Probability Matching and the Preference for Randomization

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Kirby Nielsen (OSU)

FUR York
Some day in June

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Kirby Nielsen (OSU) ← on the market

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What This is About

- People randomize (mix) in lots of settings
  - Sometimes even irrationally
- Is it all connected?
  - Mixing in one setting $\Rightarrow$ mixing in another setting?
- Are there any theories that can explain it?
- Is it a heuristic?

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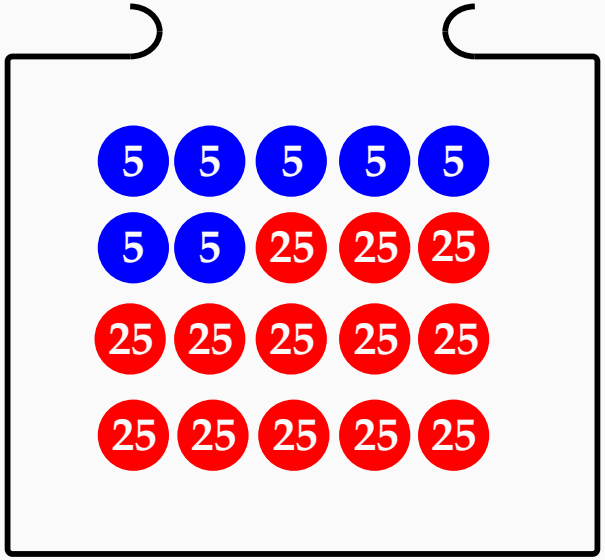
- Is it a heuristic? TBD.

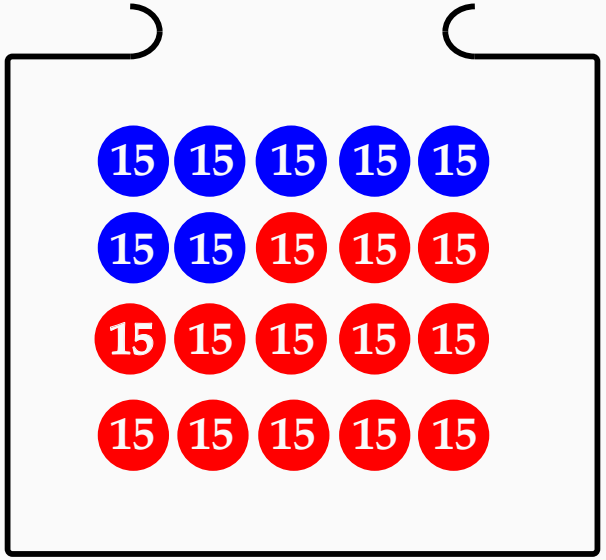
DECISION PROBLEM ONE:

Risky-Safe

Decision Problem 1: Risky-Safe



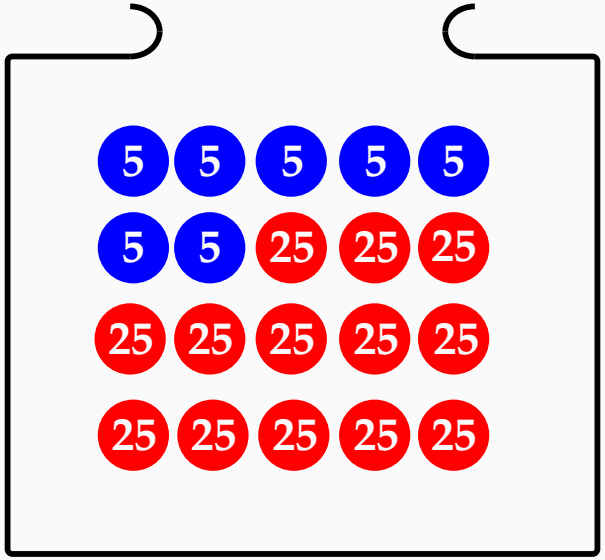
Risky Bet (65%)



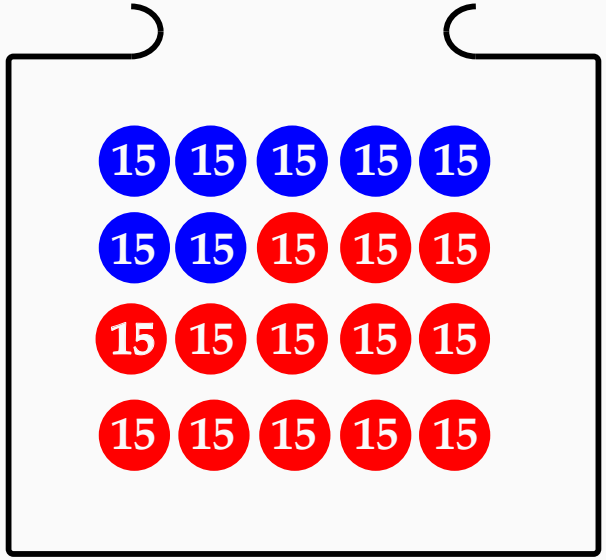
Safe Bet

- **Pick 1 time:** Safe $\succ$ Risky

Decision Problem 1: Risky-Safe



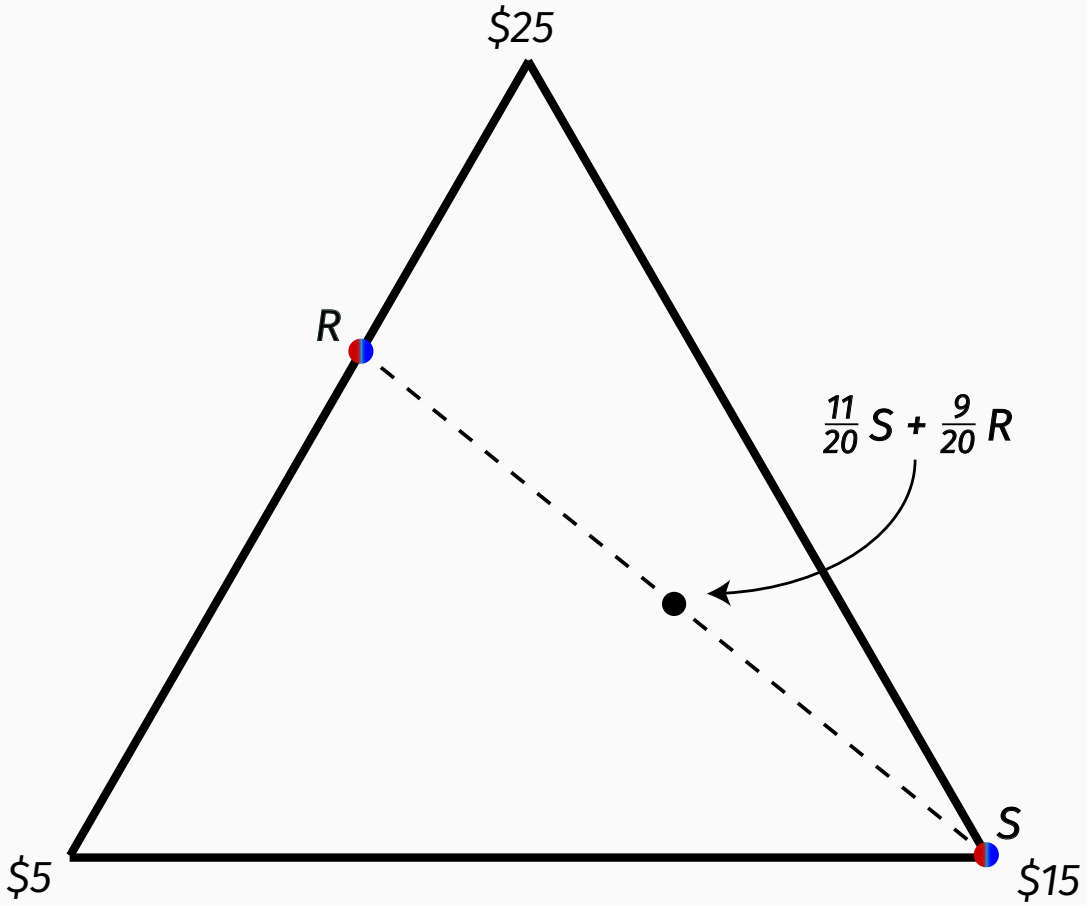
Risky Bet (65%)



Safe Bet

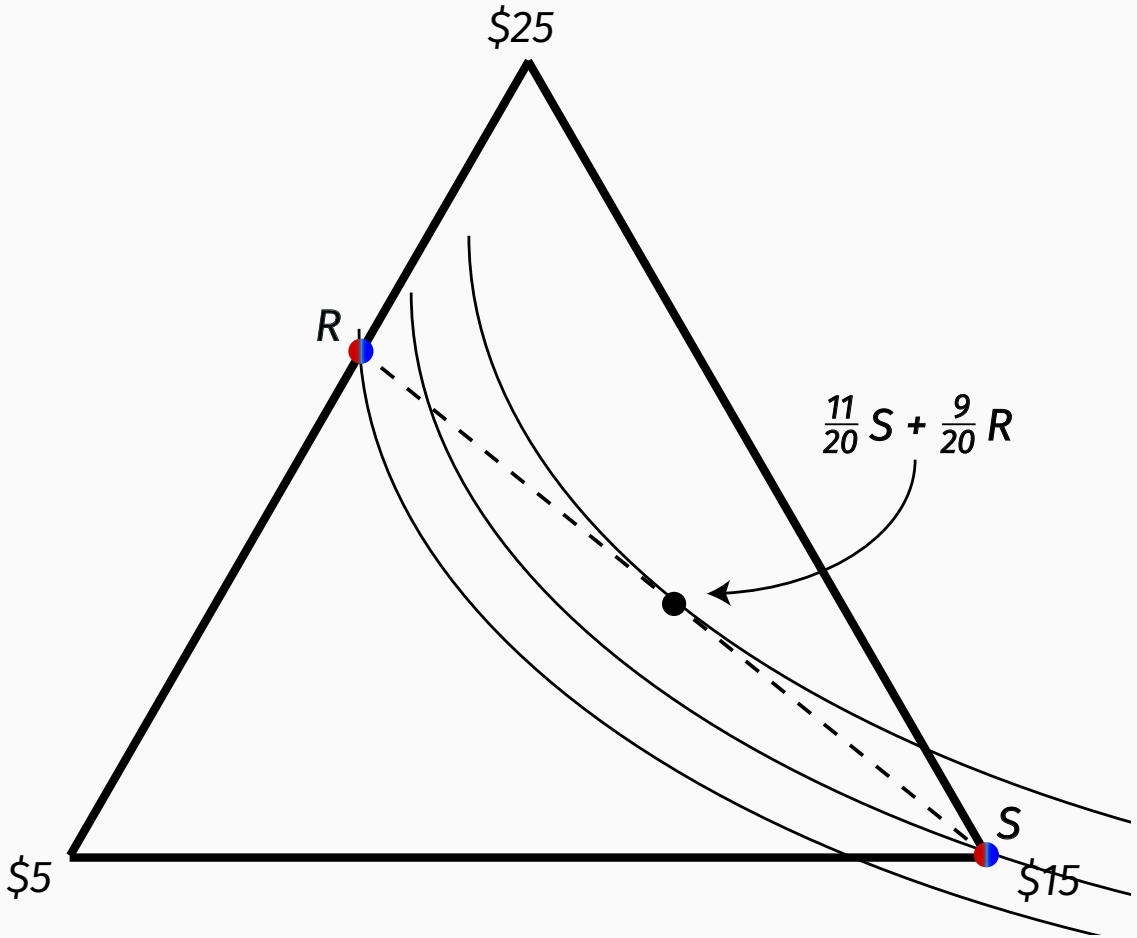
- **Pick 1 time:** Safe $\succ$ Risky
- Our experiment: **Pick 20 times, one is paid randomly**
  - 14% pick Risky all 20 times
  - 32% pick Safe all 20 times
  - 54% mix. Average: 11 Safe, 9 Risky

Mixing



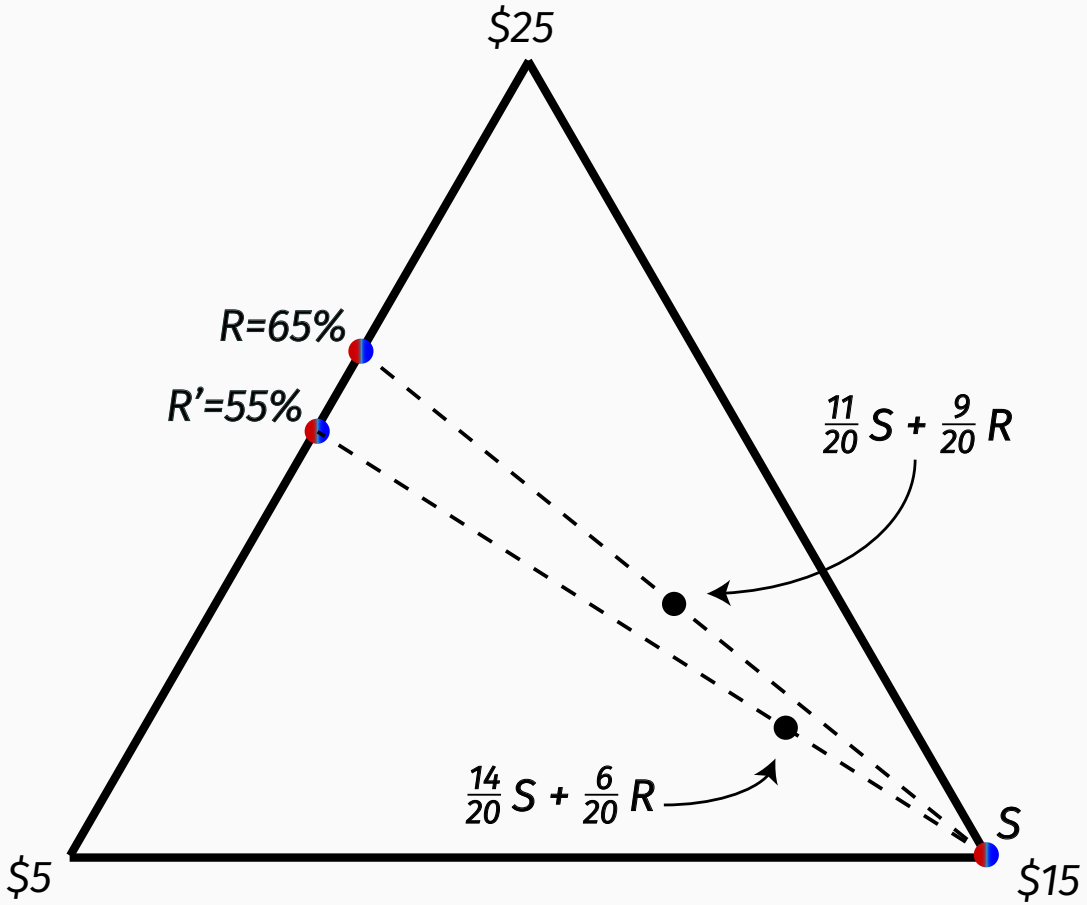
Reduced compound lottery

Convex Preferences



Non-linear prefs $\Rightarrow$ Violates EU.

Strictly Convex Preferences



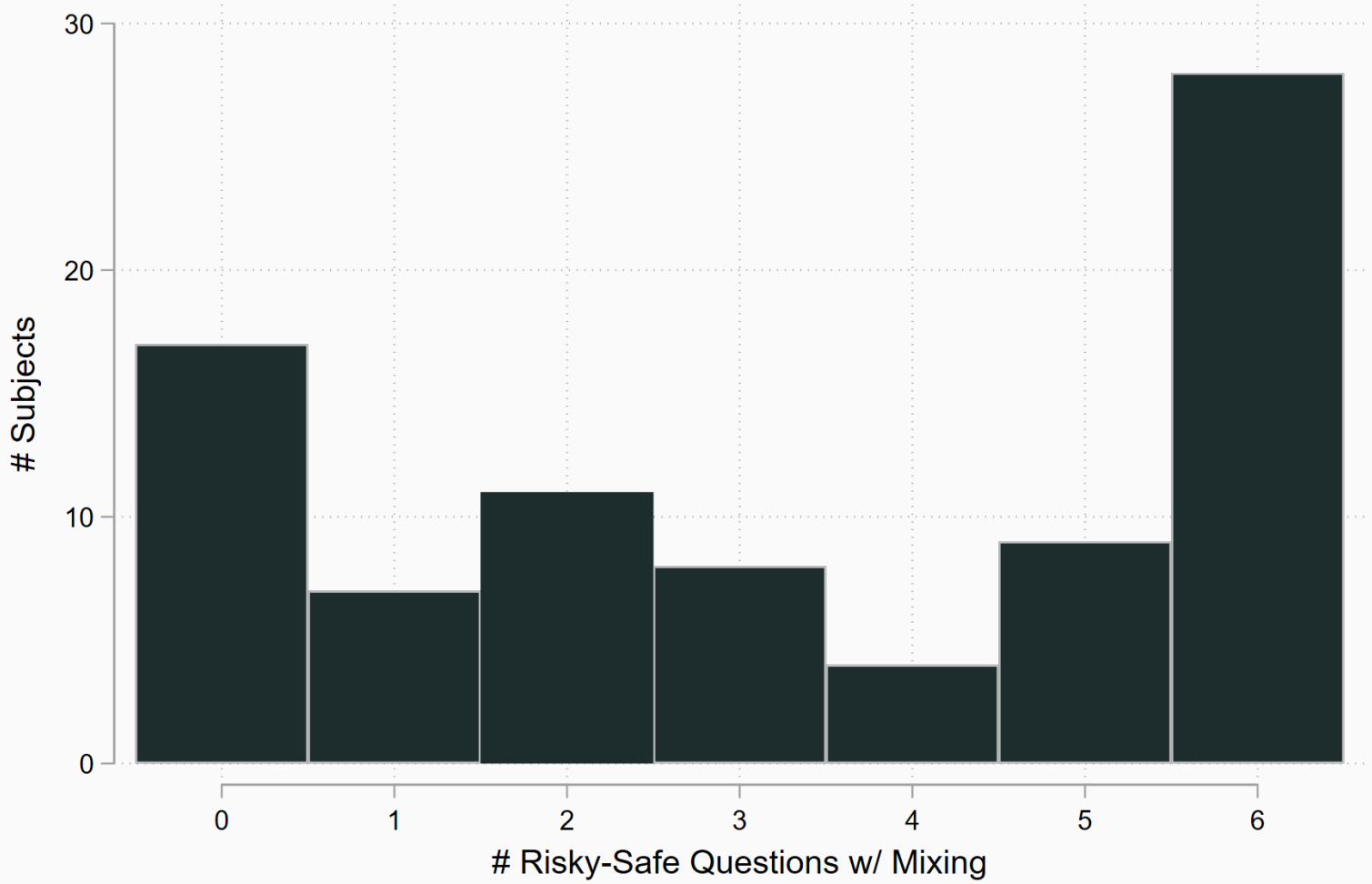
EU + Indifference? No. We see mixing in both.

Results

Baseline Treatment: $n = 84$

Pr(Red):	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**
	Risky-Safe					
% who mix:	55%	60%	54%	57%	57%	54%
Avg # Risky|mix	5.9	6.9	9.3	10.0	9.9	11.1

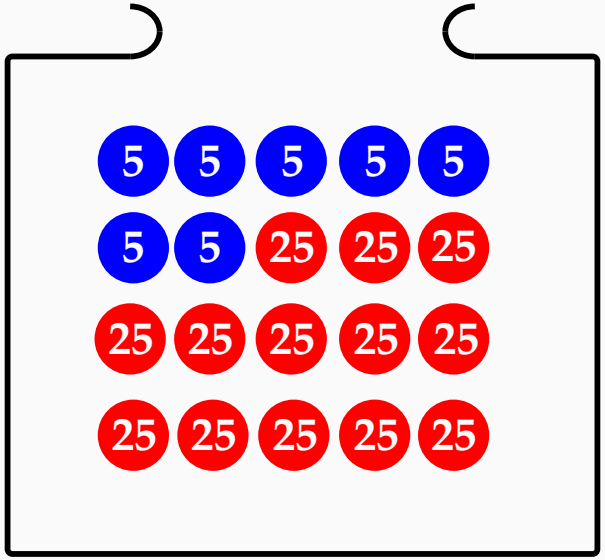
Results: Correlation Between Questions



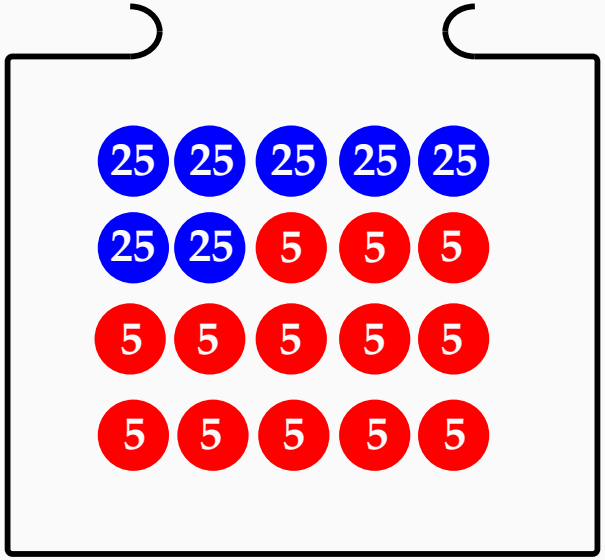
Pairwise Cramer Coefficients all in $[0.51, 0.70]$, sig. at $p < 0.001$.

DECISION PROBLEM TWO:
Red-NotRed

Decison Problem 2: Red-NotRed



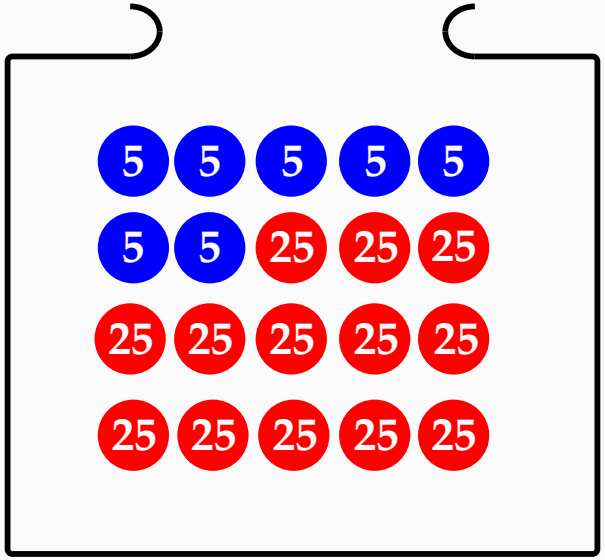
Red (65%)



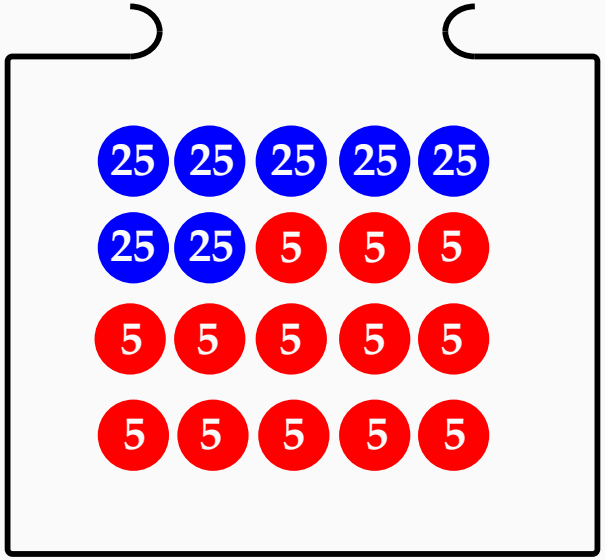
NotRed (35%)

- **Pick 1 time:** Red $\succ$ NotRed

Decison Problem 2: Red-NotRed



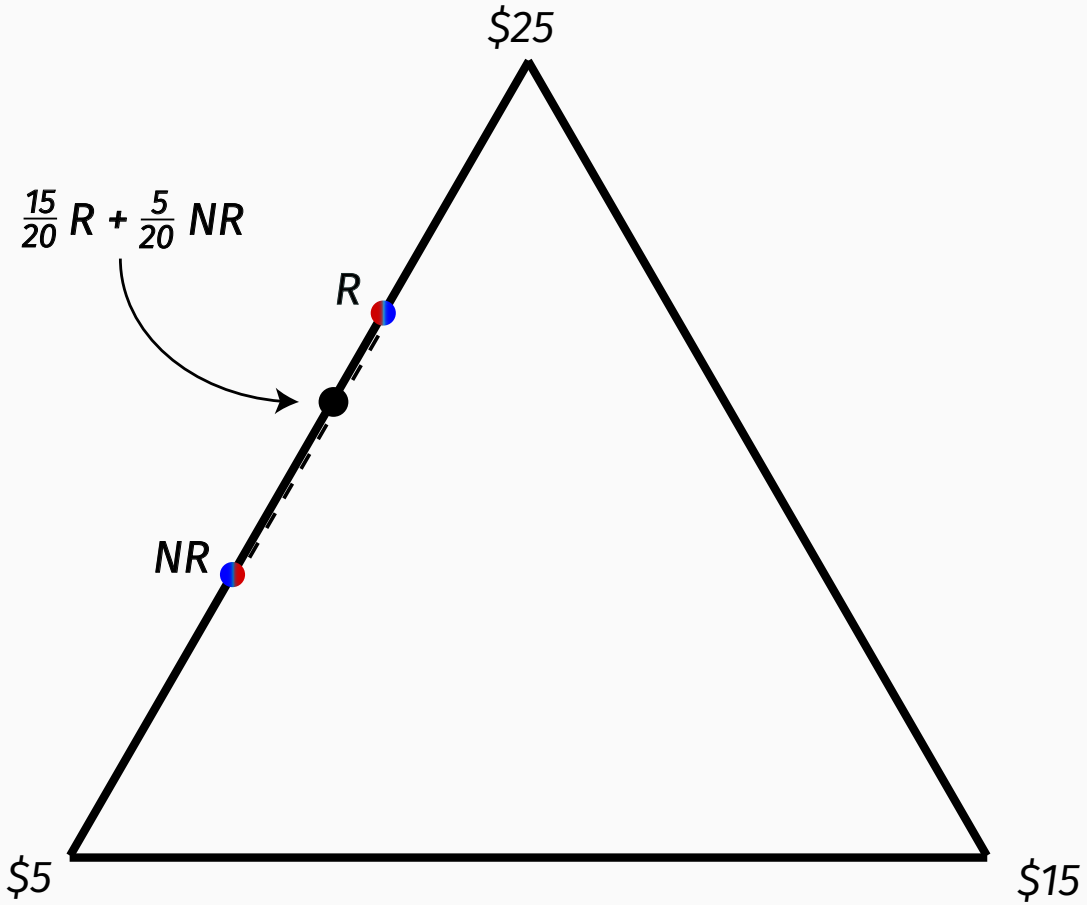
Red (65%)



NotRed (35%)

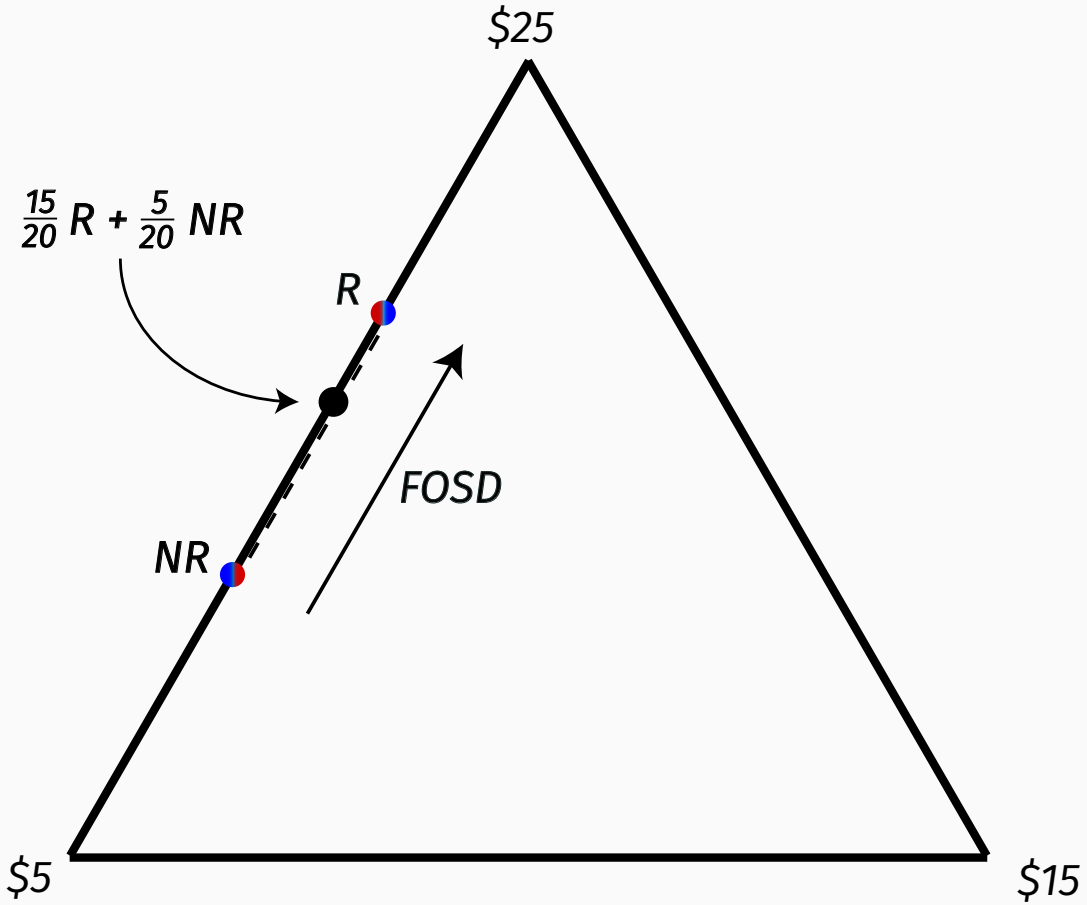
- **Pick 1 time:** Red $\succ$ NotRed
- Our experiment: **Pick 20 times, one is paid randomly**
  - 54% pick Red all 20 times
  - 1% pick NotRed all 20 times
  - 45% mix. Average: 15 Red, 5 NotRed

Mixing



Reduced compound lottery

Irrational Mixing



Mixture violates FOSD (not just EU).

Results

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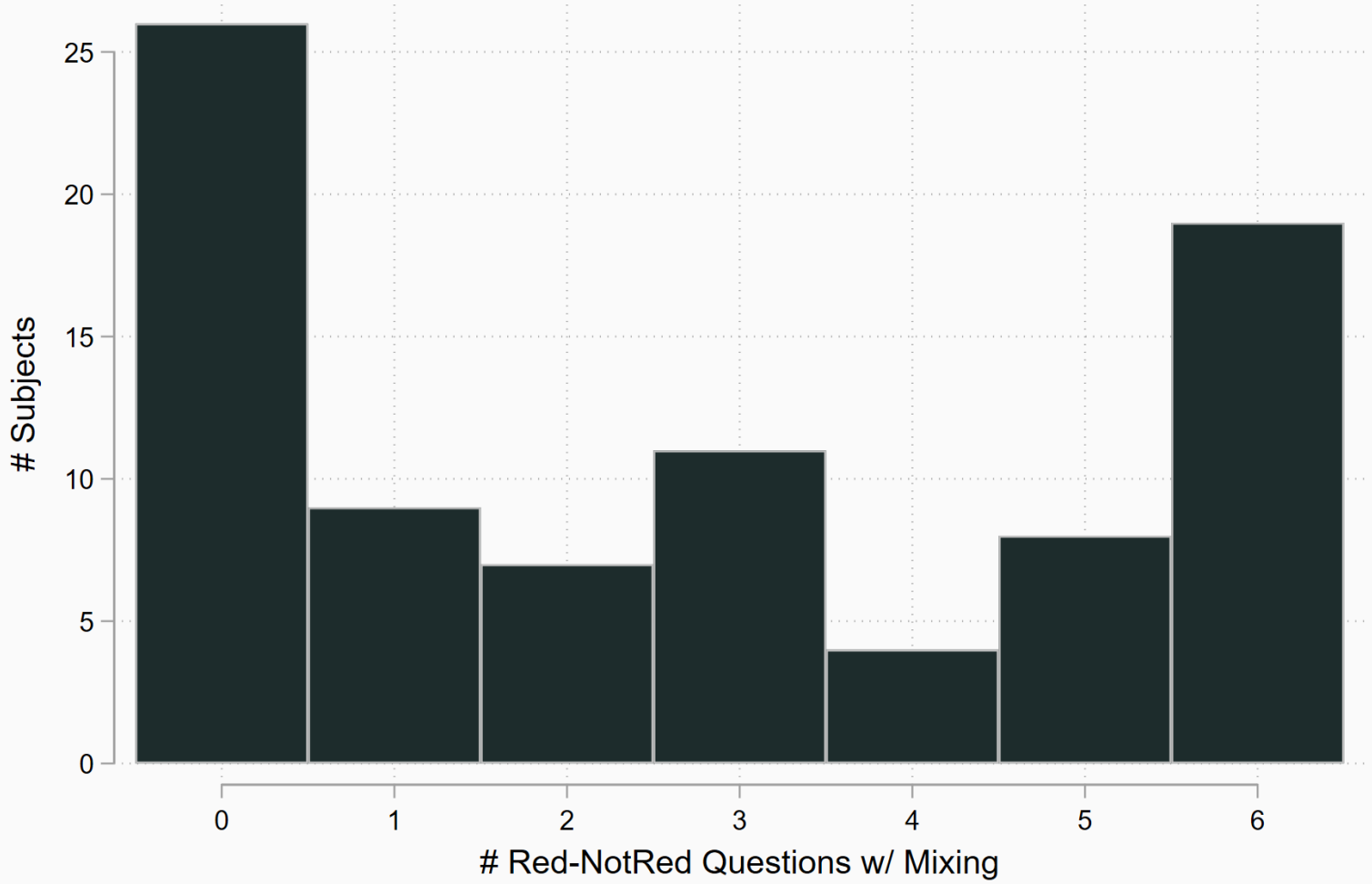
	Risky-Safe					
% who mix:	55%	60%	54%	57%	57%	54%
Avg # Risky|mix	5.9	6.9	9.3	10.0	9.9	11.1
	Red-NotRed					
% who mix:	57%	54%	45%	39%	39%	35%
Avg # Red|mix:	11.4	13.7	14.5	14.1	15.2	16.0

Results

Baseline Treatment: $n = 84$

Pr(Red):	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**
	Risky-Safe					
% who mix:	55%	60%	54%	57%	57%	54%
Avg # Risky|mix	5.9	6.9	9.3	10.0	9.9	11.1
	Red-NotRed					
% who mix:	57%	54%	45%	39%	39%	35%
Avg # Red|mix:	11.4	13.7	14.5	14.1	15.2	16.0
Modal % Red|mix:	50%	60%	65%	70%	75%	95%
Pr(Red):	**55%**	**60%**	**65%**	**70%**	**75%**	**80%**

Results: Correlation



Pairwise Cramer Coefficients all in $[0.47, 0.70]$, sig. at $p < 0.001$.

Correlation Across Problems

- Mix in Red-NotRed $\Rightarrow$ Mix in Risky-Safe?

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  - 78%

Correlation Across Problems

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- Mix in Risky-Safe $\Rightarrow$ Mix in Red-NotRed?

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- Mix in Red-NotRed $\Rightarrow$ Mix in Risky-Safe?
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  - 63%

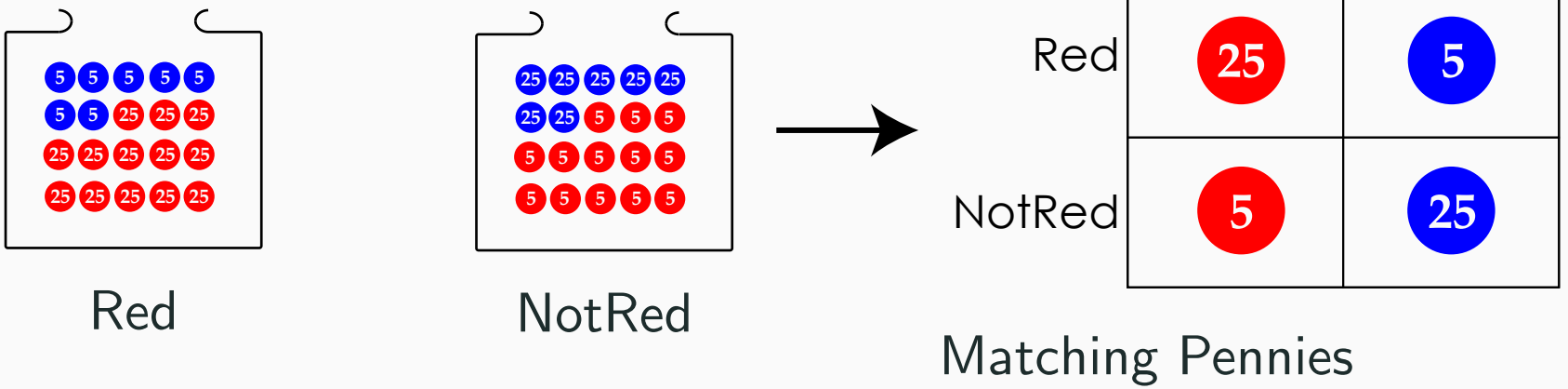
Correlation Across Problems

- Mix in Red-NotRed $\Rightarrow$ Mix in Risky-Safe?
  - 78%
- Mix in Risky-Safe $\Rightarrow$ Mix in Red-NotRed?
  - 63%

- Definite evidence of 'mixing types'

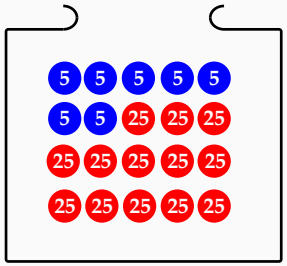
MIXING IN GAMES

Mixing in Games

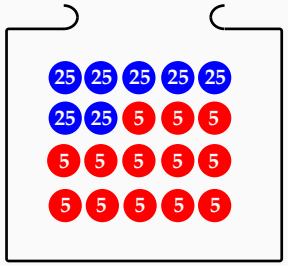


- Play against past players
  - No social preferences
  - Probability given (55% and 80%)

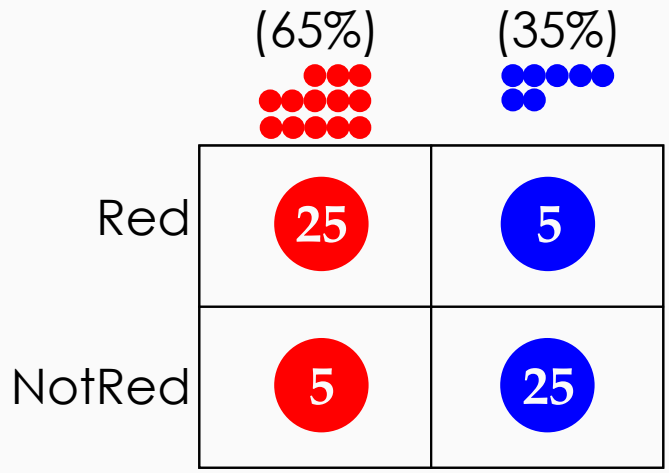
Mixing in Games



Red



NotRed



Matching Pennies

Pr(Red):	**55%**	**80%**
	Red-NotRed	
% who mix:	57%	35%
Avg # Red|mix:	11.4	16.0
	Matching Pennies	
% who mix:	71%**	35%
Avg # Red|mix:	12.1**	15.2

Correlation Across Problems

- Mix in Red-NotRed $\Rightarrow$ Mix in Matching Pennies?

Correlation Across Problems

- Mix in Red-NotRed $\Rightarrow$ Mix in Matching Pennies?
  - **55% Question:** 88%
  - **80% Question:** 66%

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  - **55% Question:** 88%
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- Mix in Matching Pennies $\Rightarrow$ Mix in Red-NotRed?
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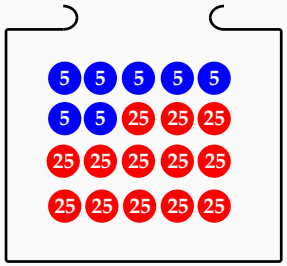
  - **80% Question:** 66%

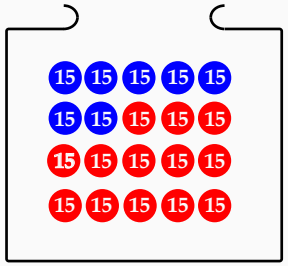
- Definite evidence of 'mixing types'

GAMES WITH STRATEGIC UNCERTAINTY

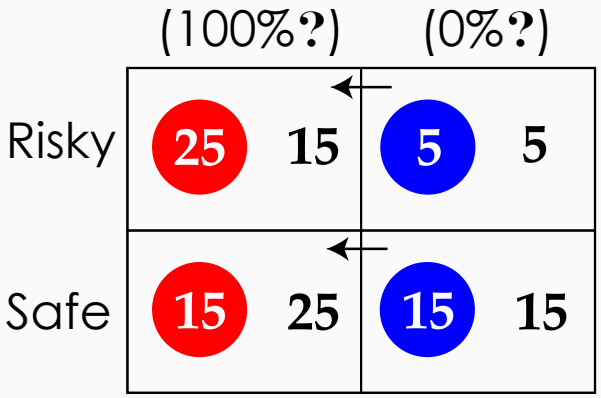
Mixing in Games



Risky



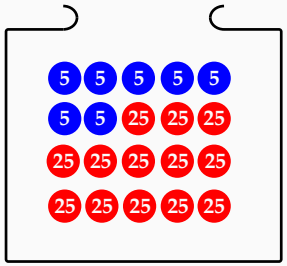
Safe



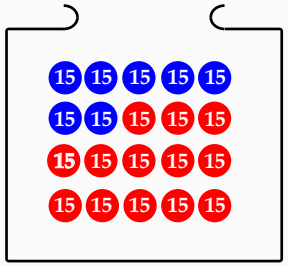
Dominance Solvable

- Play against current players
  - Social preferences
  - Elicit beliefs
    - 80% belief $\Rightarrow \approx$ 80% Risky-Safe question, *e.g.*

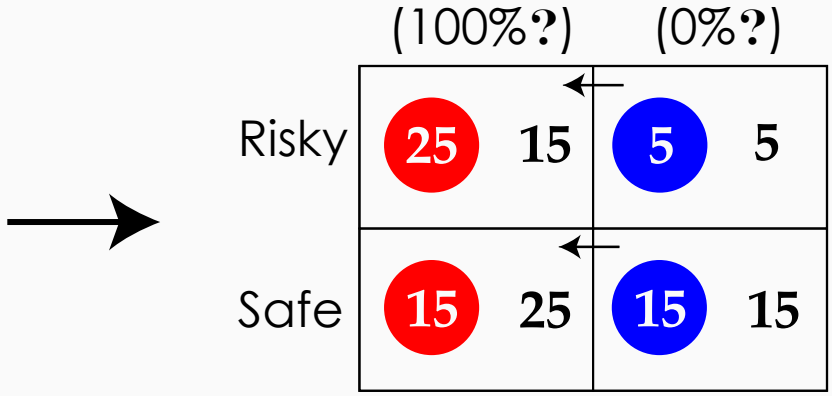
Mixing in Games



Risky



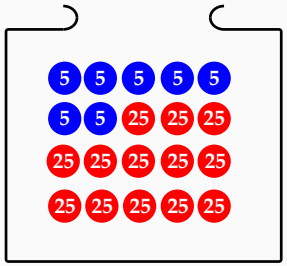
Safe



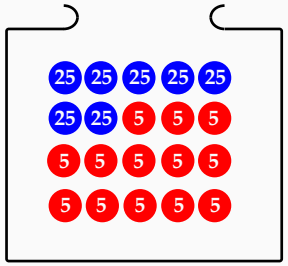
Dominance Solvable

- Result:
  - 69% have belief $\geq 75\%$
  - Choose Safe 3.5 times more (on avg.) than in corresponding Risky-Safe decision.
  - Strategic uncertainty $\Rightarrow \uparrow$ mixing on Safe

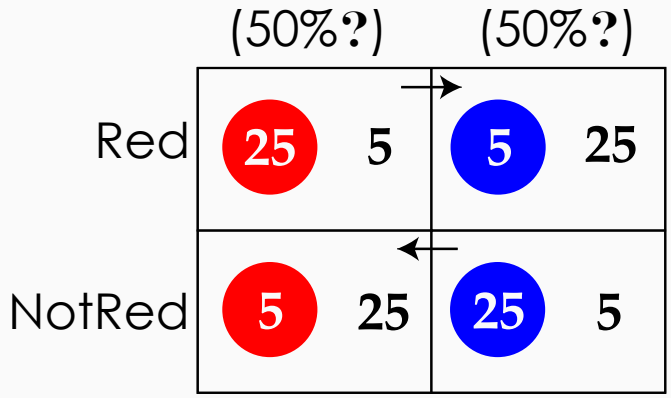
Mixing in Games



Red



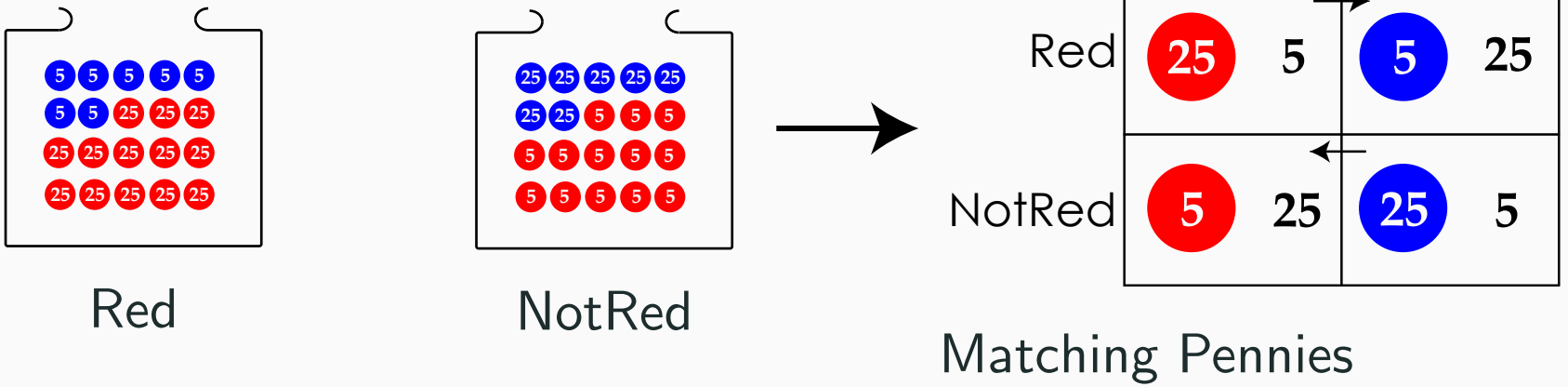
NotRed



Matching Pennies

- Play against current players
  - Social preferences
  - Elicit beliefs
    - 55% belief $\Rightarrow \approx$ 55% Red-NotRed question, *e.g.*

Mixing in Games



- Result:
  - Only 29% have belief $= 50\%$ (not far off, though)
  - Choose NotRed 5.2 times more (on avg.) than in corresponding Risky-Safe decision.
  - Strategic uncertainty $\Rightarrow \uparrow$ irrational mixing

THEORY TESTING

Theory Testing

One theory: Negative correlation

Bet #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INDEPENDENT:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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One theory: Negative correlation

Bet #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INDEPENDENT:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CORRELATED:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Theory Testing

One theory: Negative correlation

Bet #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INDEPENDENT:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CORRELATED:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Data: *ZERO* difference between IND and CORR.*

(*Well, OK... slightly more mixing in games under CORR.)

Theory Testing

One theory: Negative correlation

Bet #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INDEPENDENT:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CORRELATED:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Data: *ZERO* difference between IND and CORR.*

	Mix in Red-NotRed?	
	INDEP.	CORR.
Our Data	✓	✓
Negative Correlation	✓	

(*Well, OK... slightly more mixing in games under CORR.)

Theory Testing

One theory: Negative correlation

Bet #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
INDEPENDENT:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
CORRELATED:	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Data: *ZERO* difference between IND and CORR.*

	Mix in Red-NotRed?	
	INDEP.	CORR.
Our Data	✓	✓
Negative Correlation	✓	
Modal Count Rule	✓	
Responsibility Aversion	✓*	
Irrational Diversification		✓
Convex Cost of Mistakes		✓
Source Preference		✓
Utility of Gambling		
Regret Aversion		
Failure of ROCL		

(*Well, OK... slightly more mixing in games under CORR.)

SUMMARY

Summary

- Mixing is pervasive
- Correlated across domains
- Seems to be a heuristic

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- Correlated across domains
- Seems to be a heuristic

- **Next step:** Can we "teach away" mixing?
- Reduce compound lottery for them $\Rightarrow$ show NotRed is dominated
  - Red-NotRed mixing is a mistake $\Rightarrow$ Should go away
  - Risky-Safe mixing is convex prefs $\Rightarrow$ Should persist

FIN