

# **ExpEcon Methods: Empirical Tests of Incentive Compatibility**

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ECON 8877

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# Testing IC vs. Framing Effects

A test of IC? (Cox Sadiraj & Schmidt 2014)

	$D_1$	$D_2$
Treatment 1:	$\{\$4, (\frac{1}{2}, \$10)\}$	
Treatment 2:	$\{\$4, (\frac{1}{2}, \$10)\}$	$\{\$3, (\frac{1}{2}, \$12)\}$

If we observe differences on  $D_1$ , it could be

- the mechanism was not IC, or
- the presence of  $D_2$  altered preferences (e.g., decoy effect).

Other papers that use this method:

- Cubitt Starmer Sugden (1998 Exp.1)
- Beattie & Loomes (1997)
- Cubitt Starmer Sugden (1998 Exp.2)
- Harrison & Swarthout (2014)
- Cox Sadiraj & Schmidt (2015)

# Tests Without Framing Confound

Replace Treatment 1 with a “Framed Control” treatment:

	$D_1$	$D_2$	Mechanism
Treatment 1:	$\{\$4, (\frac{1}{2}, \$10)\}$	$\{\$3, (\frac{1}{2}, \$12)\}$	Pay only $D_1$
Treatment 2:	$\{\$4, (\frac{1}{2}, \$10)\}$	$\{\$3, (\frac{1}{2}, \$12)\}$	RPS

**LESSON: Proper test of IC must show all subjects same choices.**

## Test various payment mechanisms in lottery choice setting

1. Pay All (PA)
  - PAS: Sequentially (learn outcome each period)
  - PAI: Independently at the end
2. Pay One Randomly (POR)
  - 2.1 PORpi: with prior info about all choices to be made
  - 2.2 PORnp: no info about upcoming choices
  - 2.3 PORpas: learn realized payoffs you go, then get 1 at the end
3. Pay All Correlated (PAC) (lotteries must have same state space)
  - PAC/N divides payoffs by # of decisions, to match POR
4. One Task (OT)
  - 4.1 ImpureOT: Make all choices, but only one is paid
    - Added by a referee (not me!) and reported separately

### Design:

- Choice over 5 lottery pairs
- Testing various versions of Allais paradox
- OT: between-subjects. All others: within-subject
  - Therefore OT Allais paradoxes are between-subject via Probit
- Choices on 5 separate slips of paper in an envelope

### Analyses:

- Probit on  $\Pr(\text{Allais paradox})$  including demographics, EV, etc.
- Choice frequencies
- Probit on choice frequencies

**Table 3** Test results for Hypotheses 1–4

Mechanism	CRE	CCE	DCRE	DCCE
OT	No	No	No	Yes <sup>c</sup>
PORnp	No	No	No	No
PORpi	No	Yes <sup>b</sup>	Yes <sup>c</sup>	No
PORpas	Yes <sup>a</sup>	No	No	No
PAS	No	Yes <sup>b</sup>	No	No
PAI	Yes <sup>a</sup>	No	No	No
PAC/N	No	Yes <sup>b</sup>	No	No
PAC	Yes <sup>a</sup>	No	Yes <sup>d</sup>	No

Notes: <sup>a</sup>Fan Out; <sup>b</sup>Fan In; <sup>c</sup>IRRA; <sup>d</sup>DRRA; <sup>e</sup>IARA

Can't really compare cleanly to OT

But, definite differences across mechanisms

And whether they see the questions in advance or not!

**Table 4** Observed frequencies (in %) of choices of less risky options (low and high column figures in bold)

Mechanism	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	S <sub>5</sub>	All Pairs [95 % CI]
OT (231 subjects)	<b>39.47</b>	<b>15.52</b>	27.59	28.95	38.46	28.60 [22.7, 34.4]
PORnp (40 subjects)	37.50	45.00	<b>47.50</b>	32.50	<b>60.00</b>	44.50 [37.6, 51.4]
PORpi (40 subjects)	27.50	50.00	42.50	22.50	50.00	38.50 [31.7, 45.3]
PORpas (40 subjects)	<b>22.50</b>	42.50	<b>20.00</b>	<b>10.00</b>	30.00	25.00 [18.9, 31.1]
PAS (39 subjects)	25.64	23.08	33.33	10.26	<b>17.95</b>	22.10 [16.2, 27.9]
PAC (38 subjects)	36.84	<b>52.63</b>	23.68	21.05	42.11	35.30 [28.4, 42.1]
PAC/N (40 subjects)	37.50	35.00	35.00	22.50	45.00	35.00 [28.3, 41.7]
PAI (38 subjects)	36.84	<b>52.63</b>	36.84	<b>34.21</b>	52.63	42.60 [35.5, 49.7]

All Pairs: % who chose safe in all 5 Most risk averse: PORnp and PAI  
 Least risk averse: PORpas and PAS

### What about Impure OT?

- Paper only compares Impure OT to OT
  - More risky choices under Impure OT
  - Framing effect exists!
- But we want Impure OT vs. each mechanism!
- Probit  $\Pr(\text{Safe})$  results:
  - $\text{POR}_{np}$ ,  $\text{POR}_{pi}$ , and  $\text{PAI}$  are different from ImpureOT
- But, looking at the actual choice data task-by-task, I don't find significant differences...



# Starmer & Sugden (1991)

- 22 binary lottery choice questions.  $n = 40$  per treatment
- First 20: hypothetical (piloting for another study)
- Questions 21 and 22: RPS vs. only one paid. Same page.
- Allais paradox questions.

TABLE 1—THE DESIGN OF THE EXPERIMENT

Group	Question 21	Question 22	Incentive
A	P'	P''	P'' is for real
B	P'	P''	Each problem has 0.5 chance of being for real
C	P''	P'	Each problem has 0.5 chance of being for real
D	P''	P'	P' is for real

A vs. B:  $p = 0.356$  (my calculation)

C vs. D:  $p = 0.043$  (my calculation)

- Five binary menus of lotteries
- Experiment 1 ( $n = 201$ )
  - Group 1.1: RPS:  $(1/3, D_3; 2/3, D_4)$
  - Group 1.2: RPS:  $(1/3, D_3; 2/3, D_5)$
  - (Two other groups to test IND and ROCL)
  - Use  $D_3$  to test IC. No differences.
- Experiment 3 ( $n = 202$ )
  - 3.1: 20 decisions, 1st is paid
  - 3.2: 20 decisions, 2nd is paid
  - 3.3: 20 decisions, RPS on all 20
  - 3.4: Same as 3.3 but with lower stakes
  - 3.1  $D_1$  vs 3.3  $D_1$ :  $p = 0.685$
  - 3.2  $D_2$  vs 3.3  $D_2$ :  $p = 0.120$

# Summary of Past Experiments

**Table 9**

Existing tests of incentive compatibility of the RPS mechanism that have no framing confounds. We describe each of these comparisons in the text below.

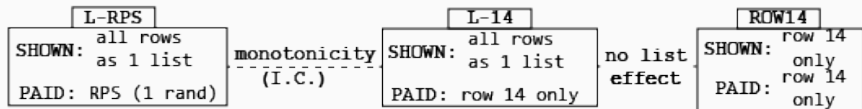
Paper	Names of treatments		<i>p</i> -Value	RPS is I.C.?
Starmer and Sugden (1991)	A vs. B		0.356	✓
Starmer and Sugden (1991)	C vs. D		<b>0.043</b>	×
Cubitt et al. (1998)	3.1 vs. 3.3		0.685	✓
Cubitt et al. (1998)	3.2 vs. 3.3		0.120	✓
Cox et al. (2014b)	PORpi vs. ImpureOT2		0.122	✓
Cox et al. (2014b)	PORpi vs. ImpureOT3		0.988	✓
Cox et al. (2014b)	PORpi vs. ImpureOT4		0.397	✓

## Brown & Healy (2018)

Row #	Option A			or	Option B		
1	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	Ball 1 pays \$15 (5% chance of \$15)	Balls 2-20 pay \$0 (95% chance of \$0)	<input type="checkbox"/>
2	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	Balls 1-2 pay \$15 (10% chance of \$15)	Balls 3-20 pay \$0 (90% chance of \$0)	<input type="checkbox"/>
3	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	Balls 1-3 pay \$15 (15% chance of \$15)	Balls 4-20 pay \$0 (85% chance of \$0)	<input type="checkbox"/>
4	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	Balls 1-4 pay \$15 (20% chance of \$15)	Balls 5-20 pay \$0 (80% chance of \$0)	<input type="checkbox"/>
	Balls 1-10 pay \$10	Balls 11-20 pay \$5	<input type="checkbox"/>		Balls 1-5 pay \$15	Balls 6-20 pay \$0	<input type="checkbox"/>
⋮			⋮		⋮		
18	(50% chance of \$10)	(50% chance of \$5)	<input type="checkbox"/>	or	(90% chance of \$15)	(10% chance of \$0)	<input type="checkbox"/>
19	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	Balls 1-19 pay \$15 (95% chance of \$15)	Ball 20 pays \$0 (5% chance of \$0)	<input type="checkbox"/>
20	Balls 1-10 pay \$10 (50% chance of \$10)	Balls 11-20 pay \$5 (50% chance of \$5)	<input type="checkbox"/>	or	All Balls pay \$15 (100% chance of \$15)	(0% chance of \$0)	<input type="checkbox"/>

[Click Here When Finished](#)

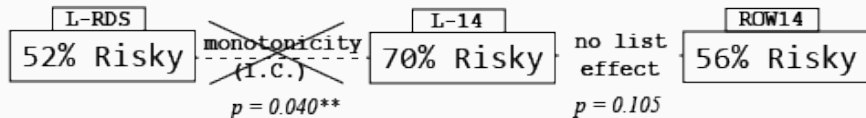
# Our Design



- Andreoni-Sprenger formatting
- Standard Ohio State subject pool.
- Between-subjects.
- Computerized.
  - List format: rows must be answered sequentially.
- Physical randomizing devices (die, bingo cage)
- No other tasks in the experiment.
- 60–63 subjects per treatment.
- Question: Do Row 14 choices differ by treatment?

# The Results

Row 14:



- Using RPS mechanism makes them switch later.  
(More thoughtful? Switching inertia?)
  - Statistically significant.
- Showing whole list makes them switcher earlier  
(Closer to the middle.)
  - Not quite significant.
- The two effects nearly offset

# Hypothesis

- Subjects are combining the decisions in a reduction-like way.  
*E.g.:* 'When to switch?'
- The 'combining' can be broken by separating the decisions.

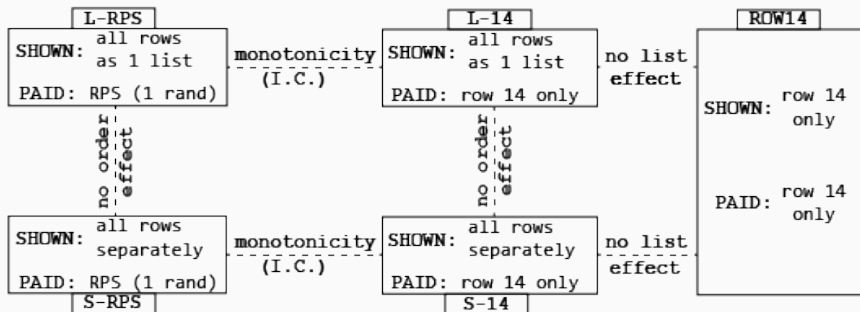
# New Treatments

'Separated' treatments.

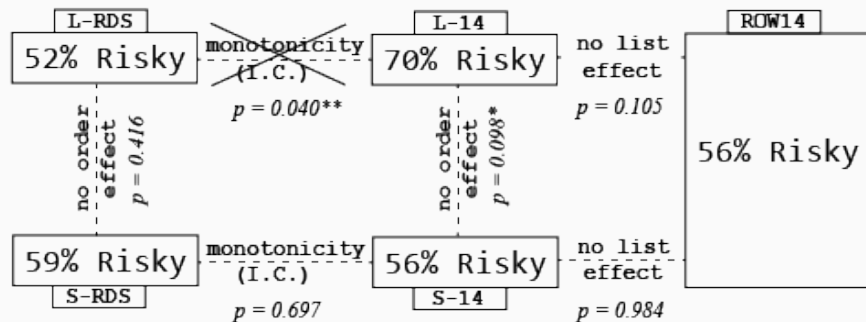
- Same 20 rows.
- Each shown on separate screen.
- Order of rows randomized for each subject.
- Still comparing RPS to Pay-14-Only.
- Still must answer every row, in order given.
  - First attempt: on paper. They shirked.
  - Second attempt: computerized, forced answers
- Still 60–63 observations per cell, between subjects.



# Full Design



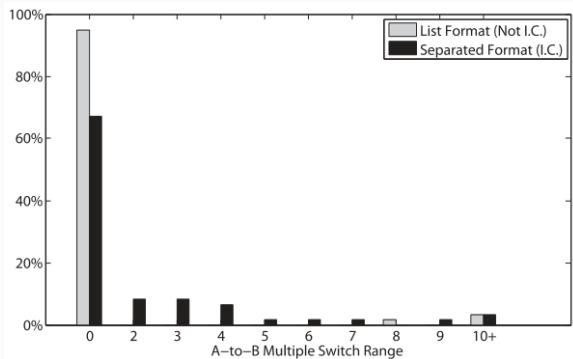
# The Results



# The Cost of Separation

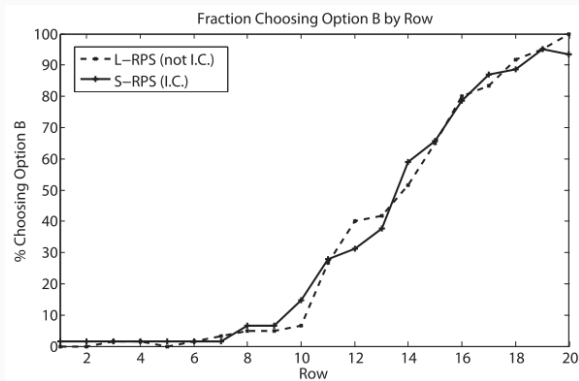
B-to-A (Risky-to-Safe) switches violate FOSD:

$Risky_{15}$  dominates  $Risky_{14}$ , but  $Risky_{14} \succ Safe \succ Risky_{15}$



**LESSON: Separating decisions hurts consistency? NO!**  
**The list format generates false consistency!**

# Biases Cancel Out



L-RPS was fine because “list effect” and “IC failure” canceled out!  
I wouldn't expect that to be true generally...

# Past Experiments

**Table 9**

Existing tests of incentive compatibility of the RPS mechanism that have no framing confounds. We describe each of these comparisons in the text below.

Paper	Names of treatments	Presentation format	<i>p</i> -Value	RPS is I.C.?
Starmer and Sugden (1991)	A vs. B	List	0.356	✓
Starmer and Sugden (1991)	C vs. D	List	<b>0.043</b>	×
This paper	L-RPS vs. L-14	List	<b>0.041</b>	×
This paper	S-RPS vs. S-14	Separated	0.697	✓
Cubitt et al. (1998)	3.1 vs. 3.3	Separated	0.685	✓
Cubitt et al. (1998)	3.2 vs. 3.3	Separated	0.120	✓
Cox et al. (2014b)	PORpi vs. ImpureOT2	Separated <sup>a</sup>	0.122	✓
Cox et al. (2014b)	PORpi vs. ImpureOT3	Separated <sup>a</sup>	0.988	✓
Cox et al. (2014b)	PORpi vs. ImpureOT4	Separated <sup>a</sup>	0.397	✓

<sup>a</sup> Cox et al. (2014b) give subjects the choices on separate slips of paper, but the subjects could have arranged them into a list-like format if they wanted.

## Other Discussion of Separation

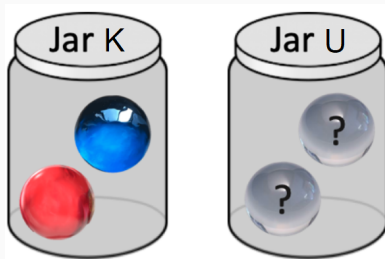
1. Kirby & Marakovic (1996) and Kirby et al. (1999)
  - Use scrambled lists in a field setting, including heroin addicts
2. Eckel et al. (2005)
  - Use scrambled with working poor
  - “we now believe that scrambling is a bad idea because it results in greater inconsistency and variance of responses.”

# RPS for Hedging Ambiguity?

Is RPS used to hedge ambiguity?

- Oechssler Rau & Roomets (2019): No
  - Issues with their design
- Baillon Halevy & Li (2022)...

## 2-Urn Ellsberg Paradox



$D_1$ :	$K = \$2.00$ if <b>red</b> from K $U = \$2.10$ if <b>red</b> from U
$D_2$ :	$K = \$2.00$ if <b>blue</b> from K $U = \$2.10$ if <b>blue</b> from U

One paid randomly via coin flip

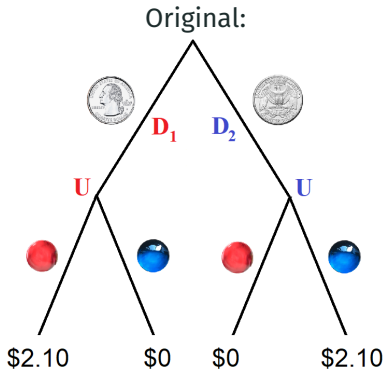
**$\Pr(\text{Red in } U) \approx \Pr(\text{Blue in } U)$  & Ambiguity Averse:  $K \succ U$  and  $K \succ U$ .**

**Raiffa (1961):** Picking  $UU$  “hedges away” the ambiguity!  $UU \succ KK$



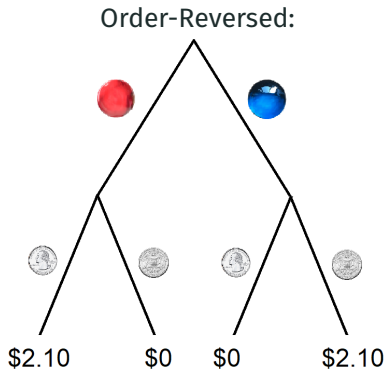
# How Hedging Works (Raiffa 1961)

Picking UU:



Ambiguity:

$KK \succ UU$

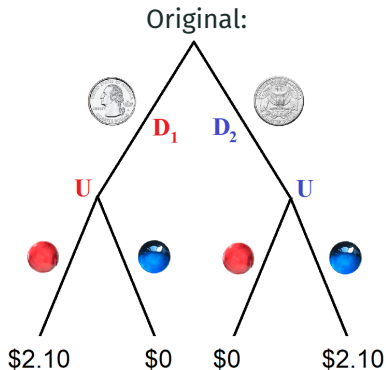


50-50 Lottery For Sure

$UU \succ KK$

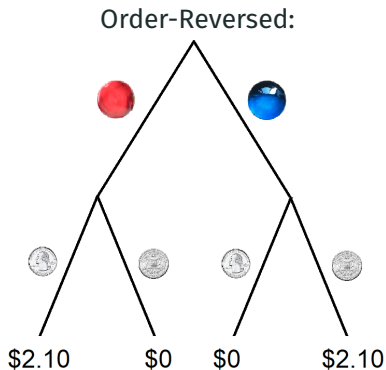
# How Hedging Works (Raiffa 1961)

Picking UU:



Ambiguity:

$KK \succ UU$



50-50 Lottery For Sure

$UU \succ KK$

**Assumption:** Order Reversal

# Past Experiments

Order reversal has support...

- Coin before  $\sim$  Coin after
  - Oechssler, Rau & Roomets (2019; ORR19)
  - Baillon, Halevy & Li (2022)

...yet people don't seem to appreciate hedging:

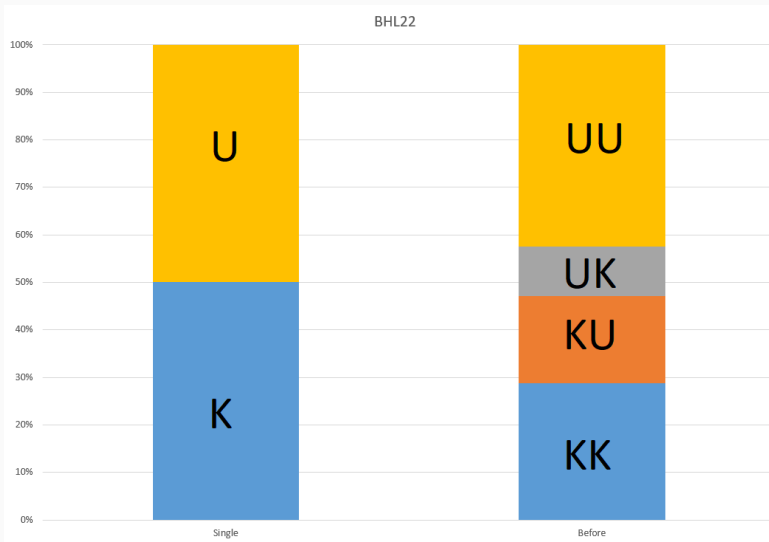
- Raiffa (1961), Dominiak & Schnedler (2011)
  - Ambiguity averse subjects don't value  $UU$  more than  $U$  and  $U$
- ORR19 find mixed evidence for hedging
  - Amb. Averse &  $\Pr(\text{blue}) \approx \Pr(\text{red})$  Subjects:
    - 50% consistent with hedging (or randomization)
    - Issues: Indifference & Cross-task contamination

# Past Experiments

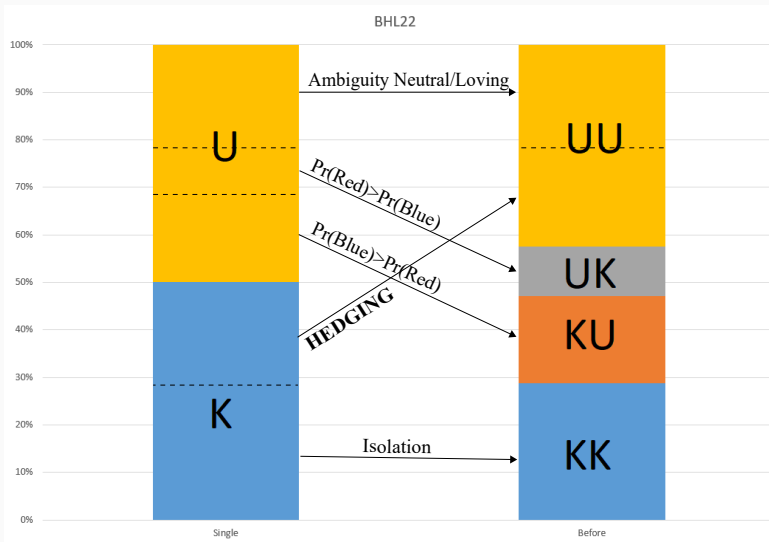
Baillon, Halevy & Li (2022) (BHL22):

- “Single” Treatment:
  - $D_0 = \{\text{K}, \text{K}, \text{U}, \text{U}\}$
  - $\text{U}$  or  $\text{U} \Rightarrow$  Ambiguity neutral/loving *or*  $\Pr(\text{red}) \geq \Pr(\text{blue})$
  - $\text{K}$  or  $\text{K} \Rightarrow$  Strictly ambiguity averse *and*  $\Pr(\text{red}) \approx \Pr(\text{blue})$
  - 50% choose  $\text{K}$  or  $\text{K}$   
 $\Rightarrow$  50% are Amb. Averse *and*  $\Pr(\text{red}) \approx \Pr(\text{blue})$   
this is a *lower bound* on Amb. Aversion
- “Before” Treatment:
  - $D_1 = \{\text{K}, \text{U}\}$ ,  $D_2 = \{\text{K}, \text{U}\}$ , coin flip **first**
  - What will Amb. Averse subjects pick?
    - Order Reversal + Hedging  $\Rightarrow \text{UU}$
    - “Isolation”  $\Rightarrow \text{KK}$
    - $\Pr(\text{red}) \geq \Pr(\text{blue}) \Rightarrow \text{UK}$  or  $\text{KU}$   
(uses Azrieli et al. 2018, ignoring stochastic choice)

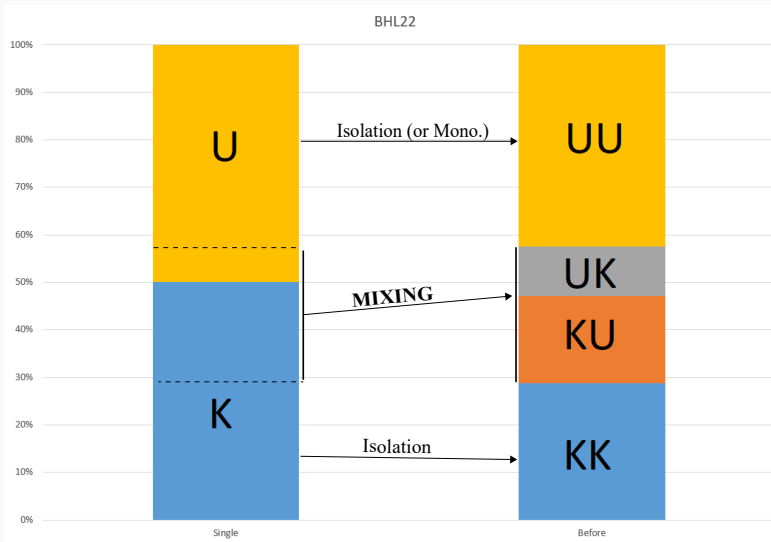
# BHL22: Results



# BHL22: Story 1



## BHL22: Story 2



it necessarily hedging?

Susan Laury's paper...



# Summary

- Theory: RPS generally fine *unless* subjects “reduce” (treat the experiment as one large decision)
- List format seems to encourage reduction, IC violations
- Separated format breaks reduction, restores IC
  - Separated *and* random order. Haven't tested which.
- List format generates *false consistency*
- Ambiguity:
  - RPS is not IC!
  - But is it really hedging??