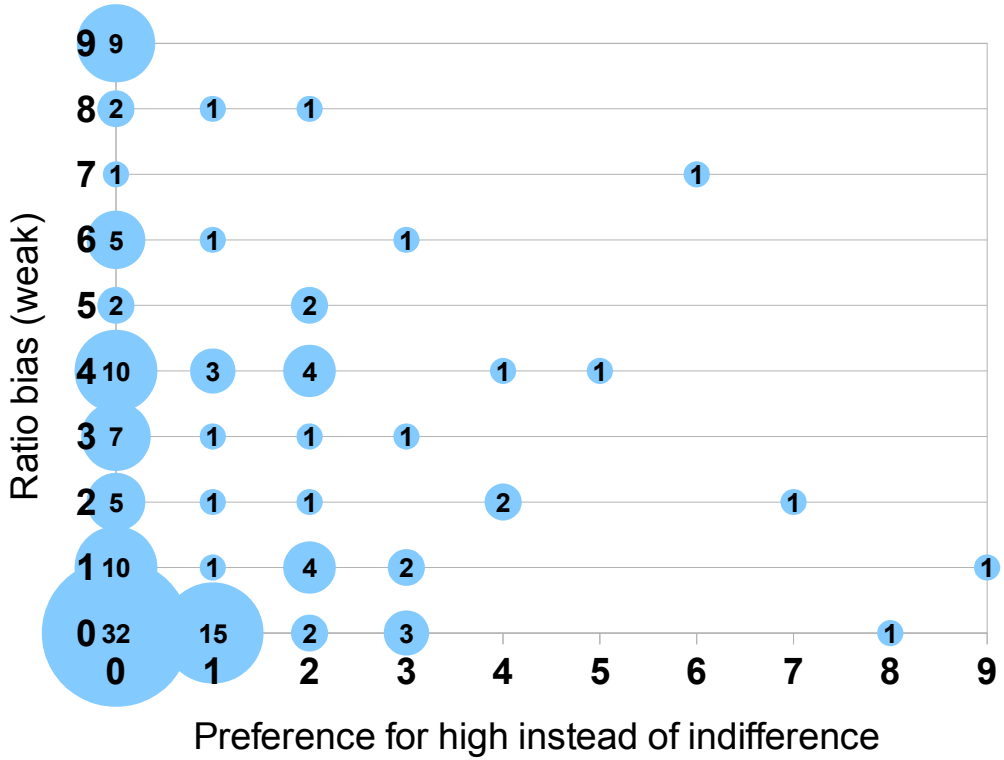
- Strong evidence that bias towards high-numbered alternatives exists
- and is different from random deviations in either direction
- It can to a certain extent be explained by problem characteristics (low probabilities) and DM characteristics (gender)
- Tendency towards indifference (regardless of which alternative is actually better) is yet another robust phenomenon


Thank you for your attention!

Behavior across settings – weak bias

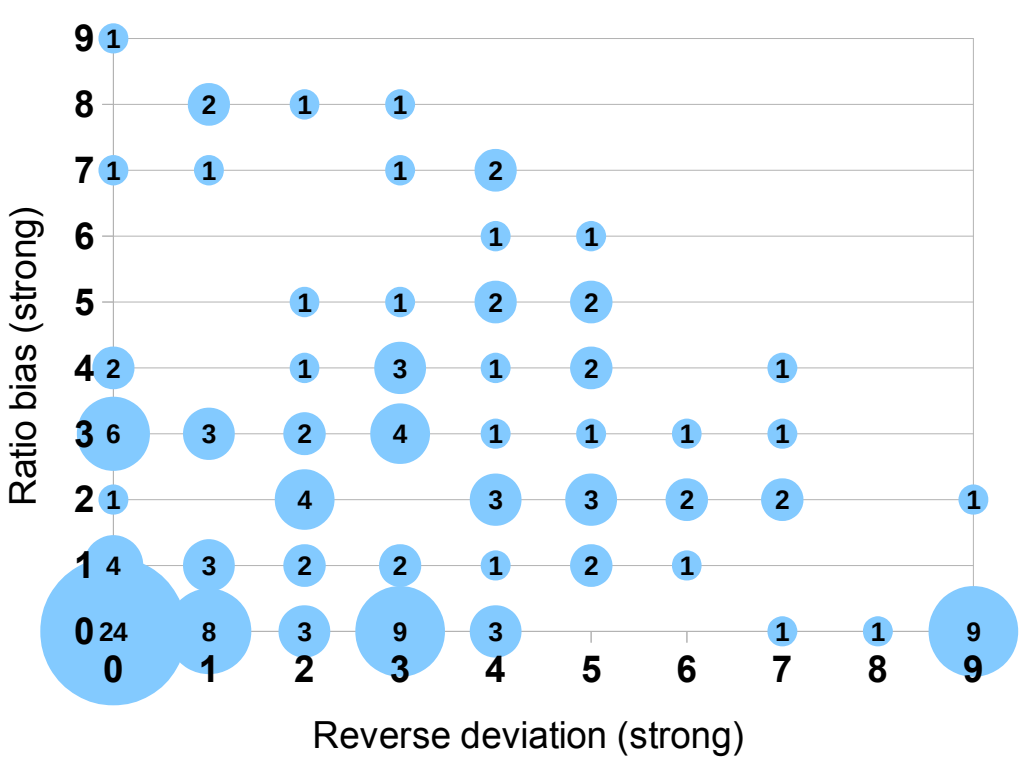


ρ = 0.702, p < 0.1%

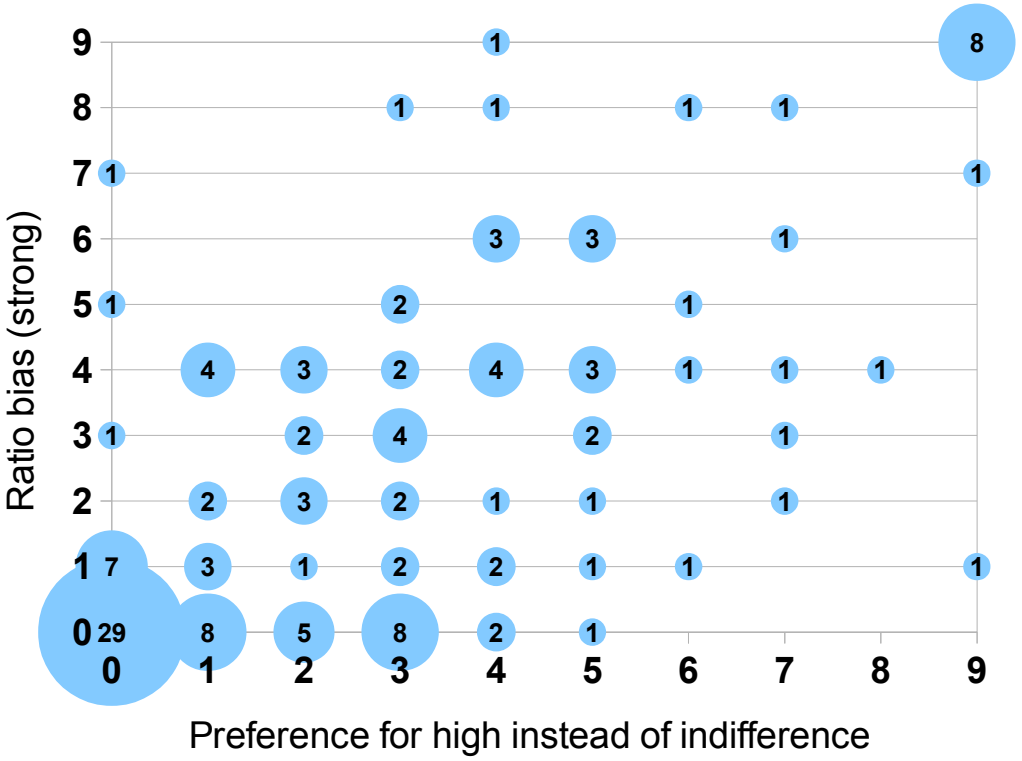


ρ = 0.047, n.s.

Behavior across settings – strong bias



ρ = 0.010, n.s.



ρ = 0.701, p < 0.1%