

PROBABILISTIC CHOICE IN RATS

Andrew Marshall and Kimberly Kirkpatrick
Kansas State University

Probability discounting in animals

5 food pellets,
 $p(\text{food}) = 1$

15 food pellets,
 $p(\text{food}) = .33$

Probability discounting in animals

5 food pellets,
 $p(\text{food}) = 1$

15 food pellets,
 $p(\text{food}) = .67$

Probability discounting in animals

5 food pellets,
 $p(\text{food}) = 1$

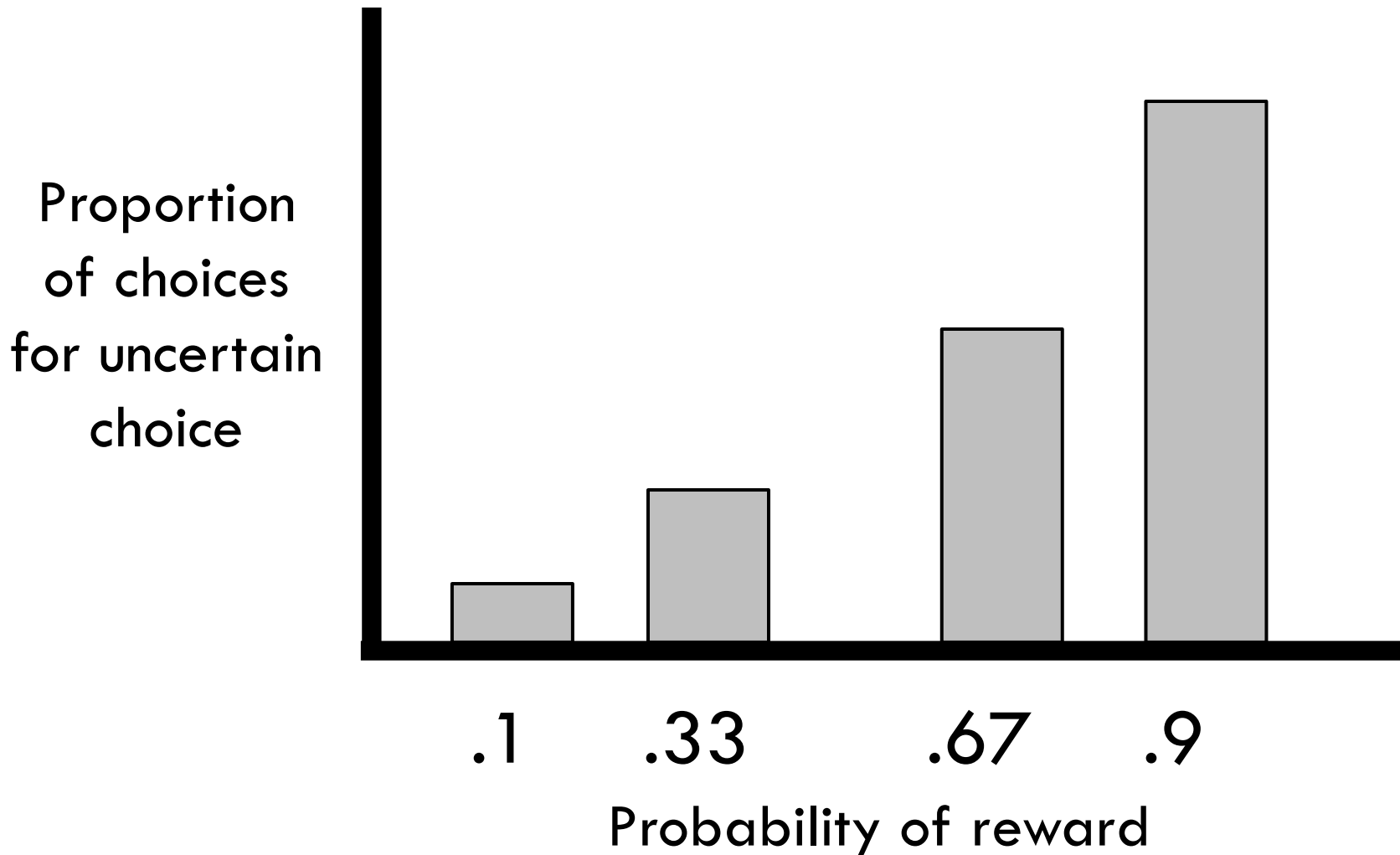
15 food pellets,
 $p(\text{food}) = .10$

Probability discounting in animals

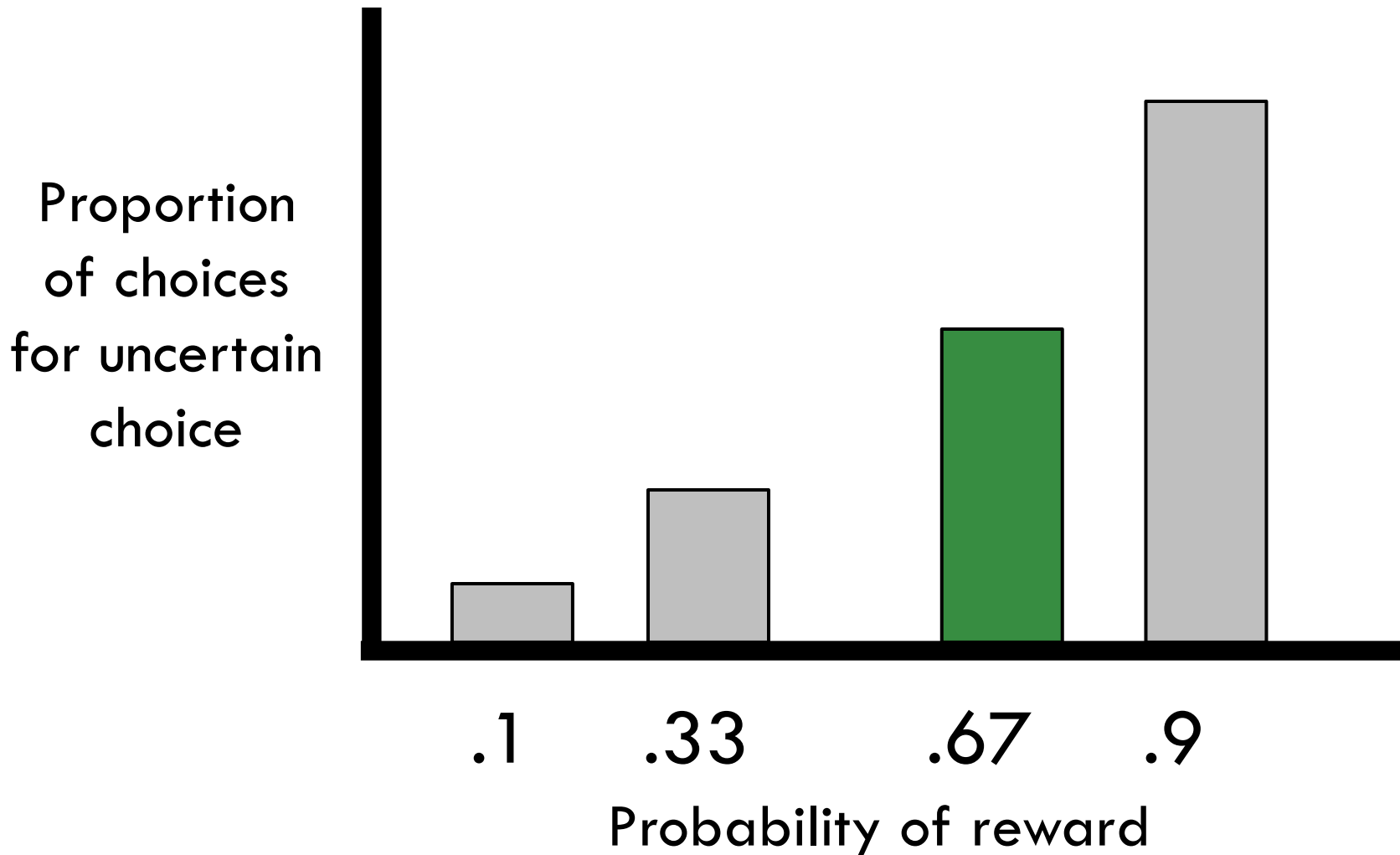
5 food pellets,
 $p(\text{food}) = 1$

15 food pellets,
 $p(\text{food}) = .90$

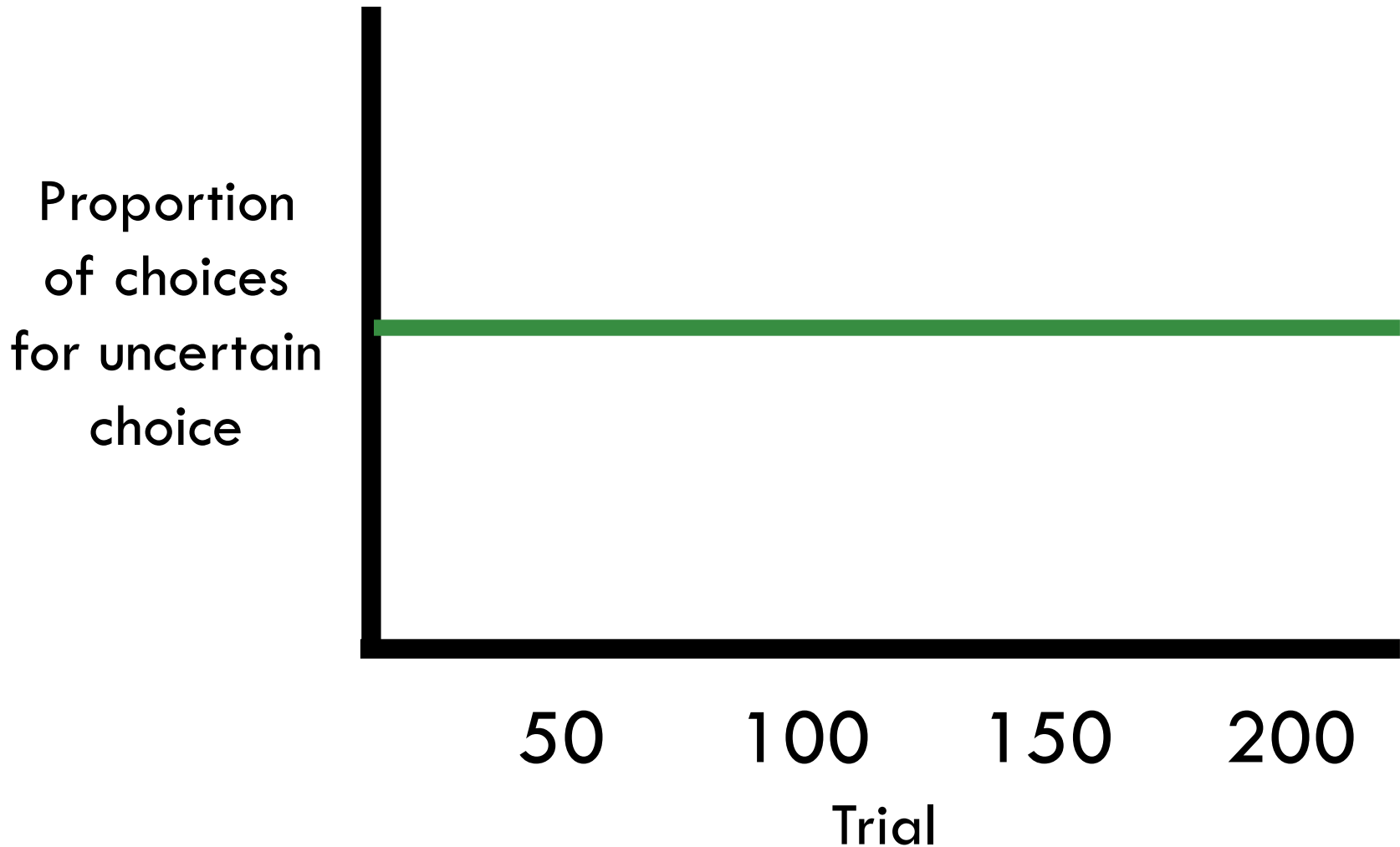
Analyzing probabilistic choice data



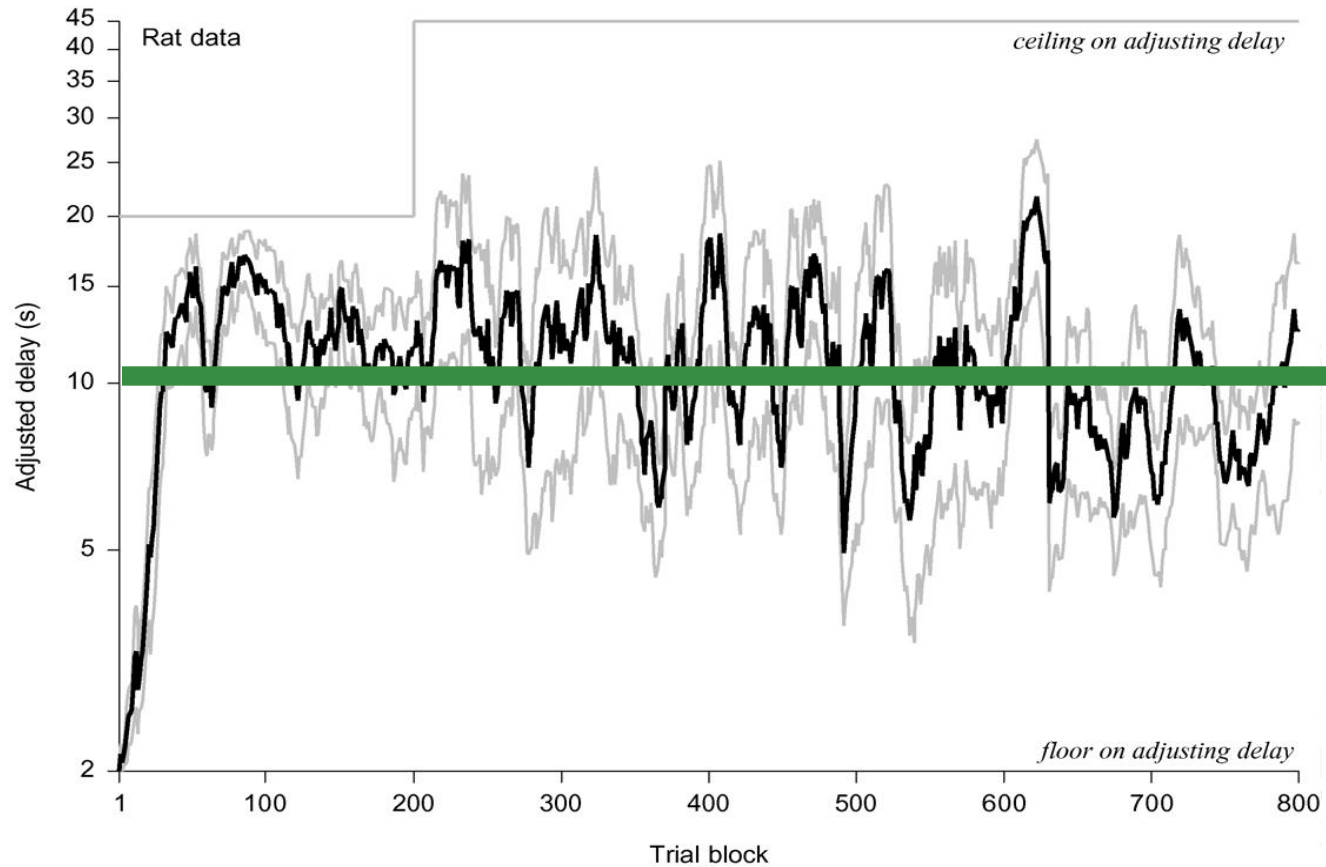
Analyzing probabilistic choice data



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Analyzing probabilistic choice data



Previous-outcome effects on behavior

- The previous trial may have effects on behavior in the current trial
 - ▣ (Amsel, 1958; Bailey & Mazur, 1990; Fantino & Royalty, 1987; Hayden & Platt, 2009; Killeen, 1970; Mellon, Leak, Fairhurst, & Gibbon, 1995; McCoy & Platt, 2005; Richter & Kay, 1980; Staddon & Innis, 1969)

Goals of the experiment

- Further investigate the effects of previous-trial outcomes on probabilistic choice behavior in a more stable experimental environment

Method

- Subjects: 24 rats
- General procedure:
 - ▣ One block of **8 forced-choice** trials
 - ▣ One block of **160 free-choice** trials
 - ▣ Choice between:
 - Certain outcome (RFT will be delivered)
 - Uncertain outcome (RFT probabilistically delivered)
 - ▣ 20-s FI followed by a 10-s ITI
- Two phases of the experiment

Method

- Certain outcome

- 1 pellet ($p = .5$)

- 3 pellets ($p = .5$)

- Uncertain outcome

- 0 pellets

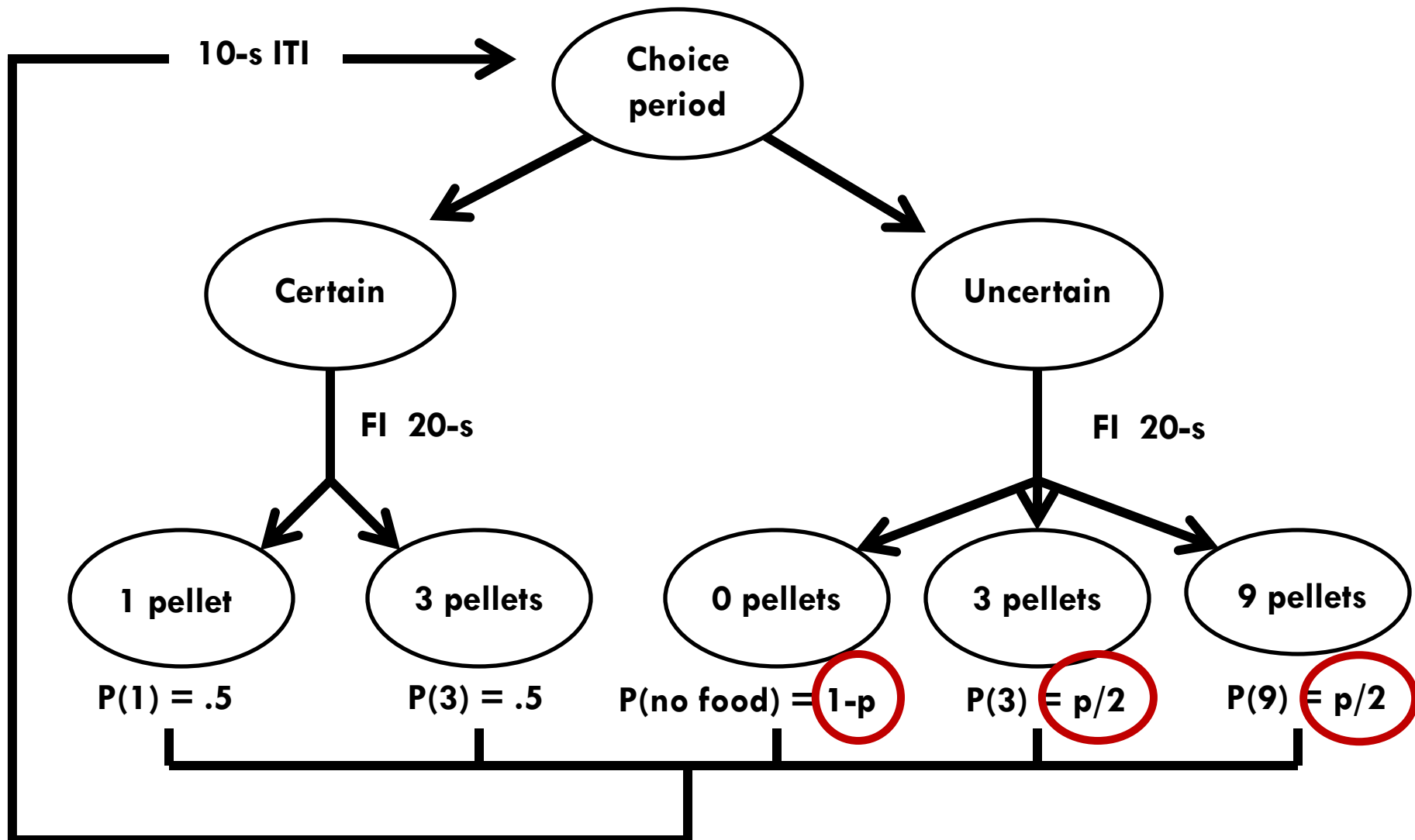
- 3 pellets

- 9 pellets

Probability of food	Expected value
1.00	2.0

Probability of food	Expected value
.10	0.6
.33	2.0
.67	4.0
.90	5.4

Method [Stable $p(\text{food})$: Phases 3-6]



Conditions

Certain Outcome

Probability of food	Expected value
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1.00	2.0
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Uncertain Outcome

Probability of food (p)	Expected value
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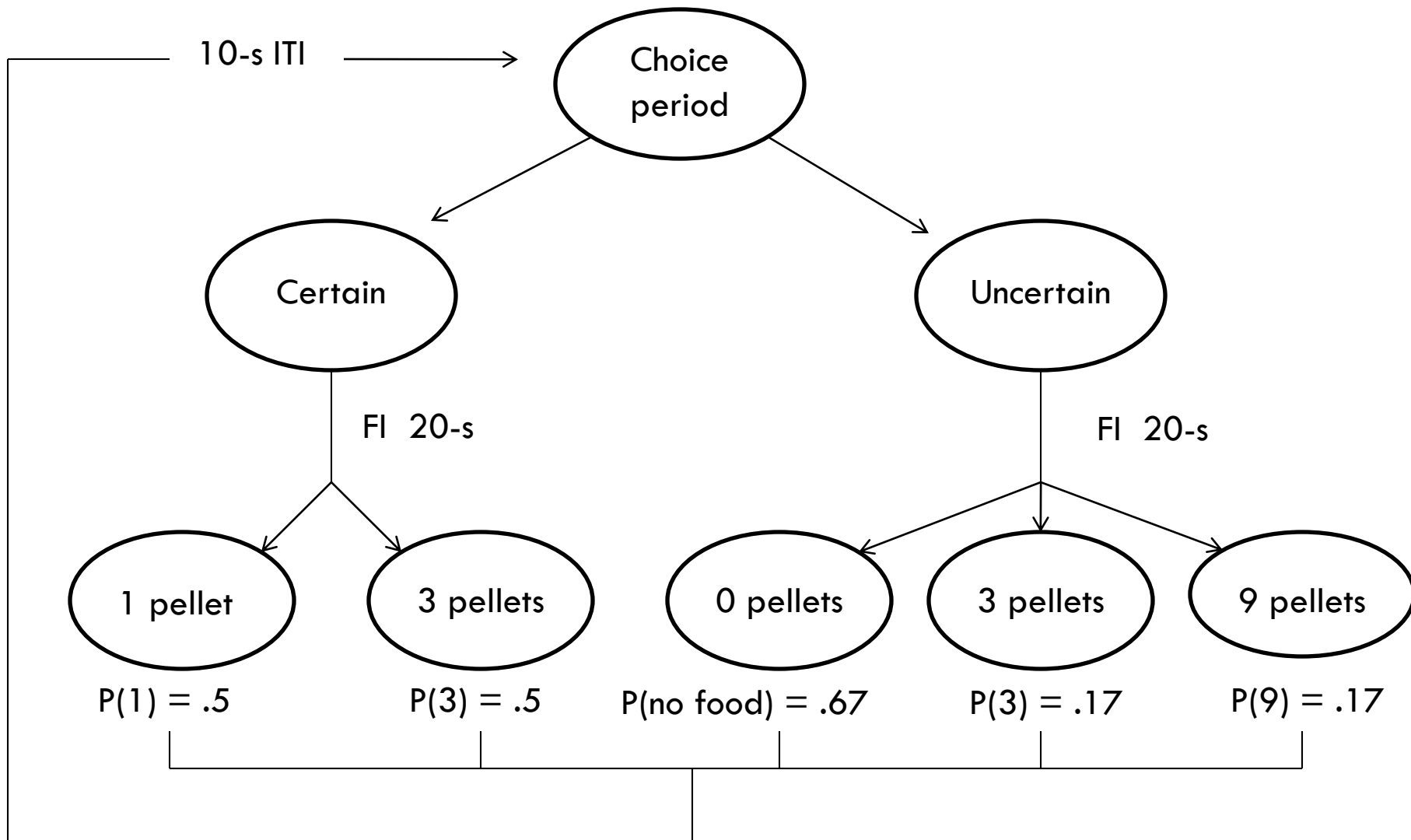
.10	0.6
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.33	2.0
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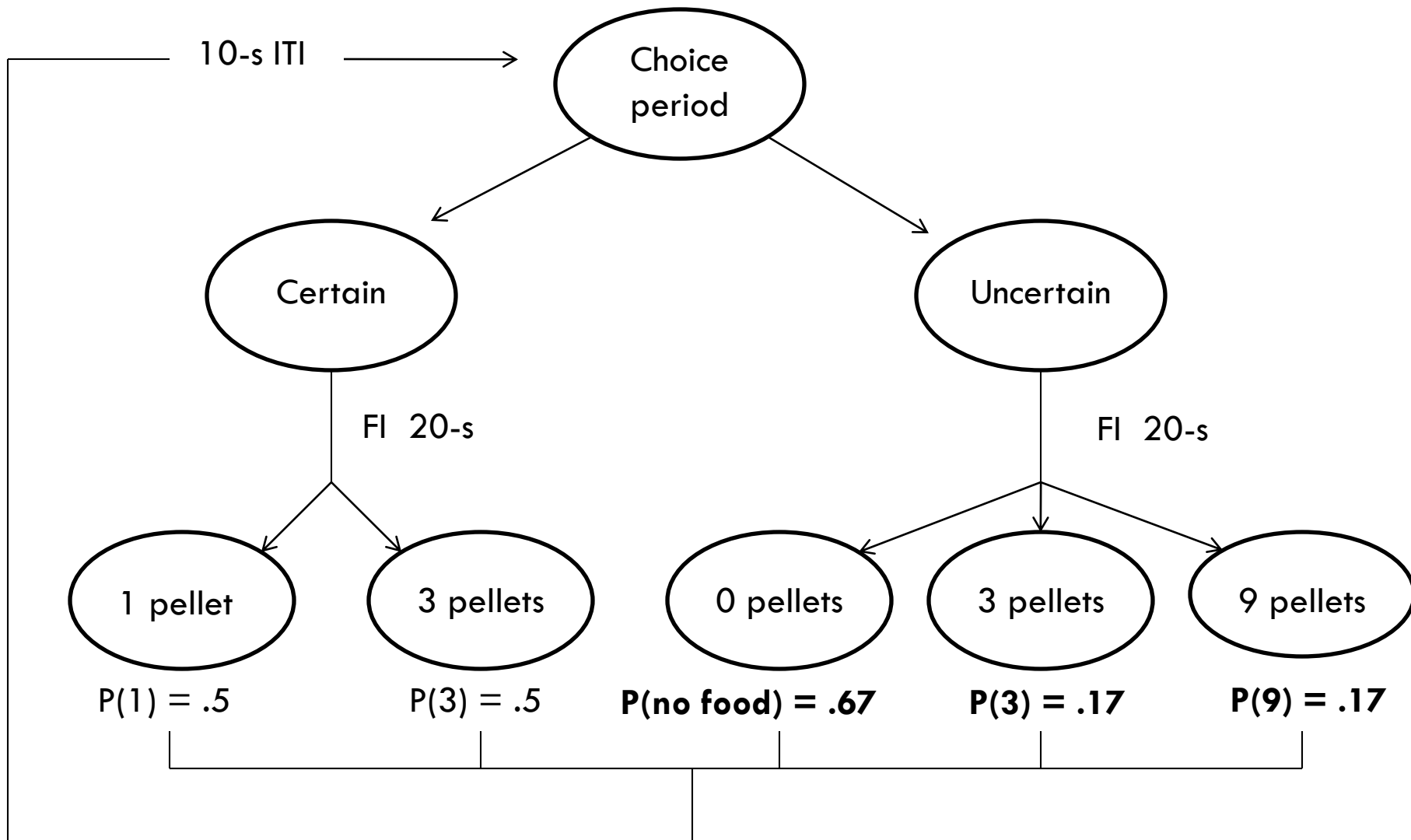
.67	4.0
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.90	5.4
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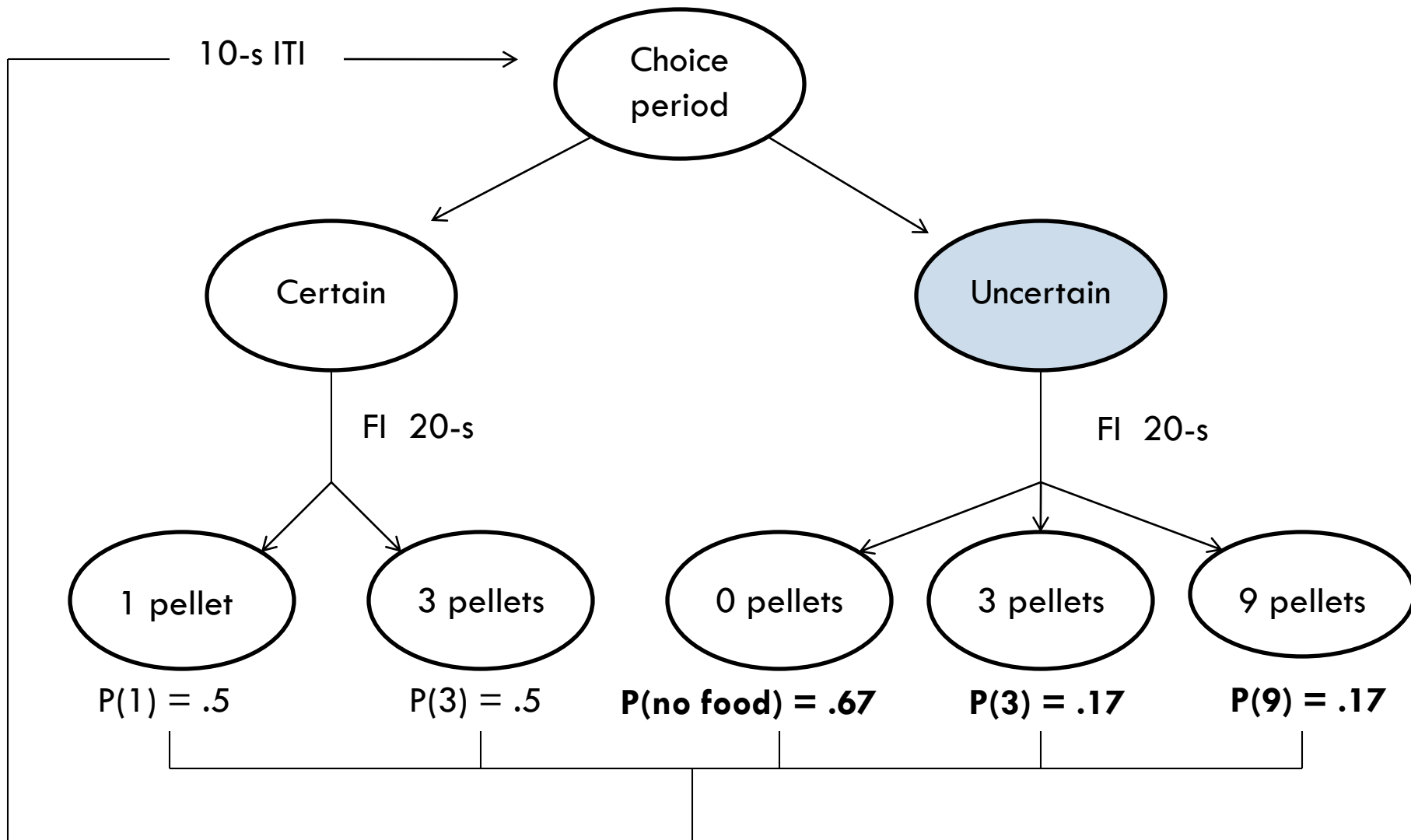
Method [Dynamic $p(\text{food})$: Phase 7]



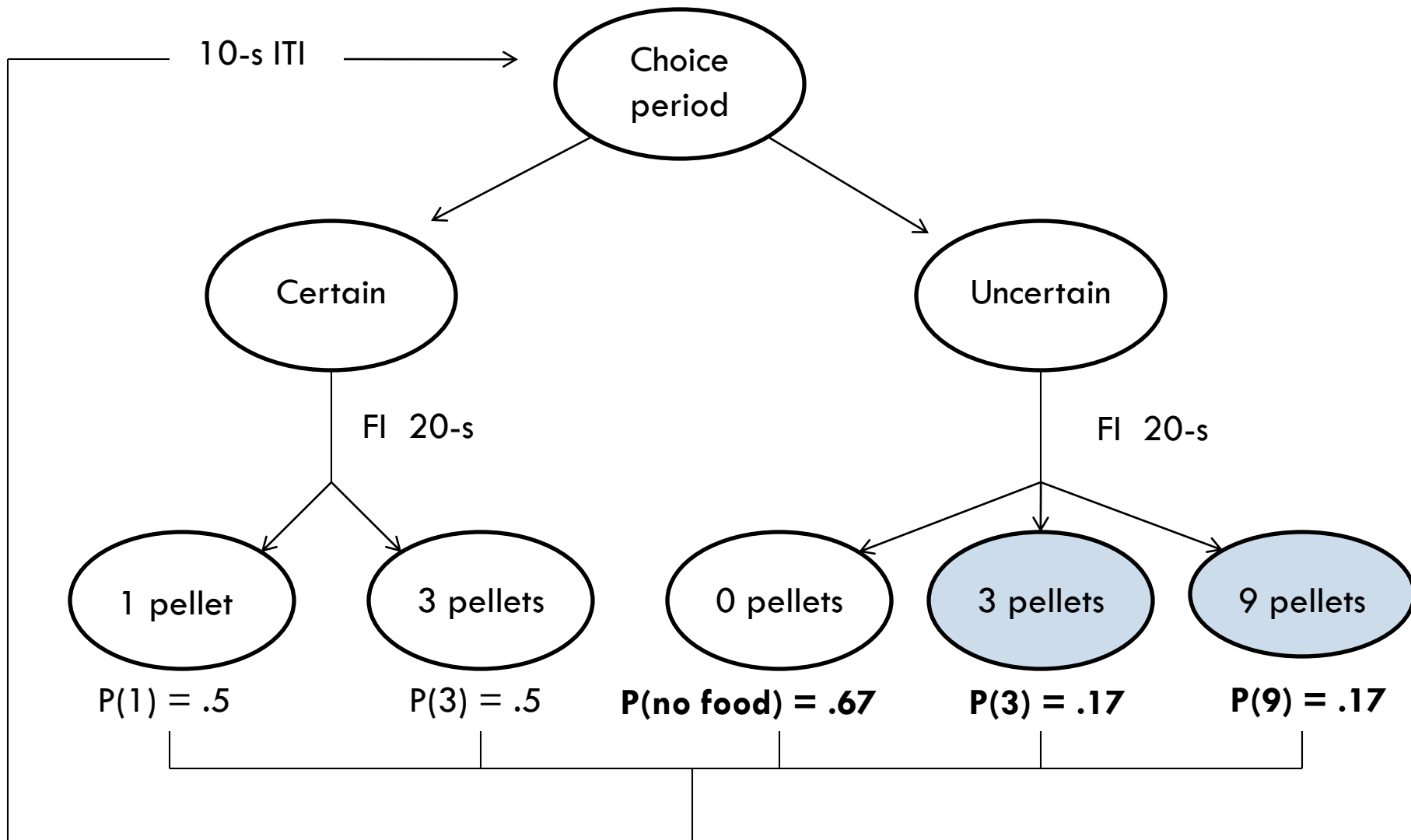
Method [Dynamic $p(\text{food})$: Phase 7]



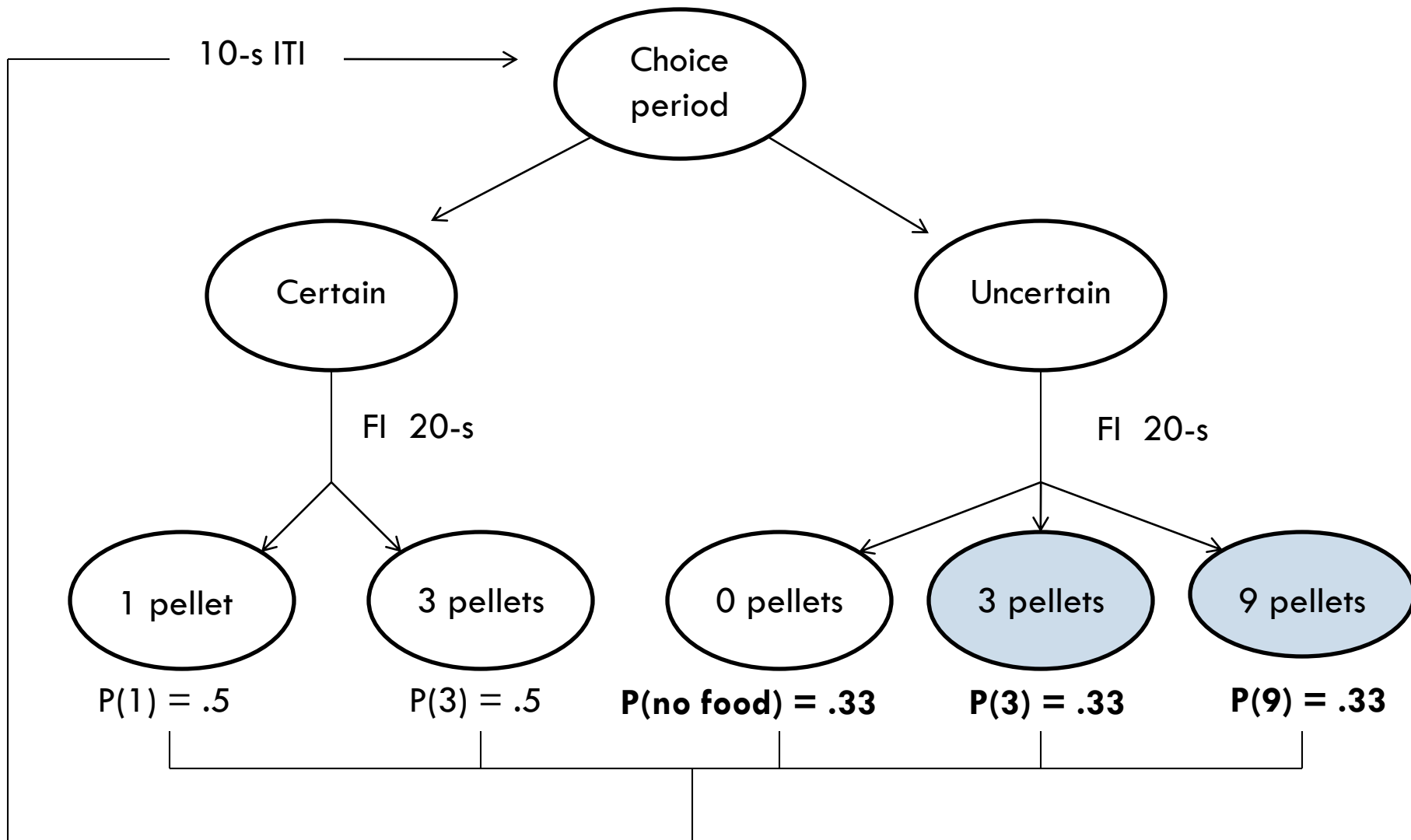
Method [Dynamic $p(\text{food})$: Phase 7]



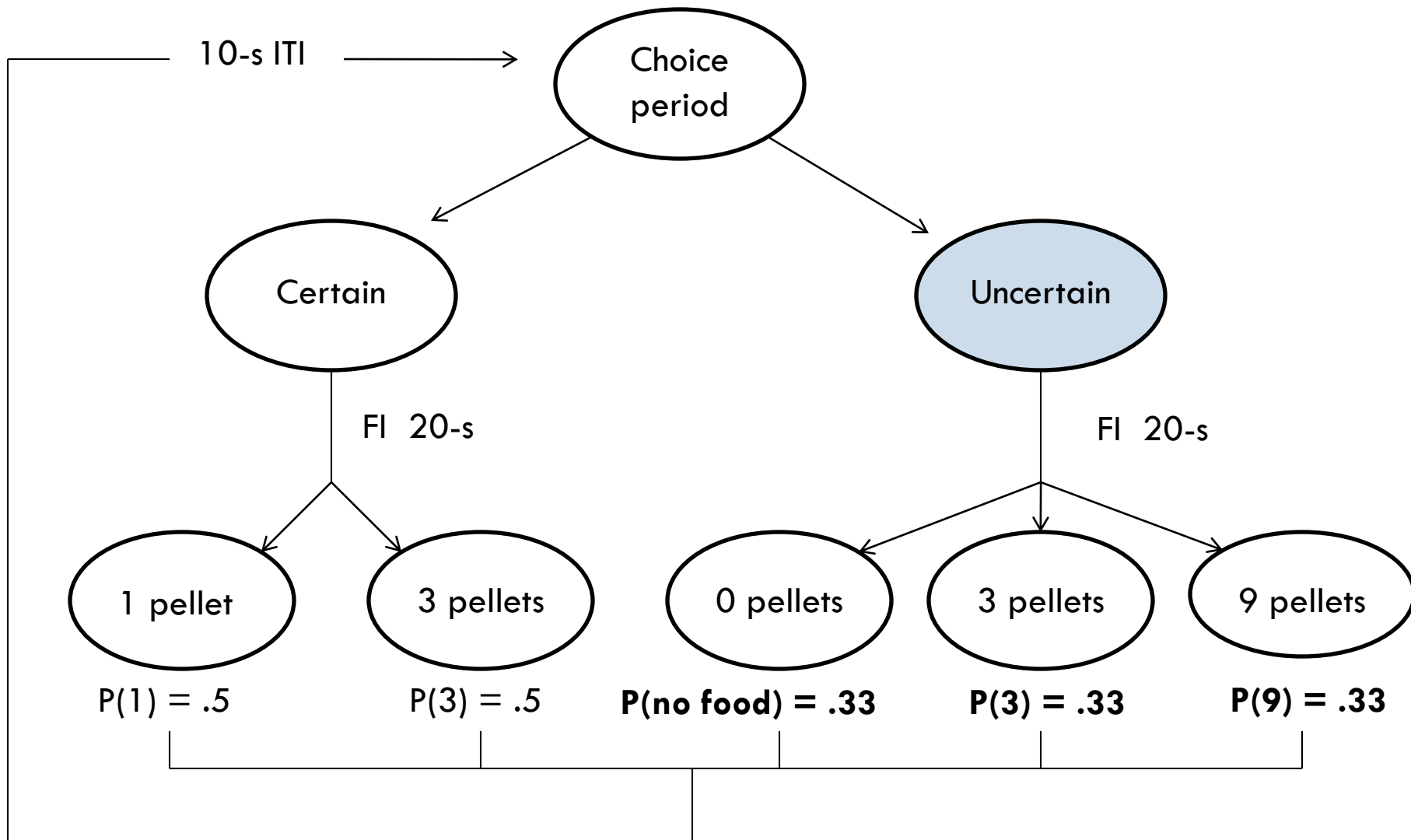
Method [Dynamic $p(\text{food})$: Phase 7]



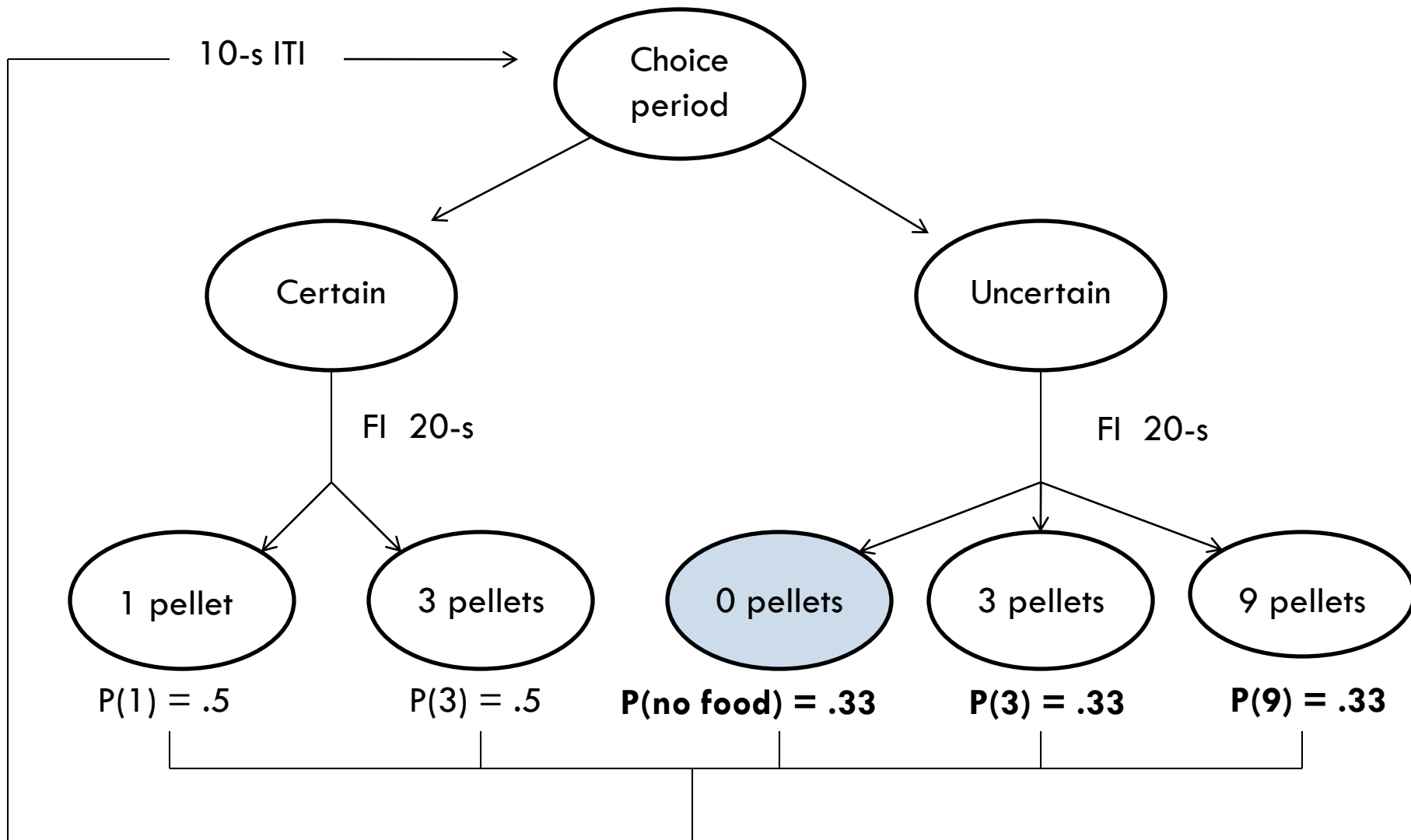
Method [Dynamic $p(\text{food})$: Phase 7]



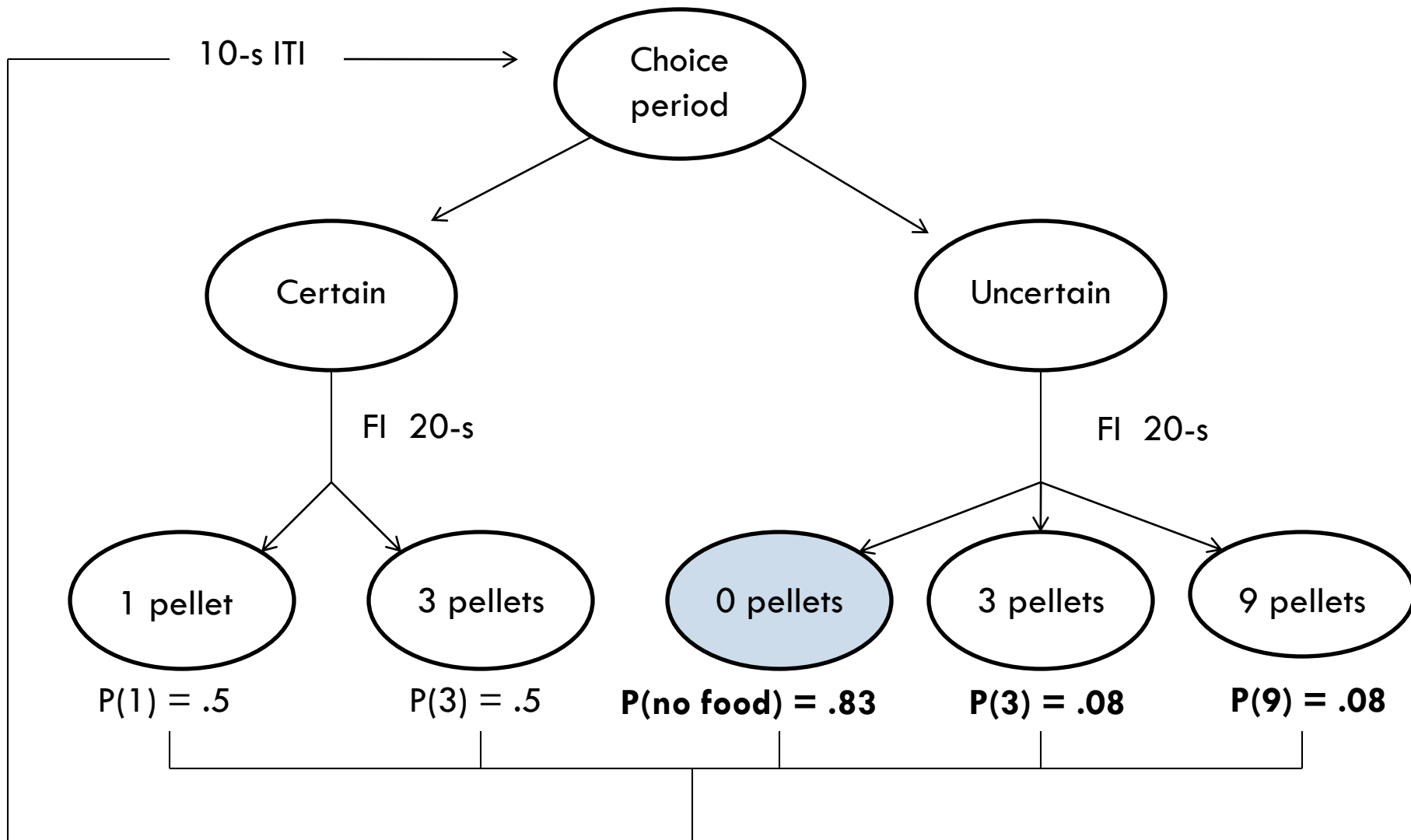
Method [Dynamic $p(\text{food})$: Phase 7]



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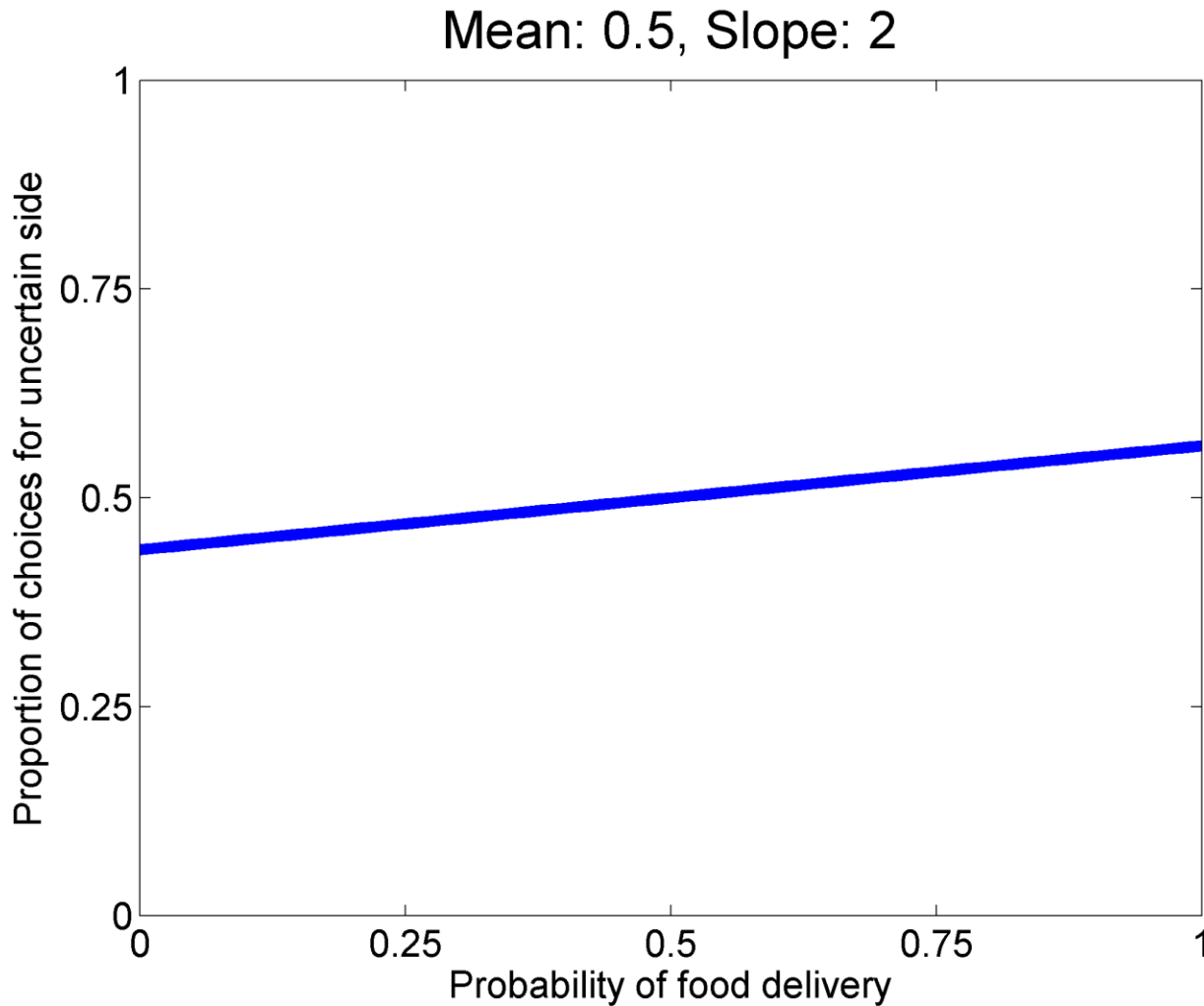
Data analysis

- Proportion of choices for the uncertain side
- Parameters of fitting a logistic function

$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

- X = probability of food,
- a = mean
- b = slope

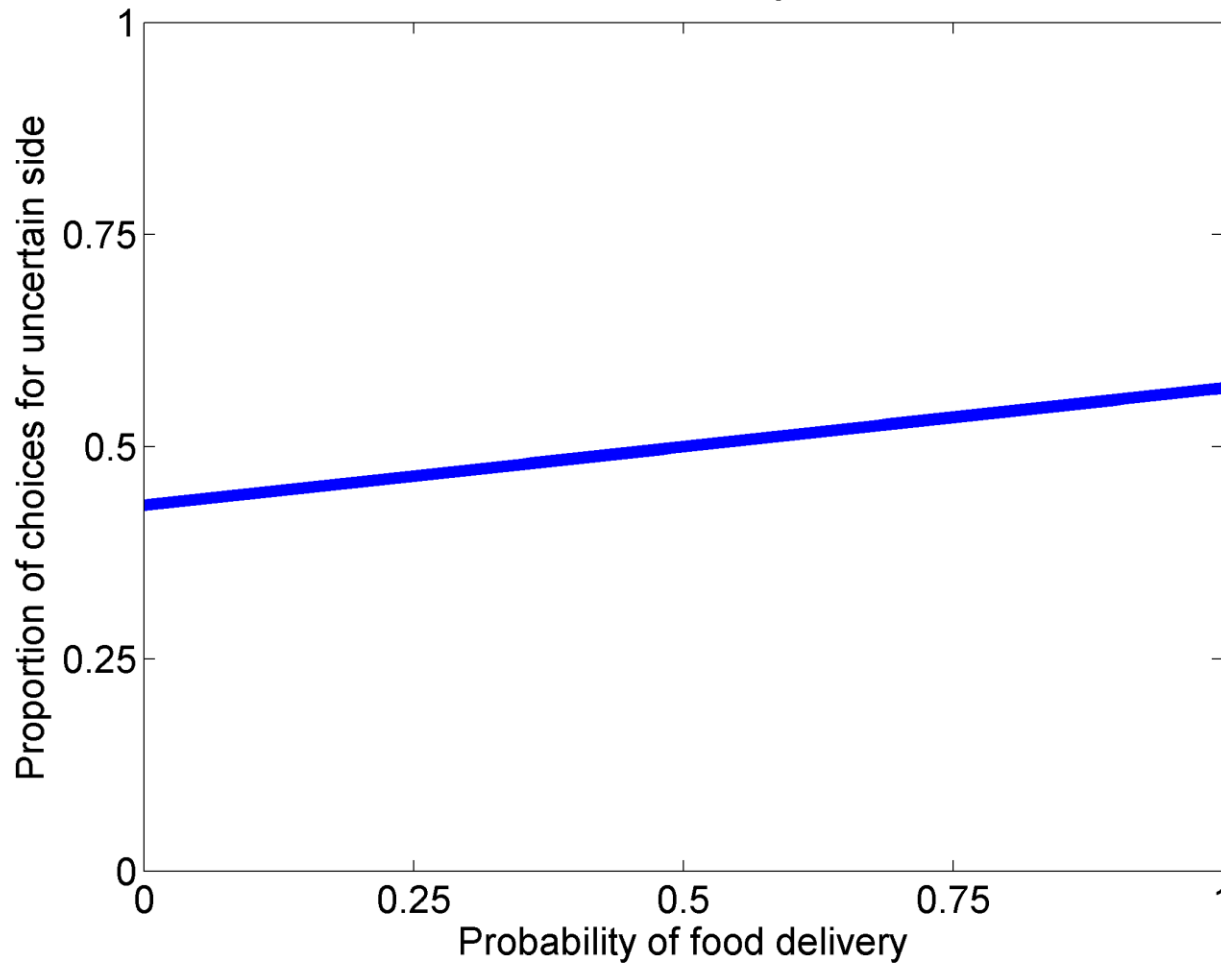
Logistic function



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

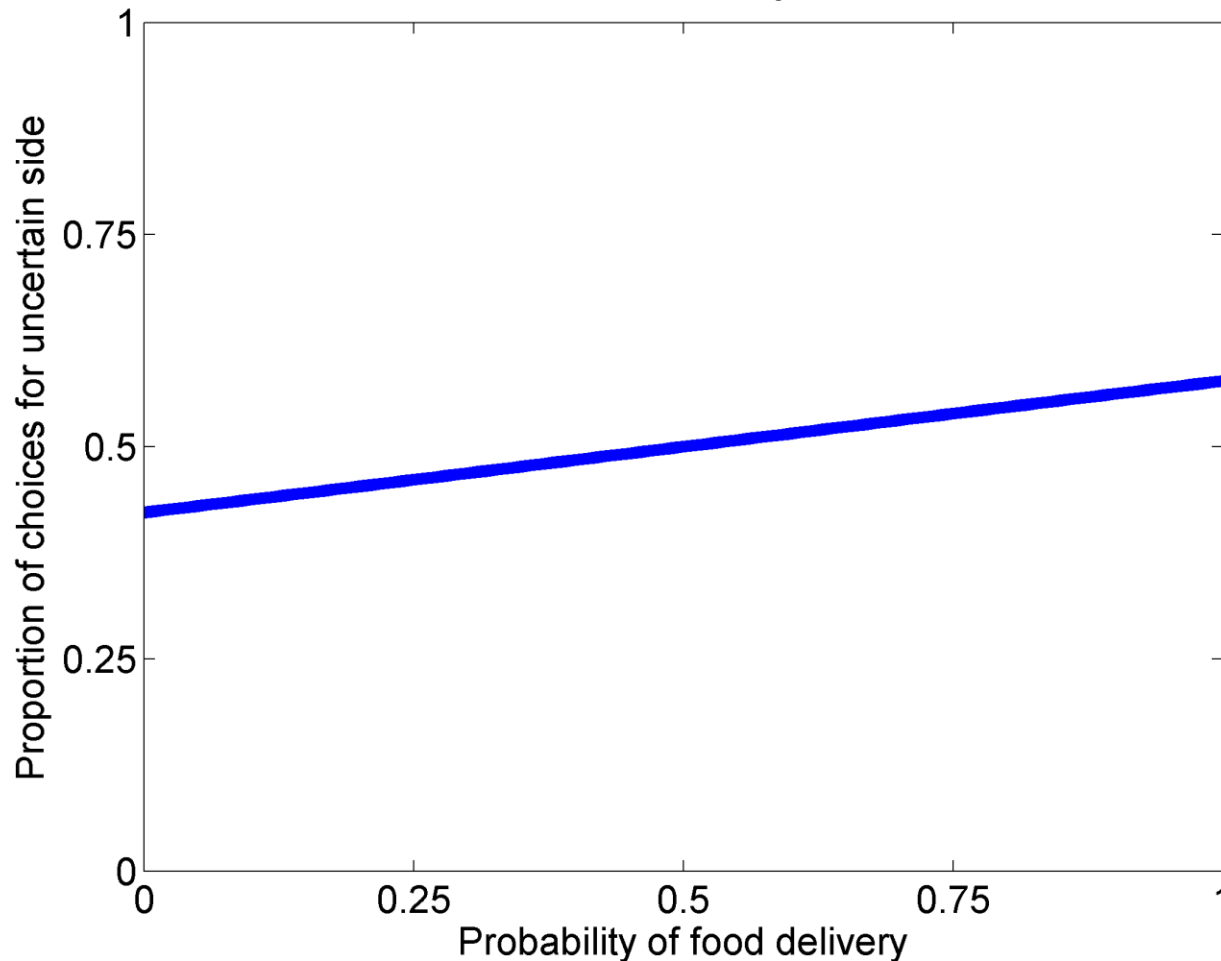
Mean: 0.5, Slope: 1.8



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

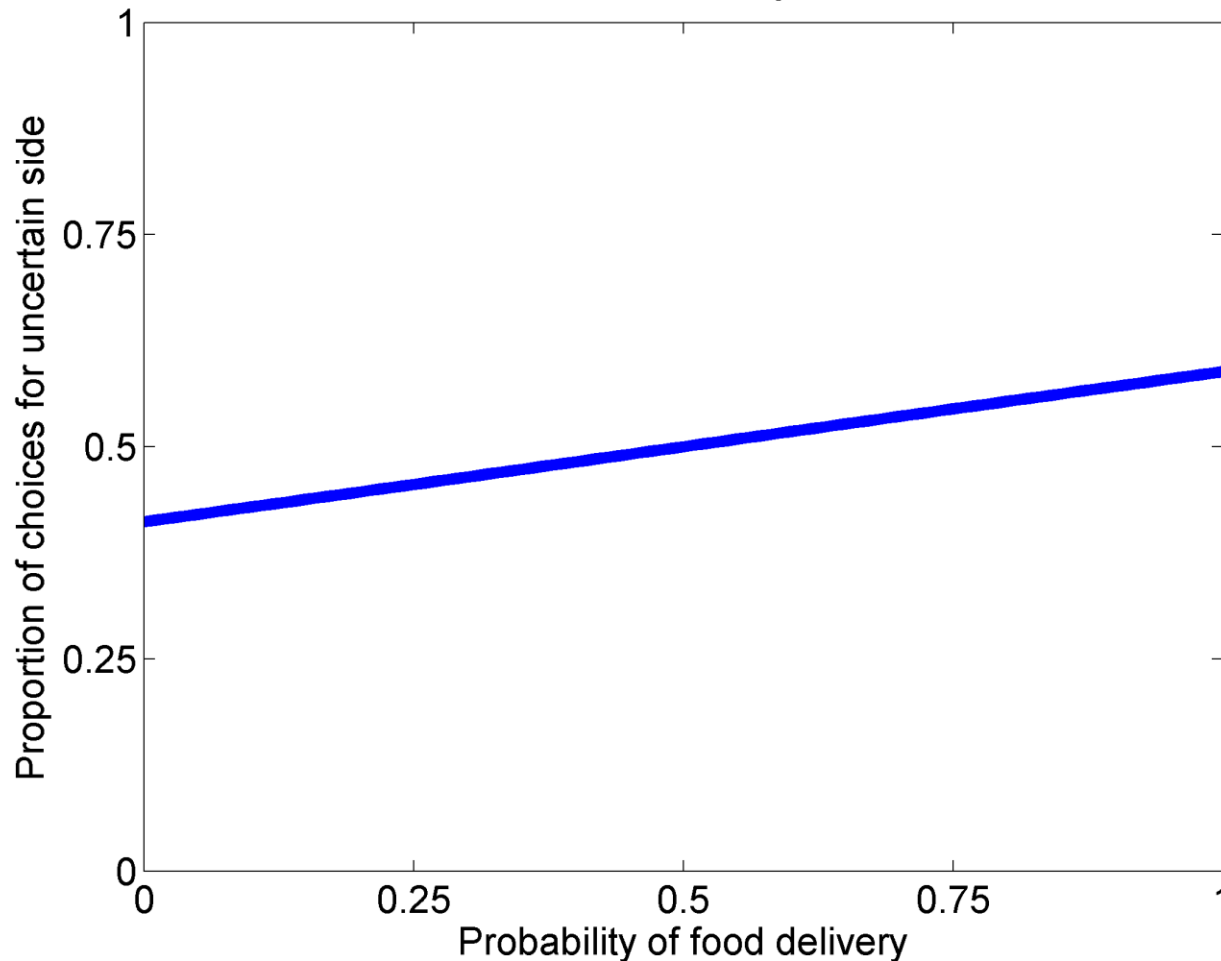
Mean: 0.5, Slope: 1.6



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

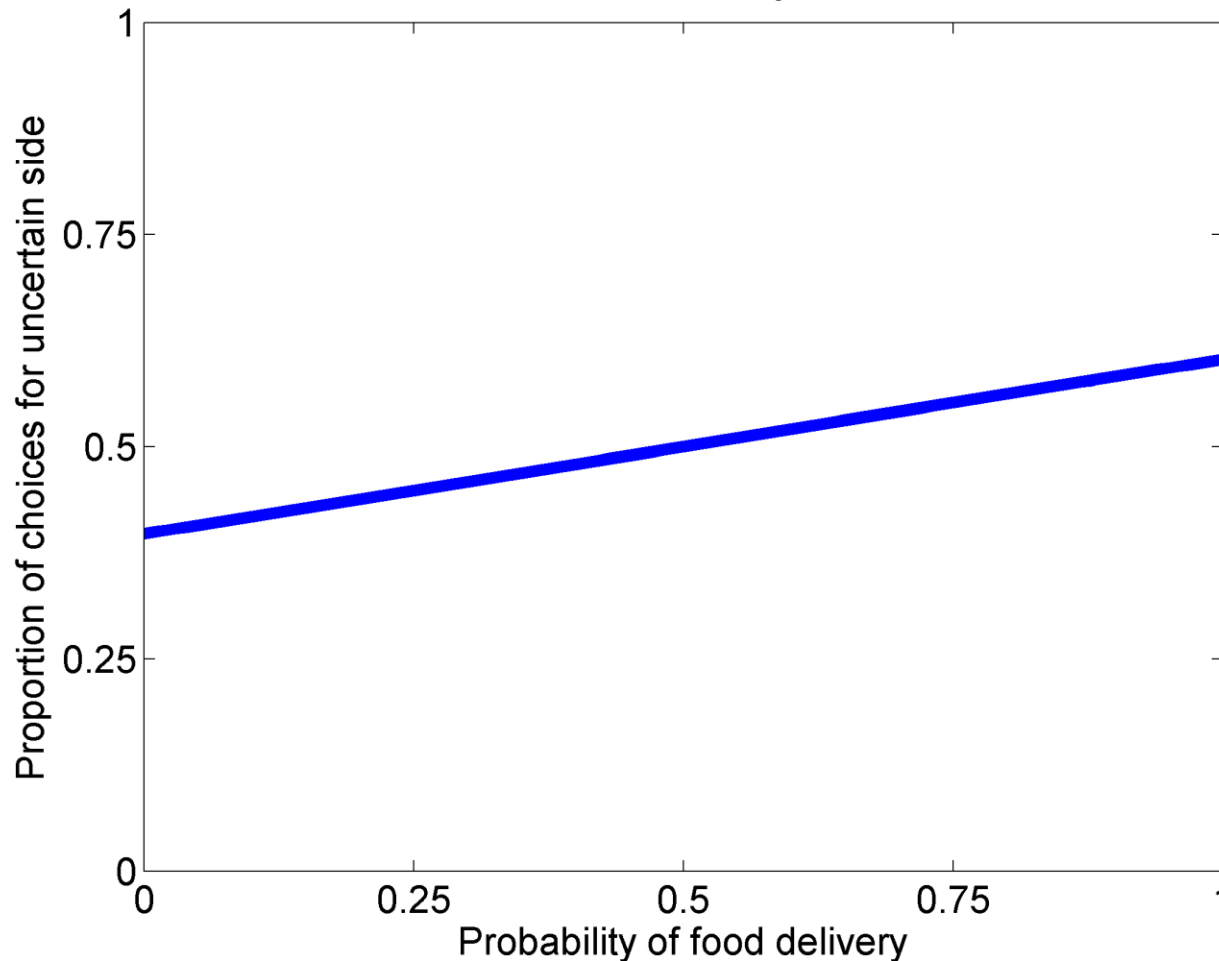
Mean: 0.5, Slope: 1.4



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

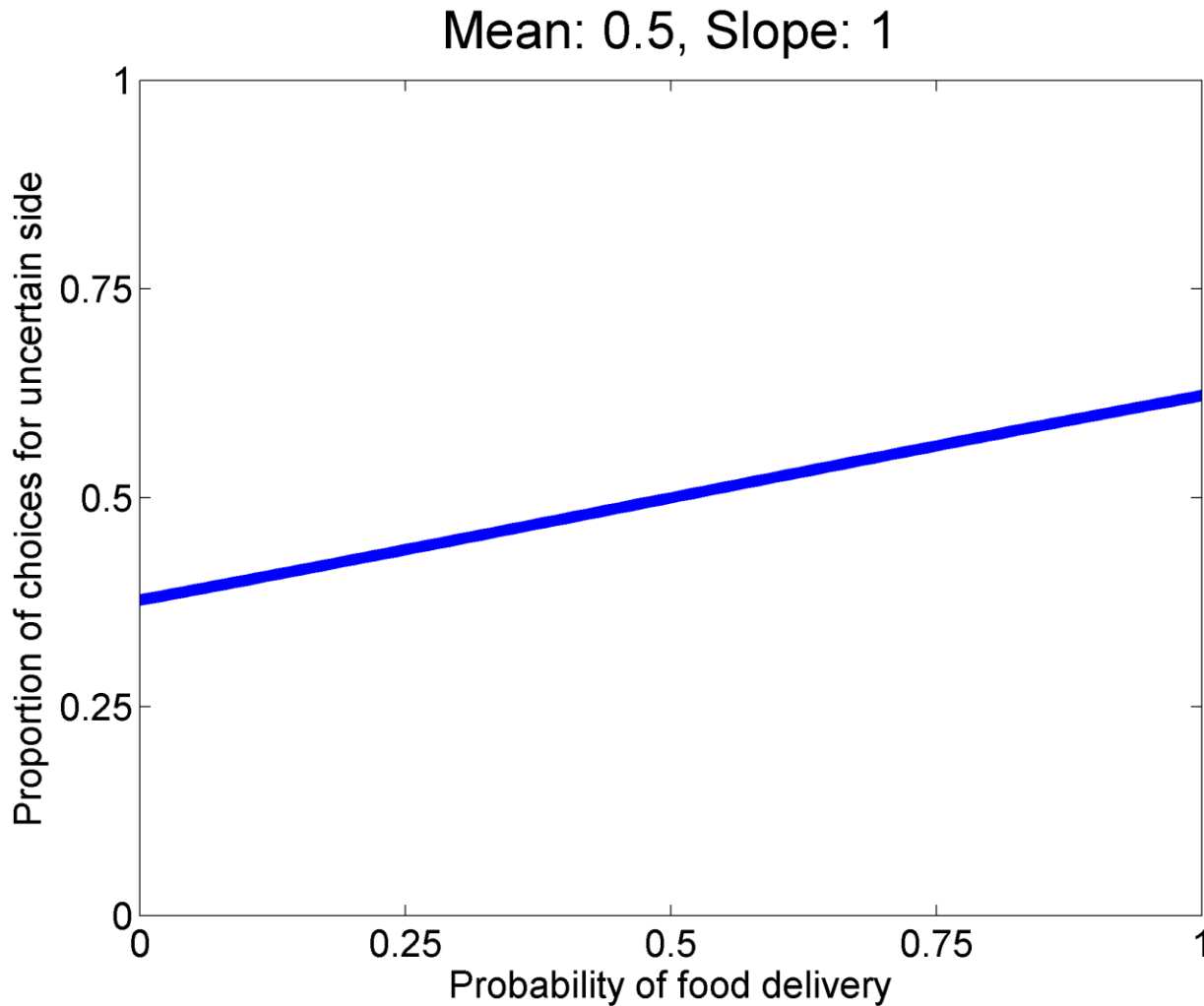
Logistic function

Mean: 0.5, Slope: 1.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

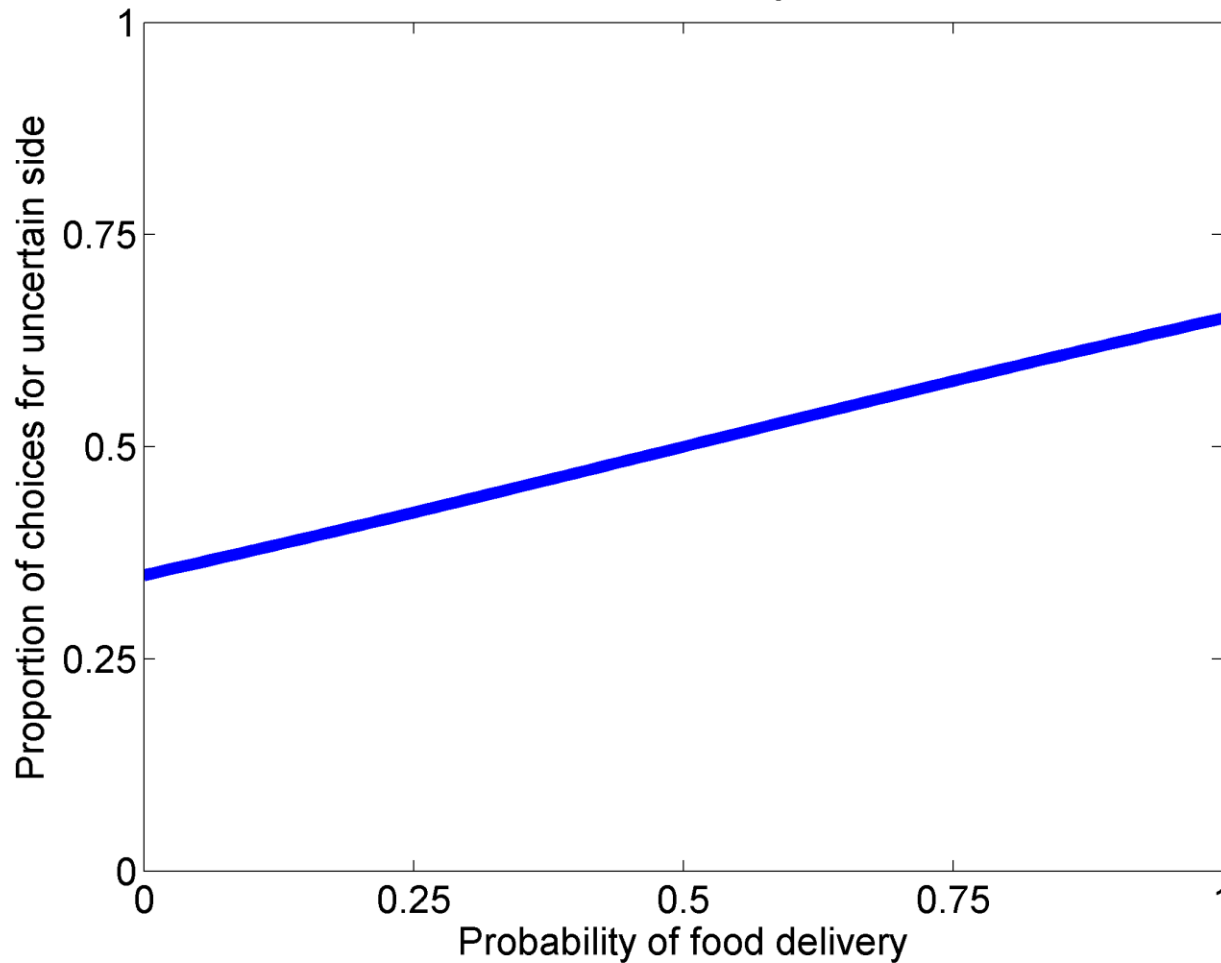
Logistic function



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

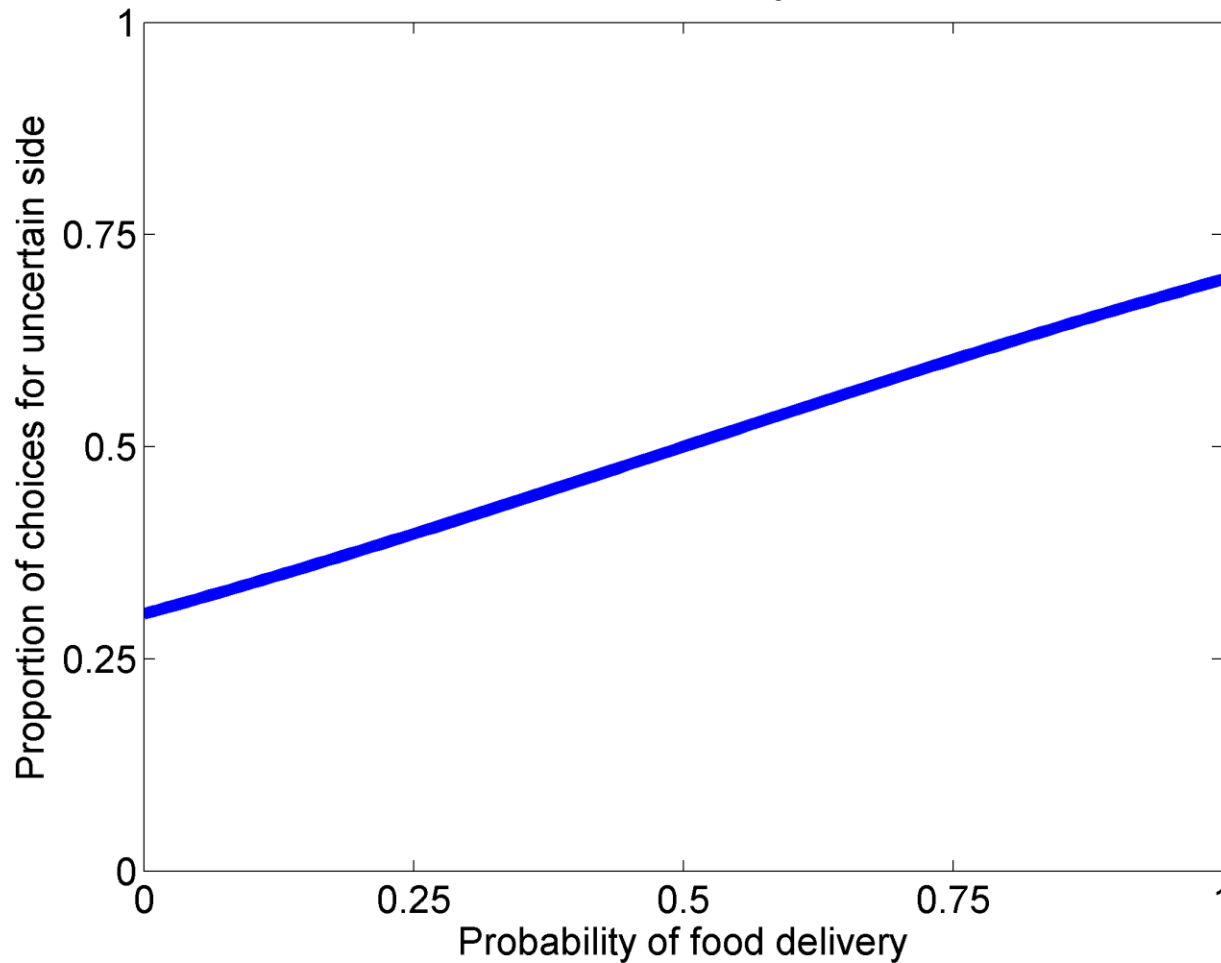
Mean: 0.5, Slope: 0.8



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

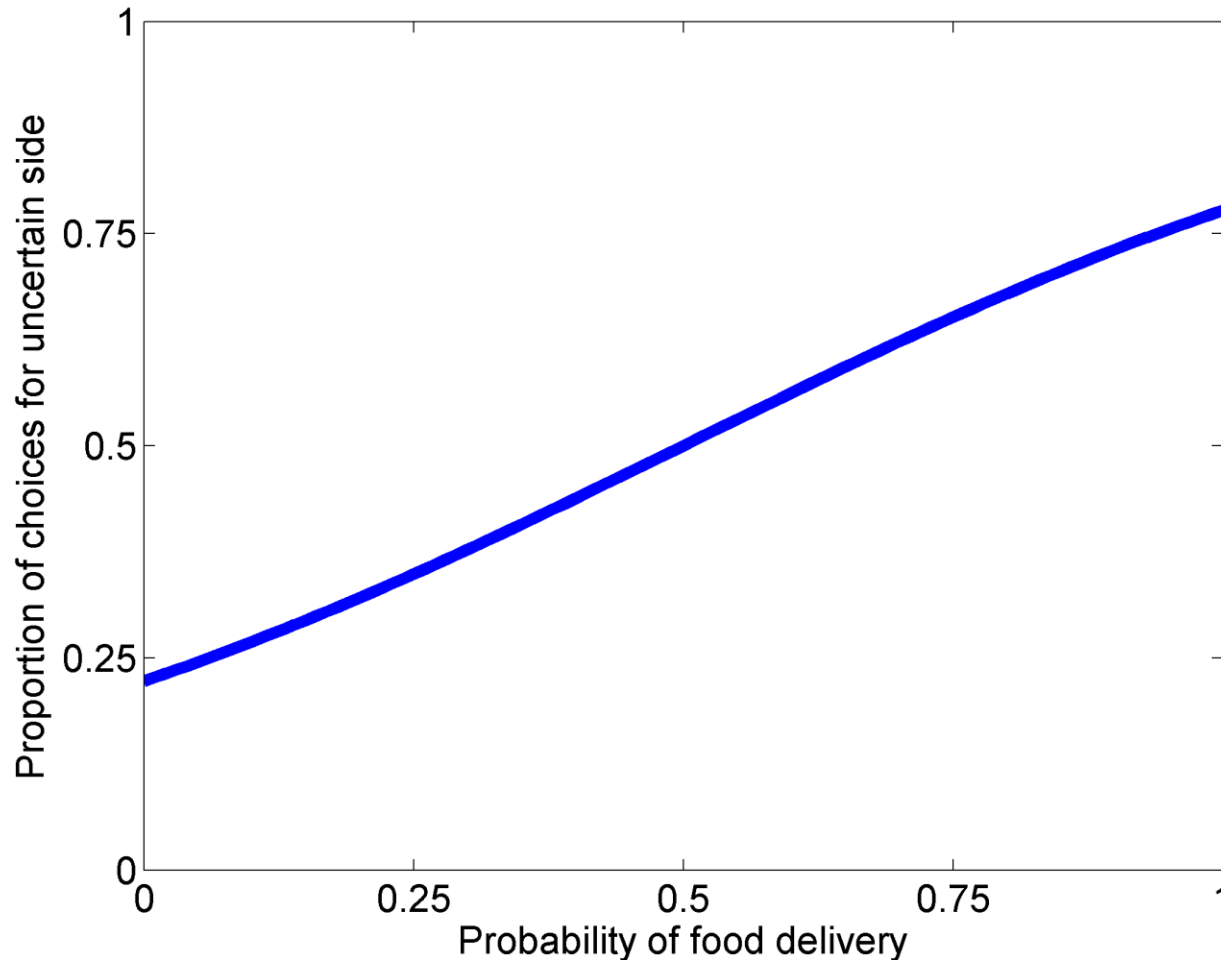
Mean: 0.5, Slope: 0.6



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

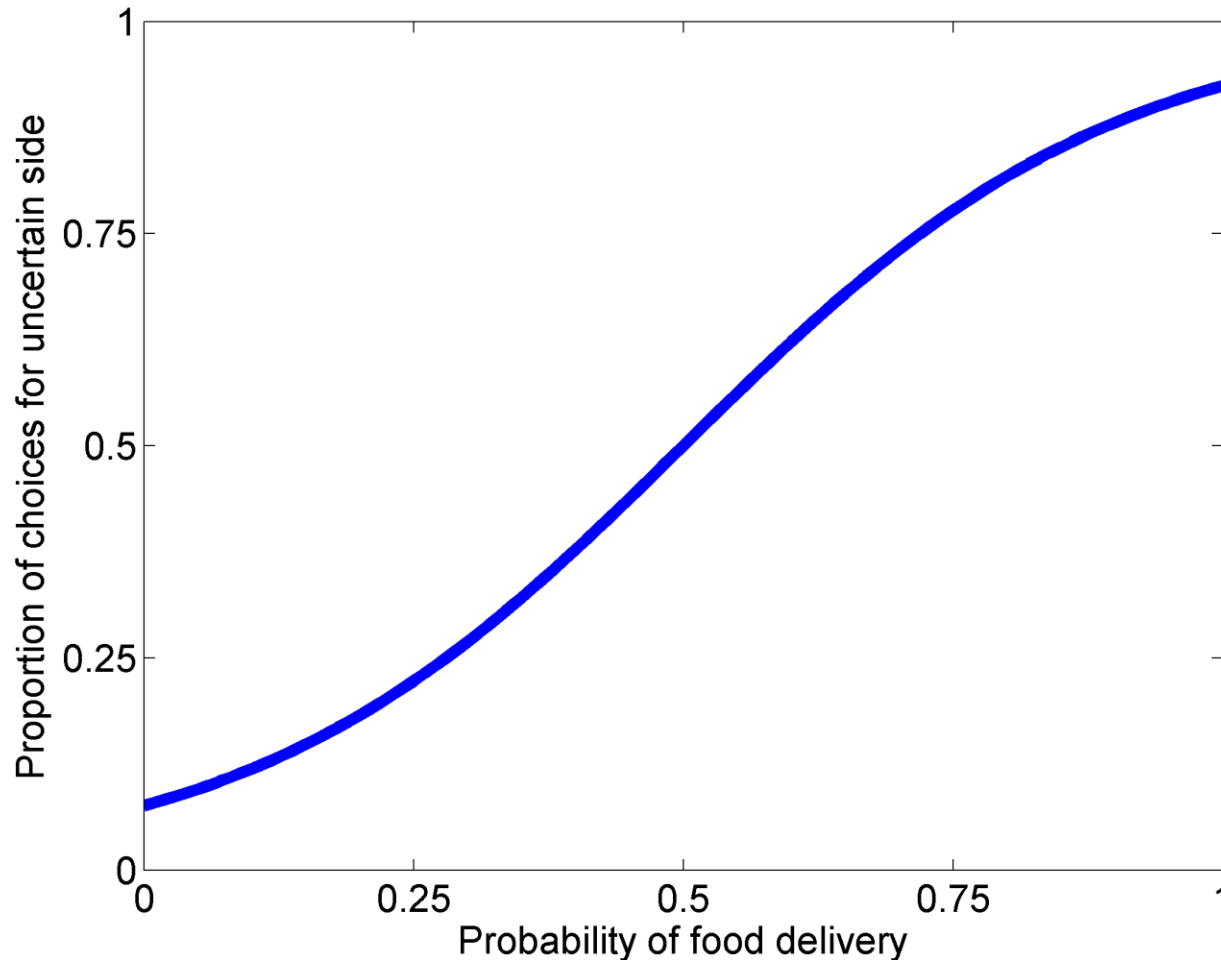
Mean: 0.5, Slope: 0.4



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

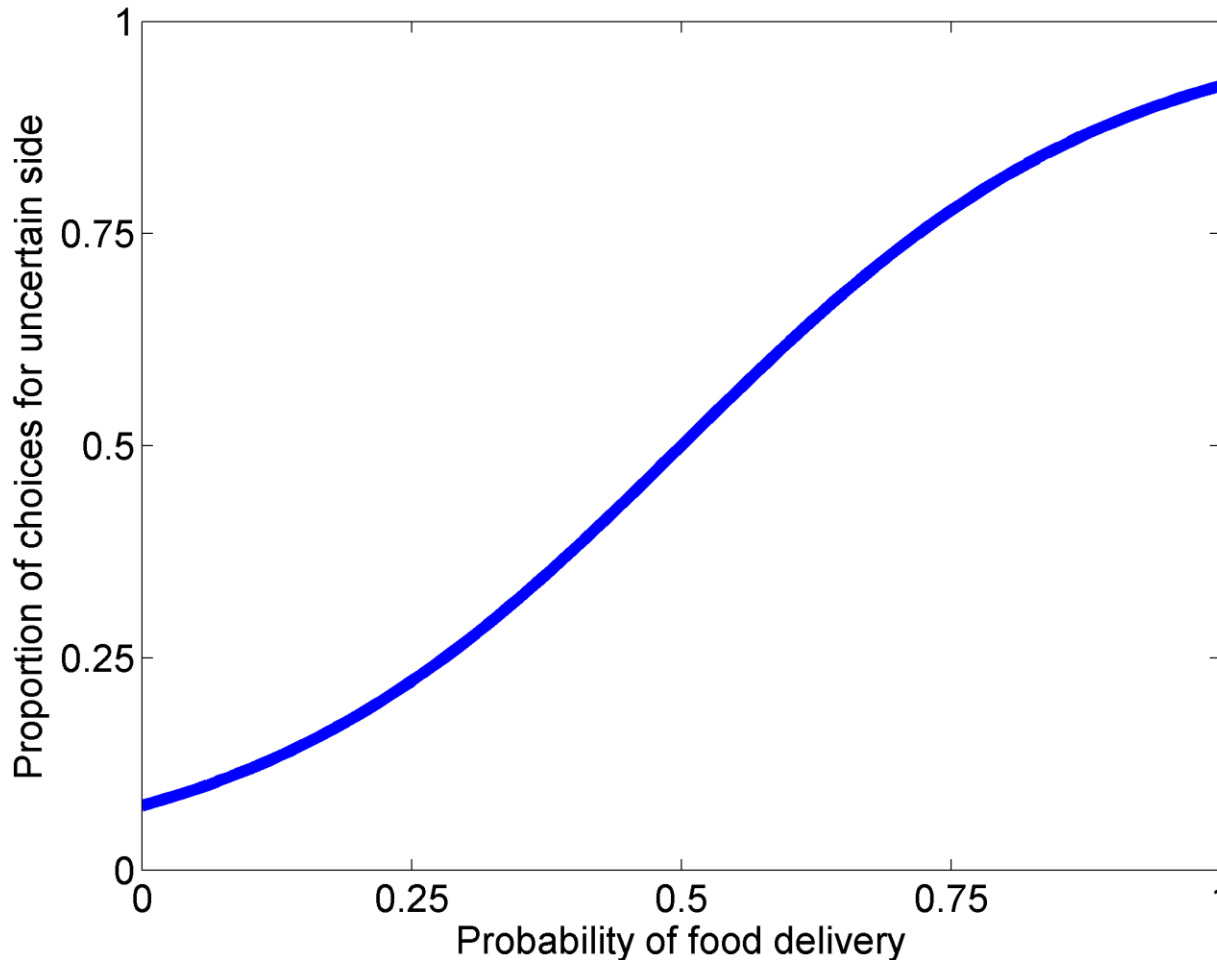
Mean: 0.5, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

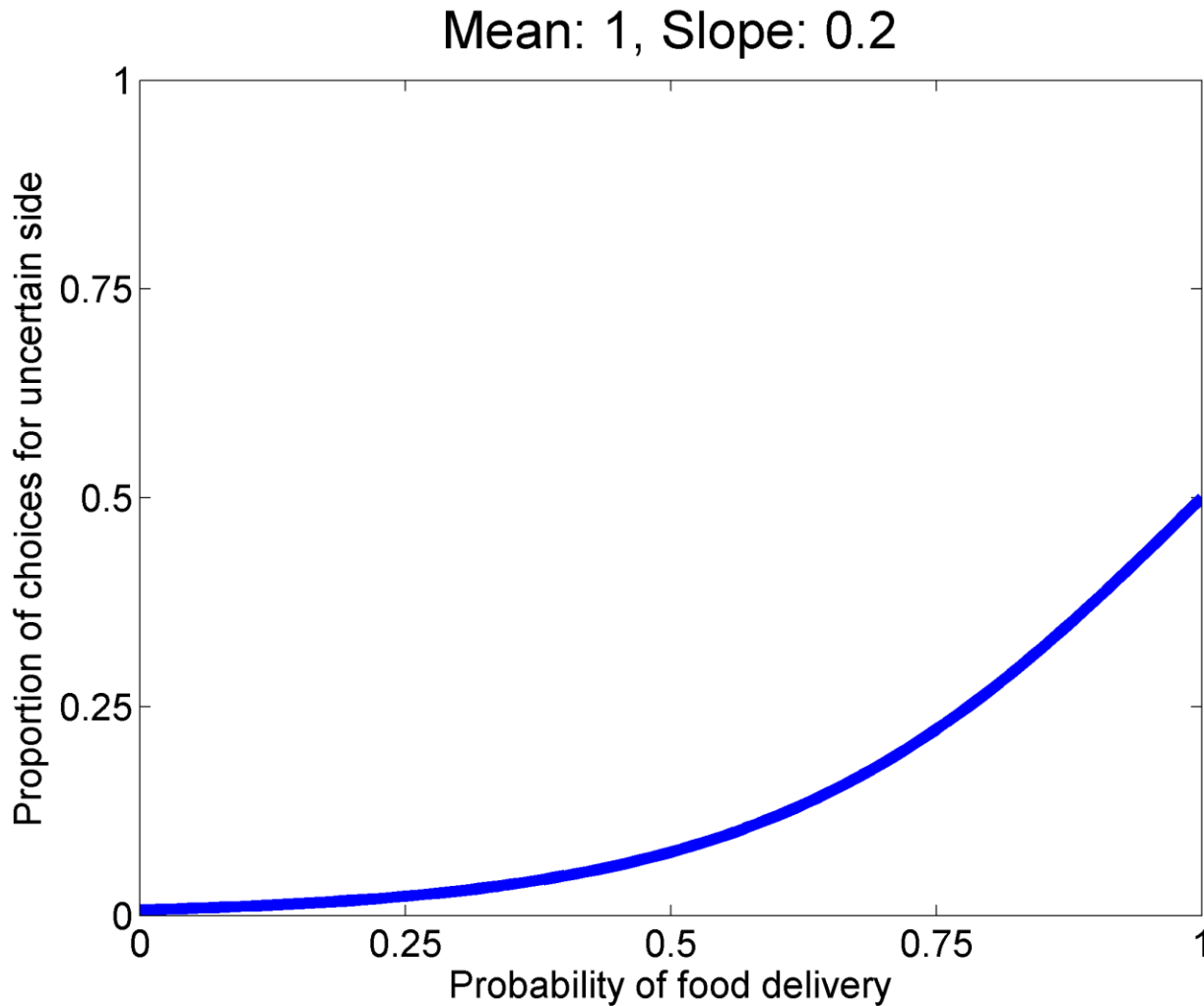
Mean: 0.5, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Smaller slope, greater sensitivity to change in probability of food

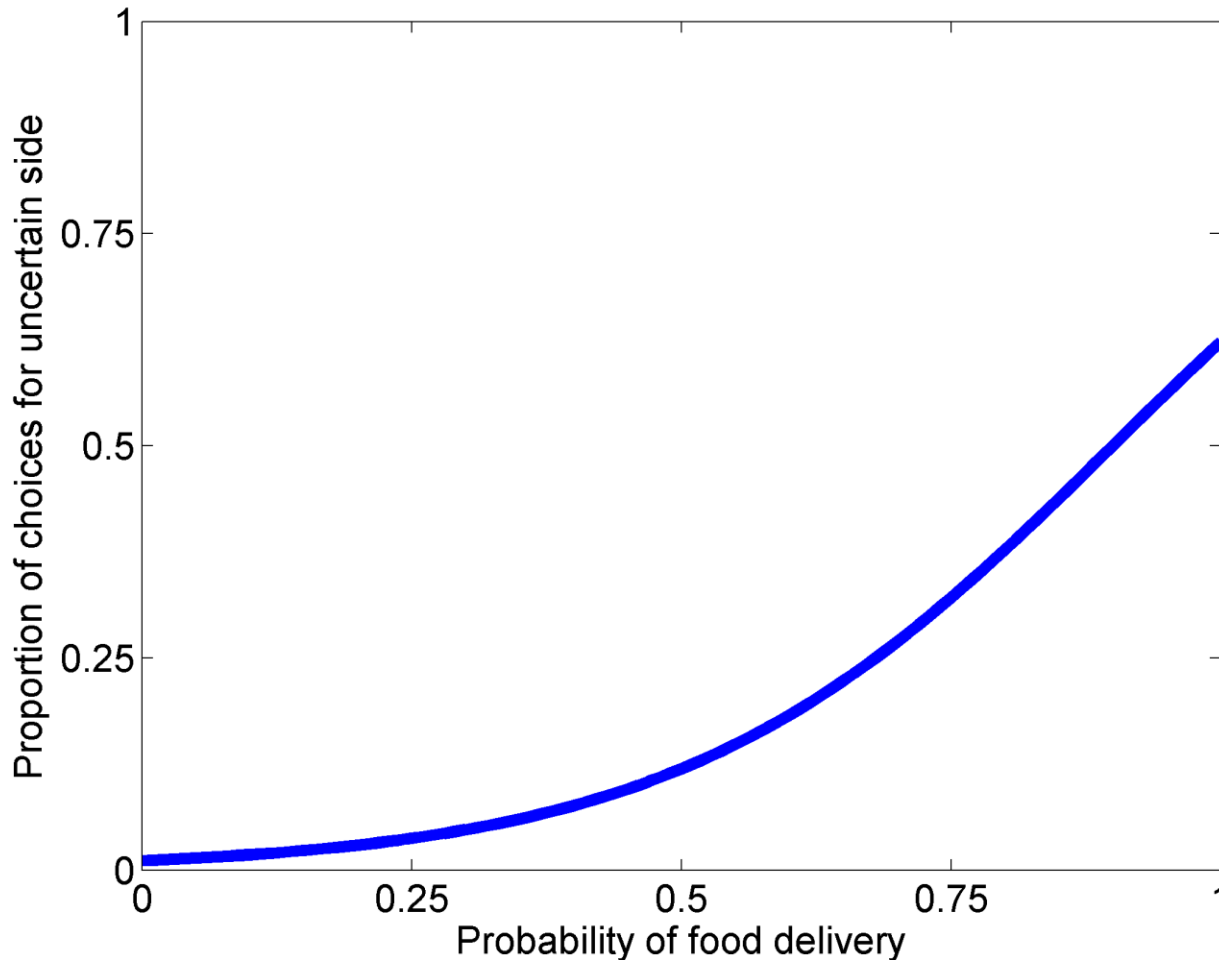
Logistic function



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

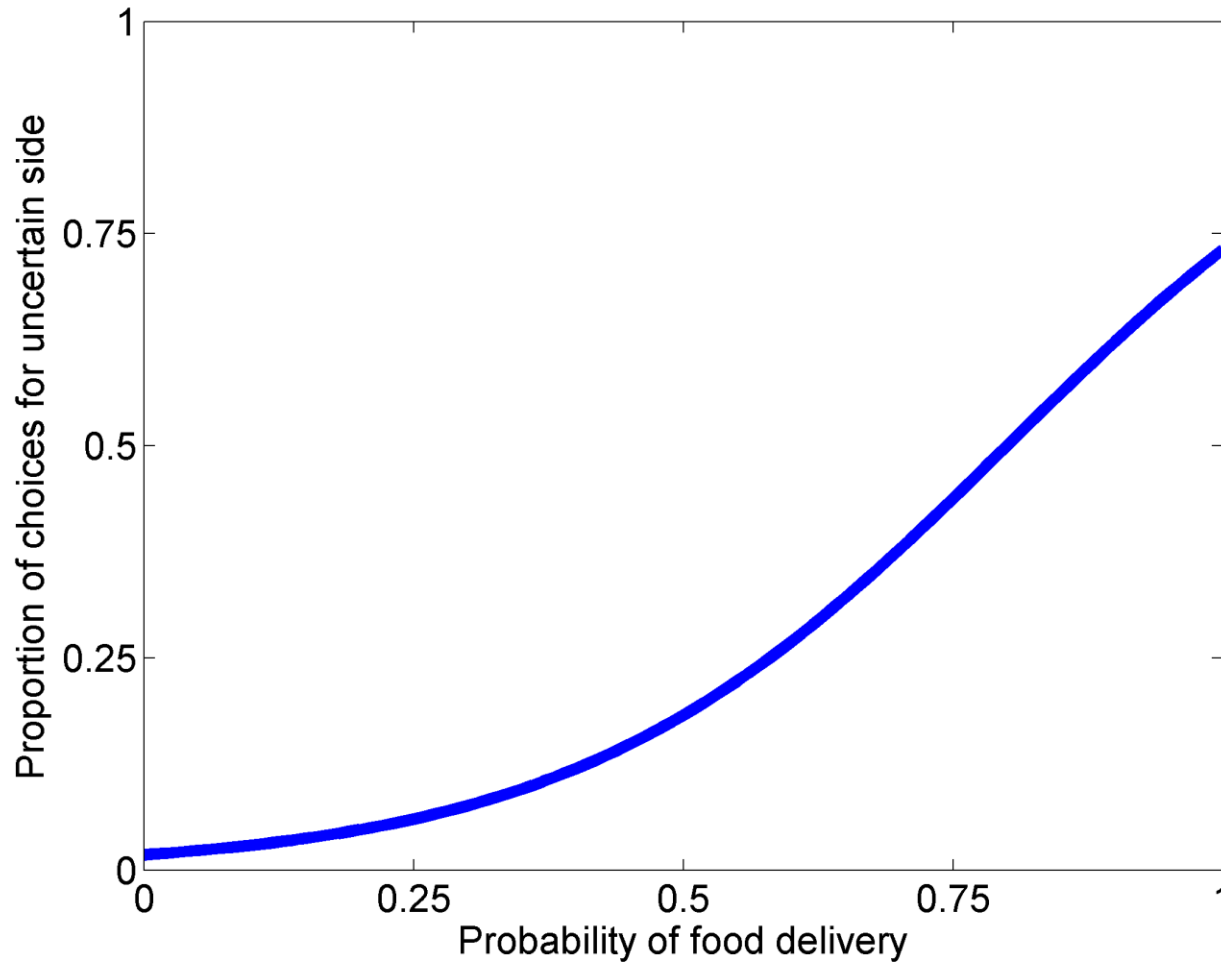
Mean: 0.9, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

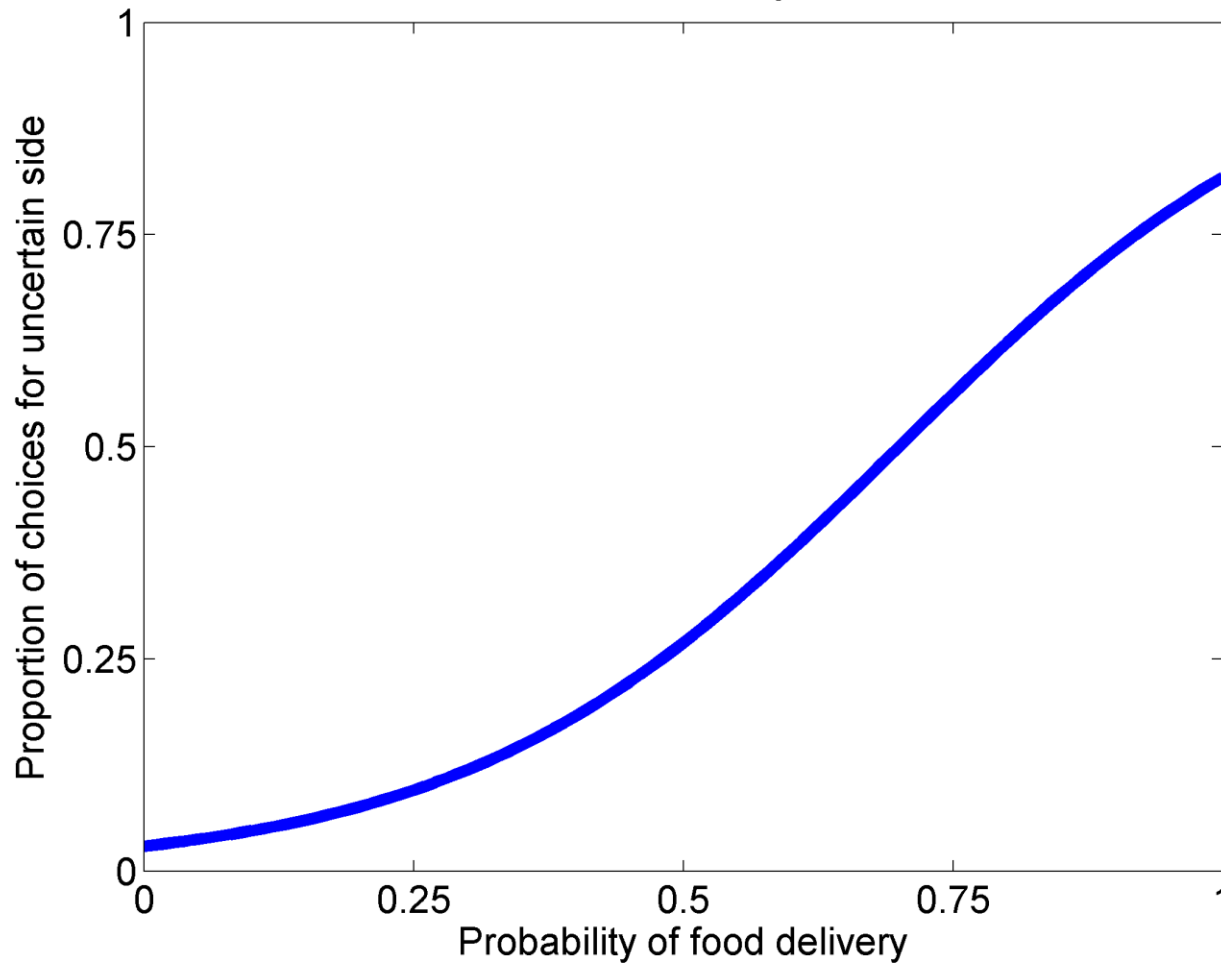
Mean: 0.8, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

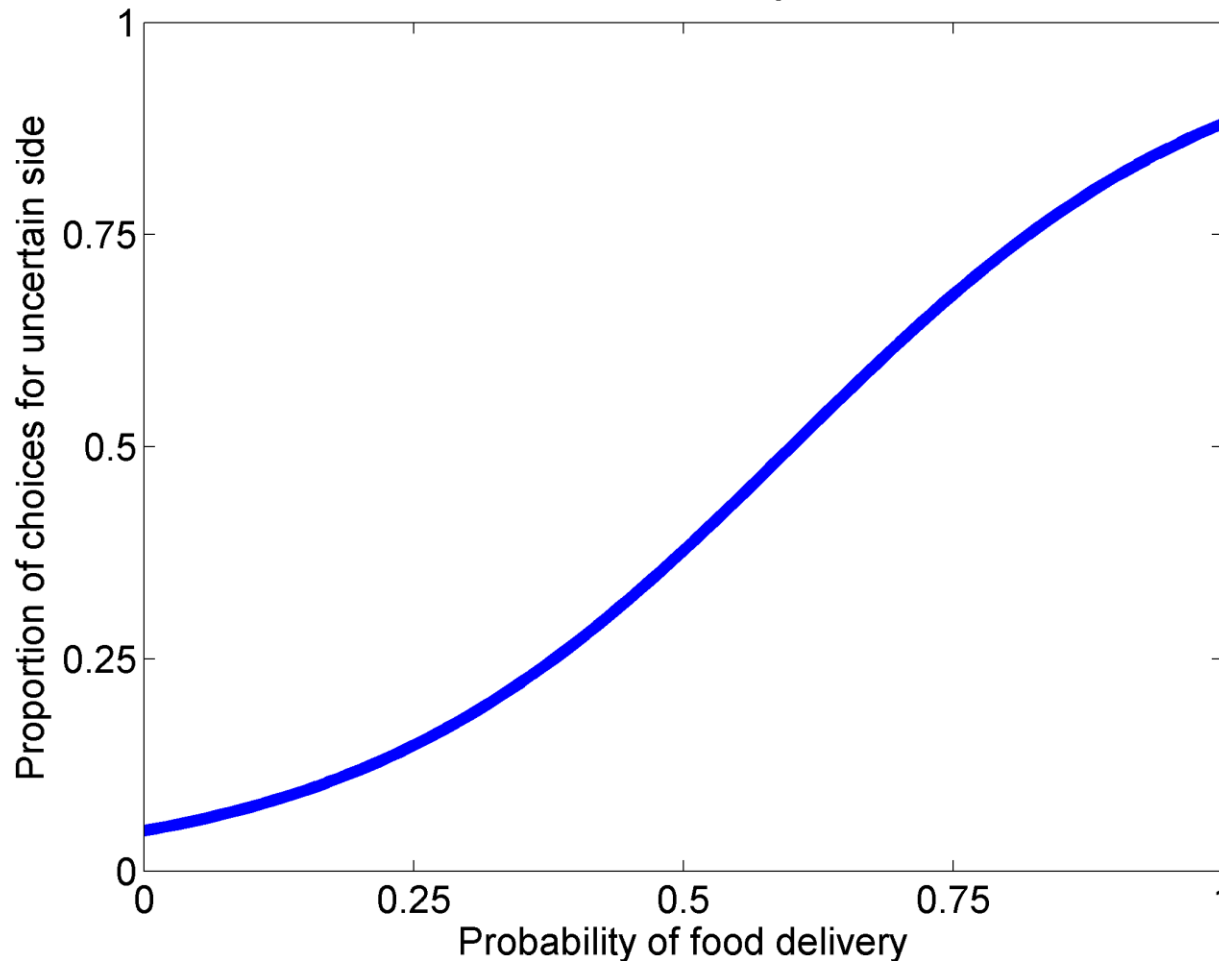
Mean: 0.7, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

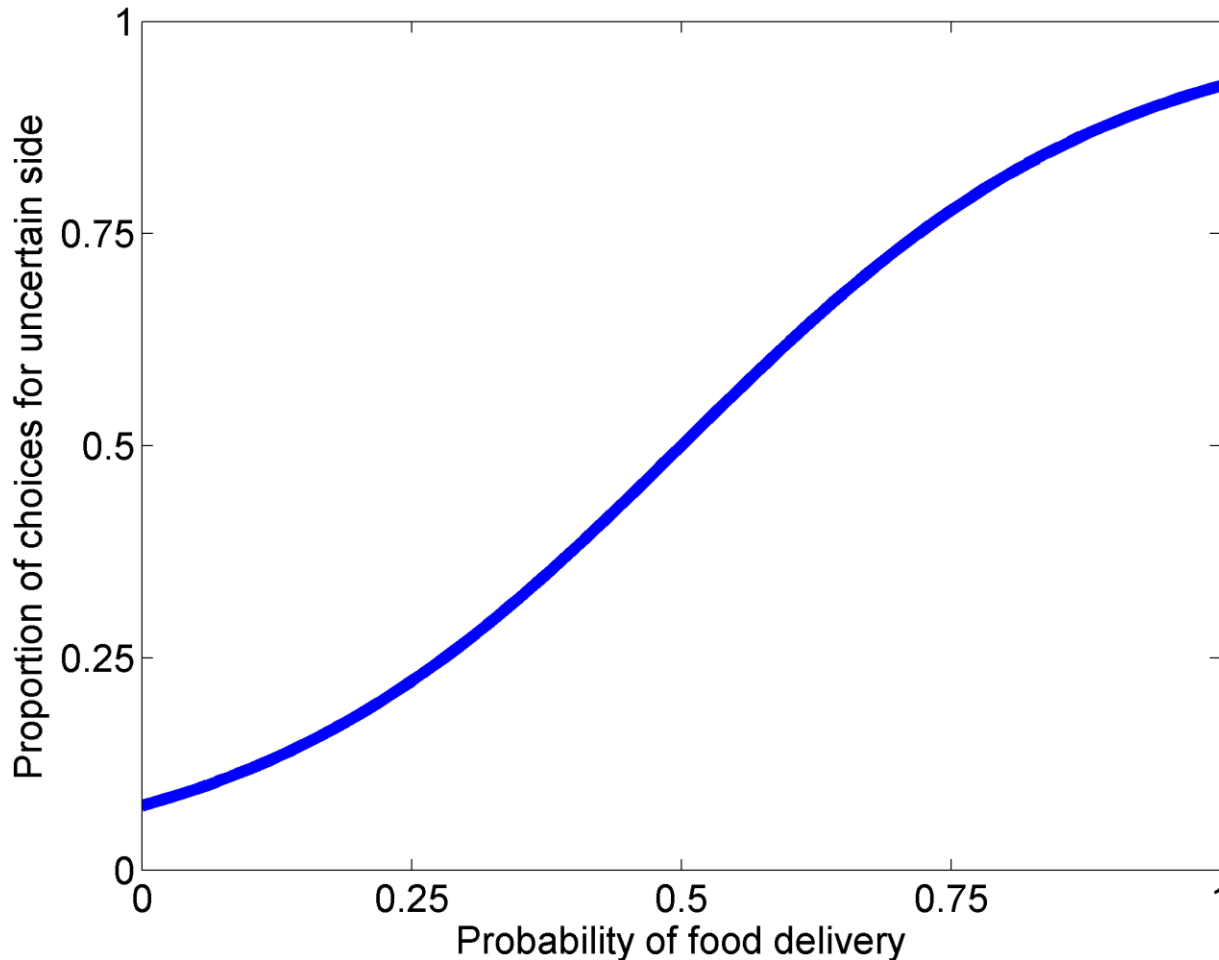
Mean: 0.6, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function

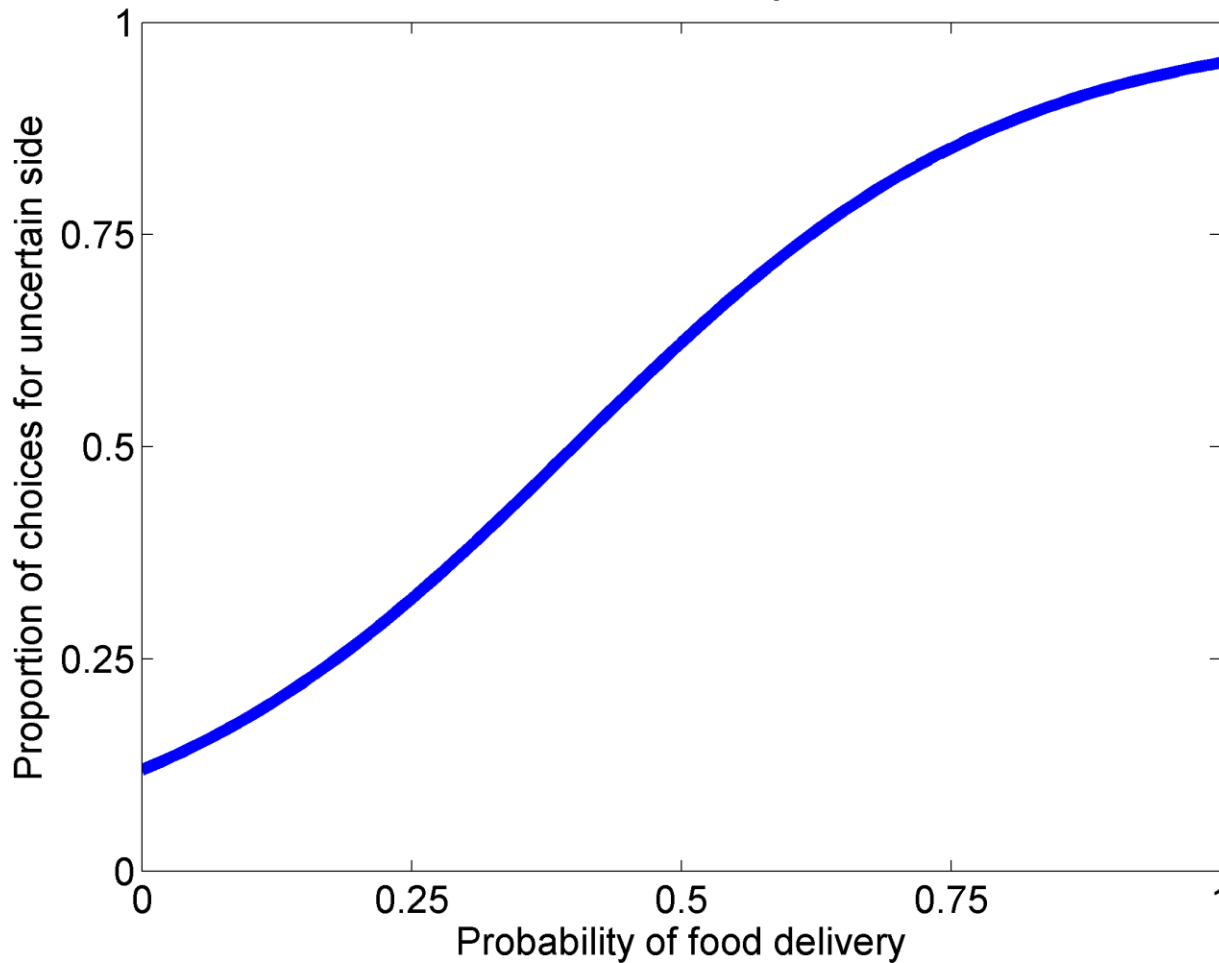
Mean: 0.5, Slope: 0.2



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

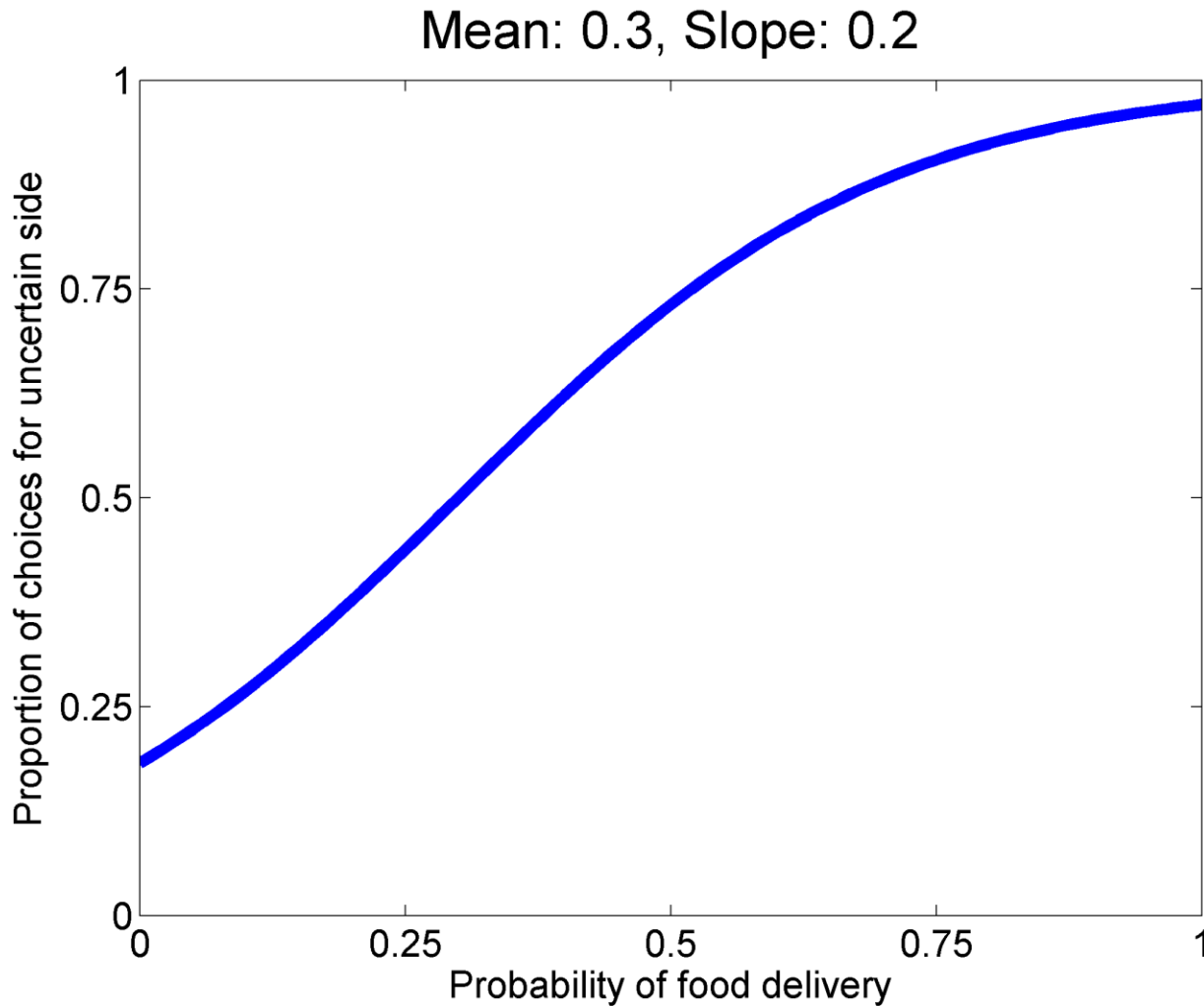
Logistic function

Mean: 0.4, Slope: 0.2



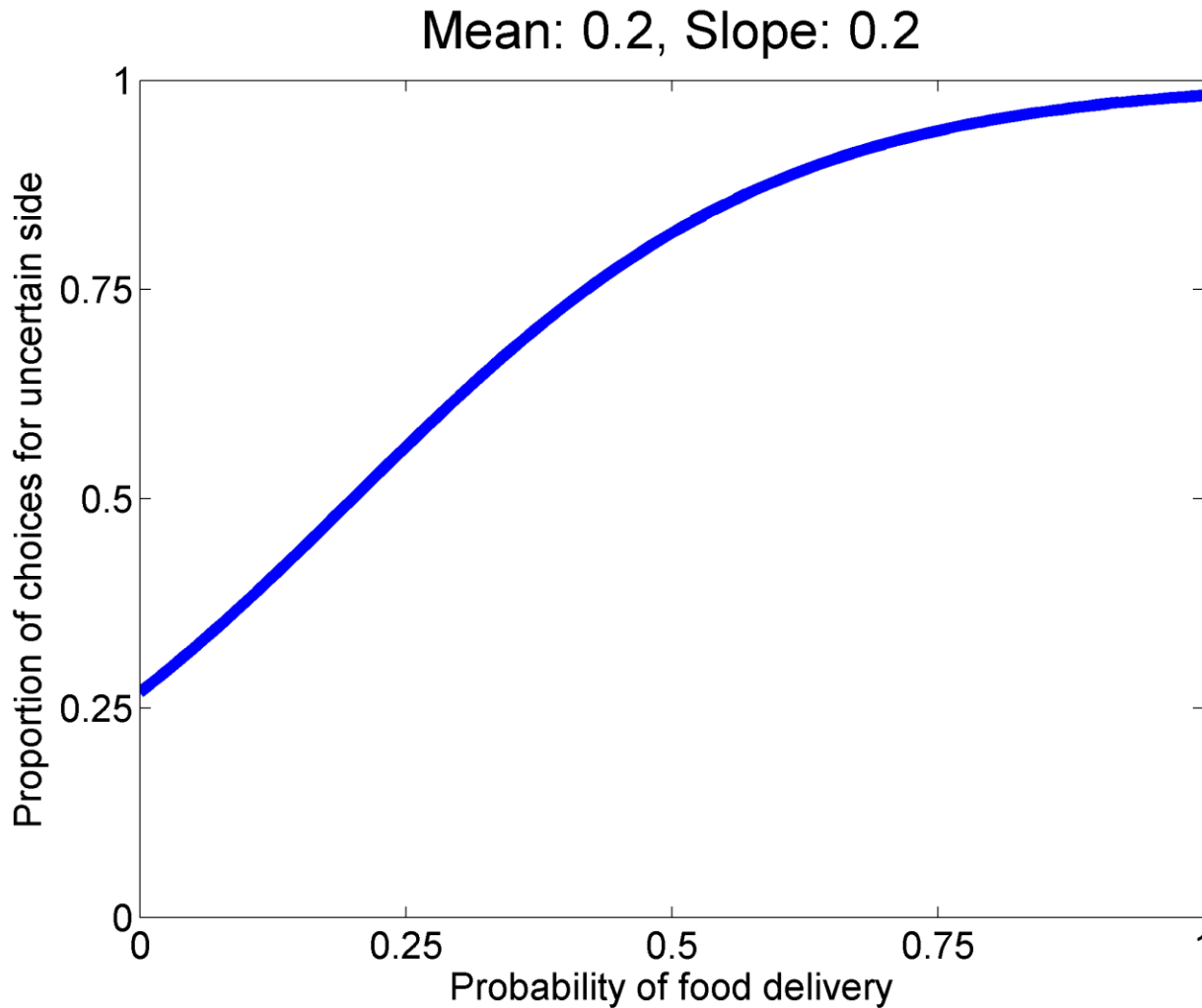
$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function



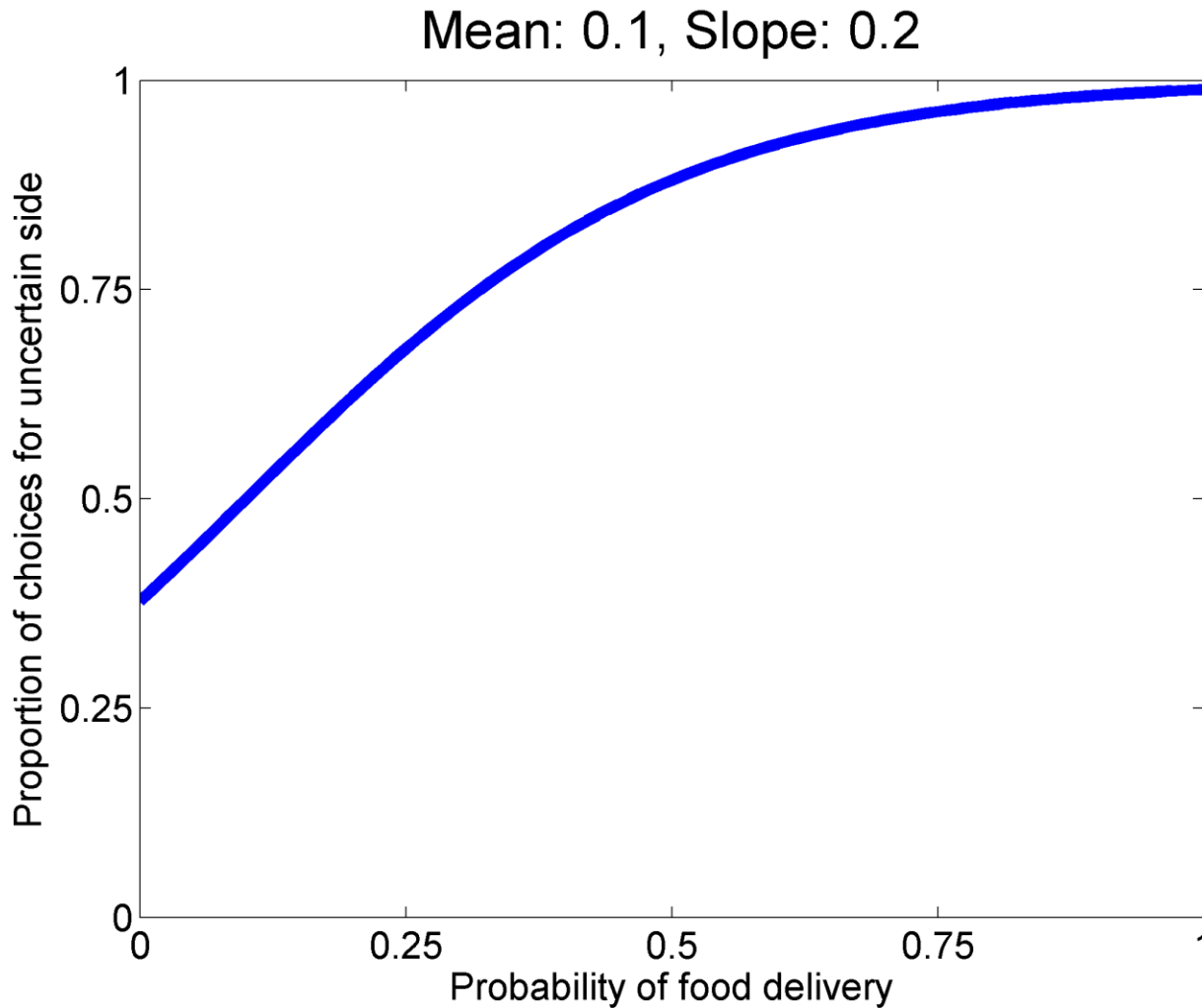
$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function



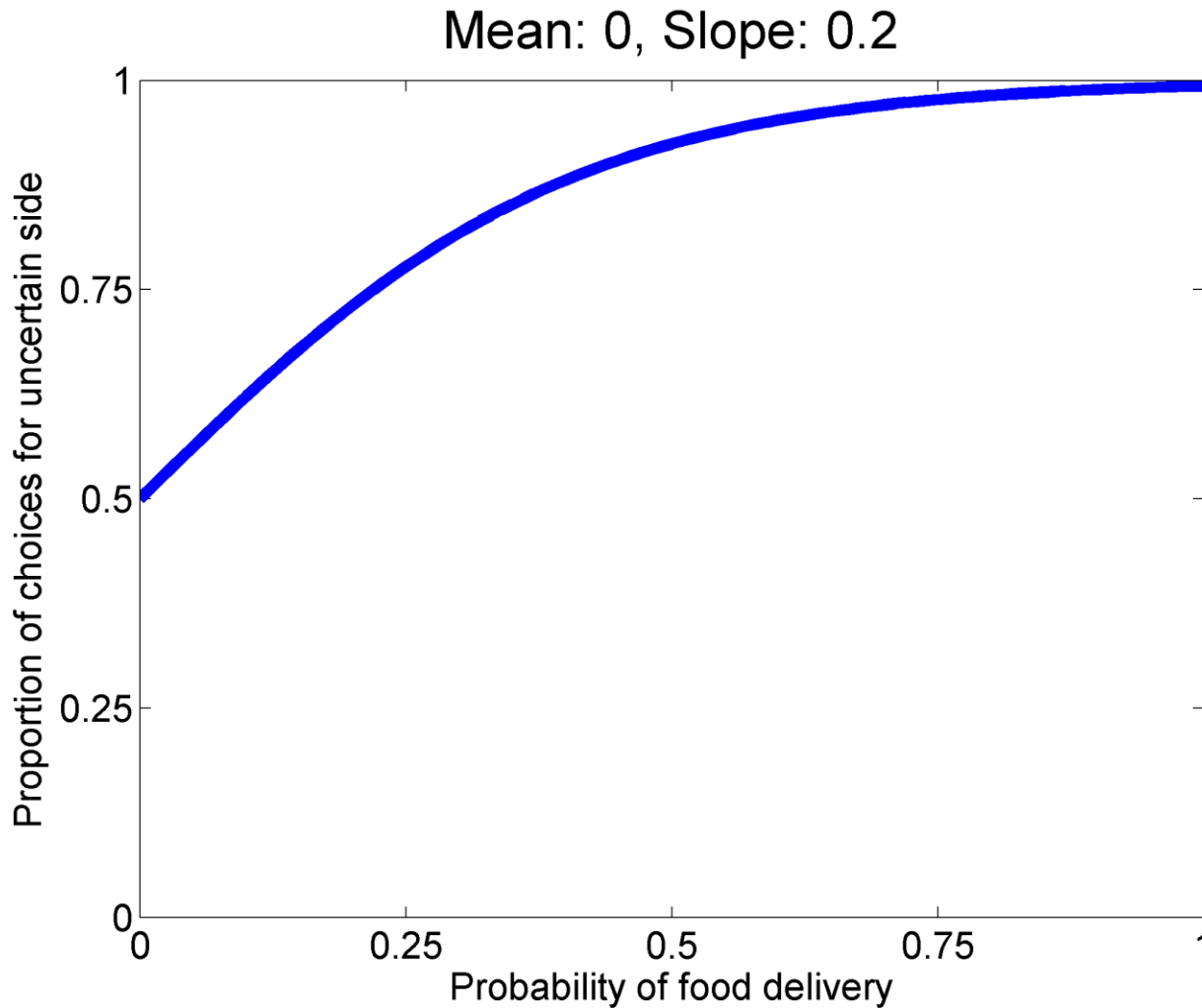
$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function



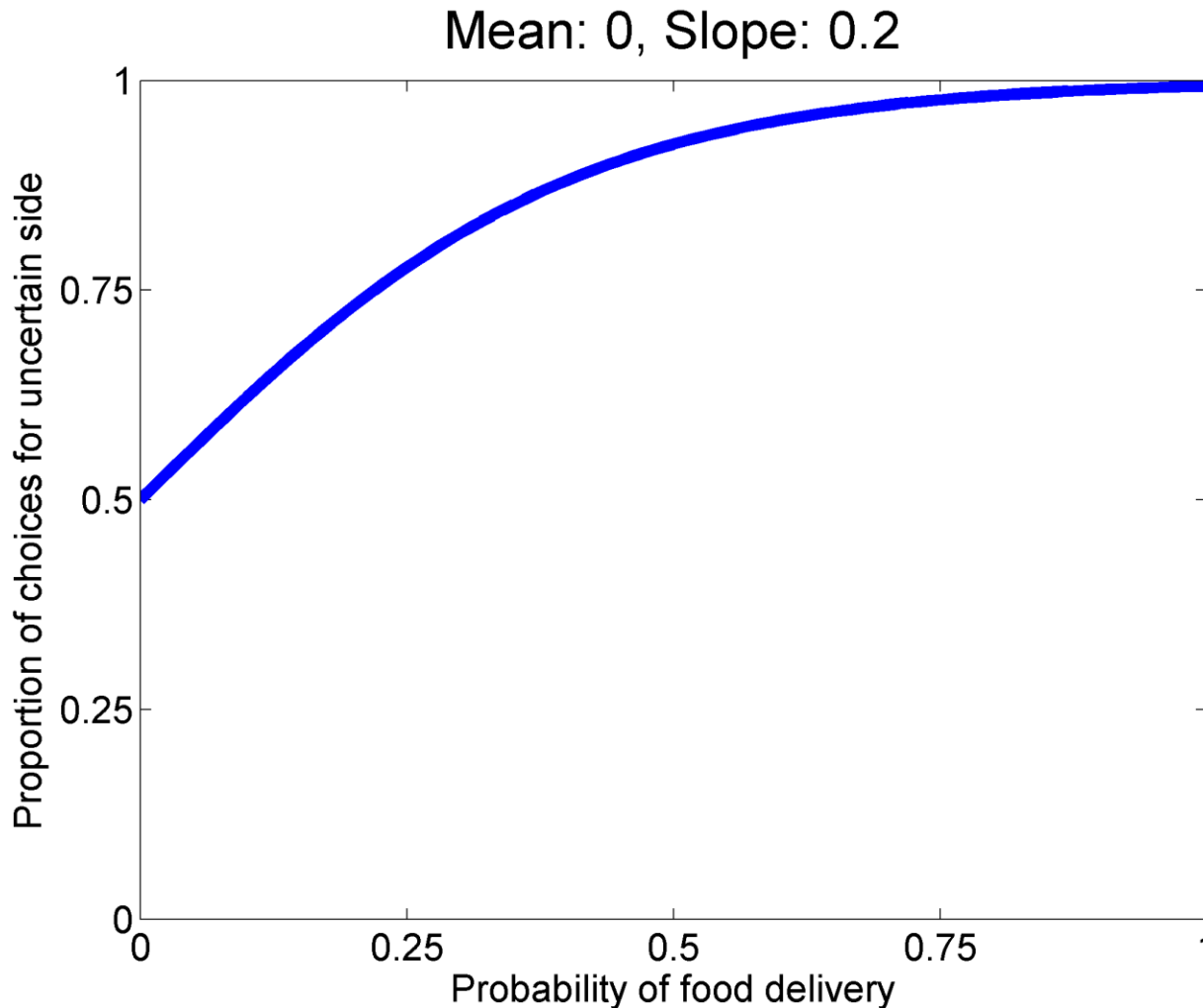
$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Logistic function



$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

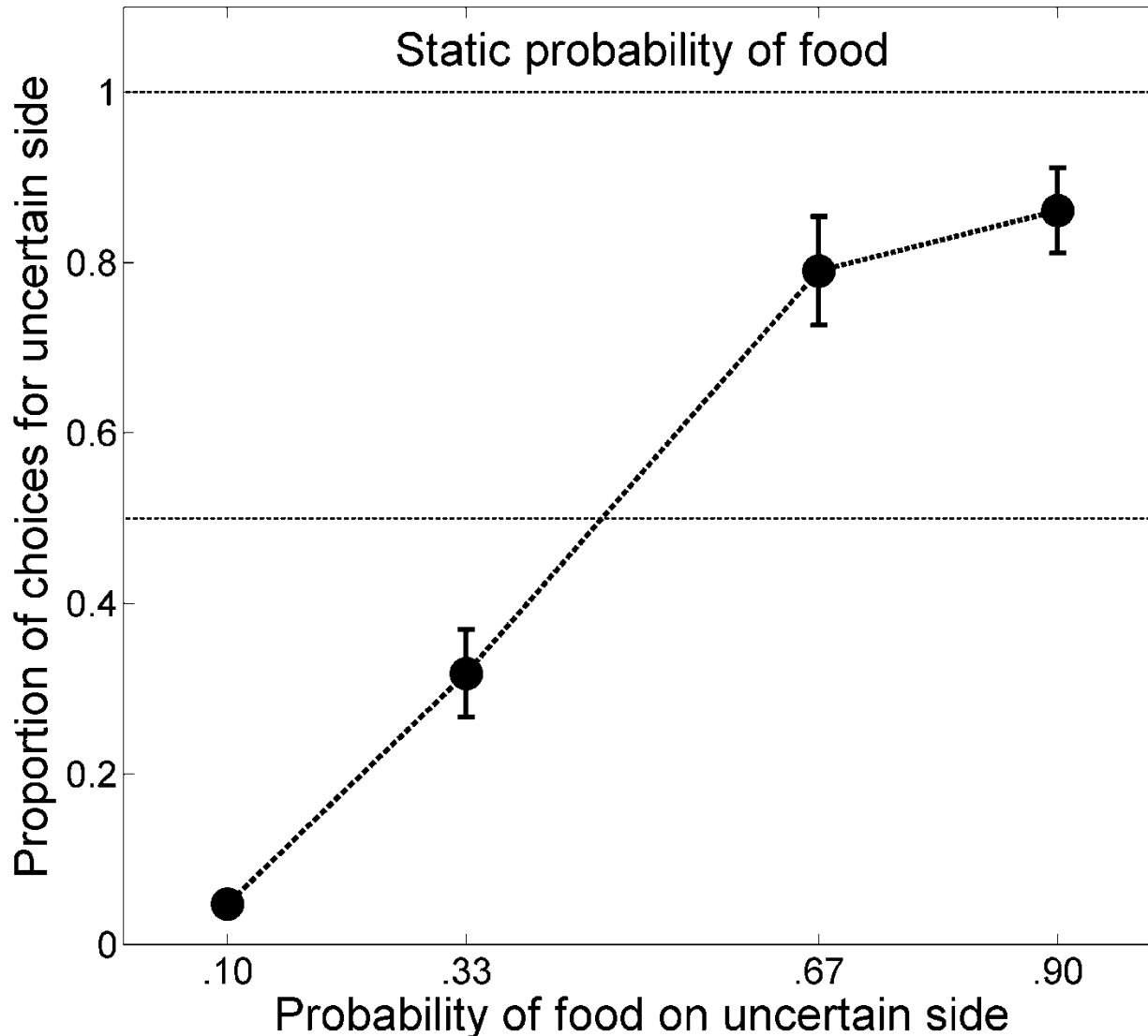
Logistic function



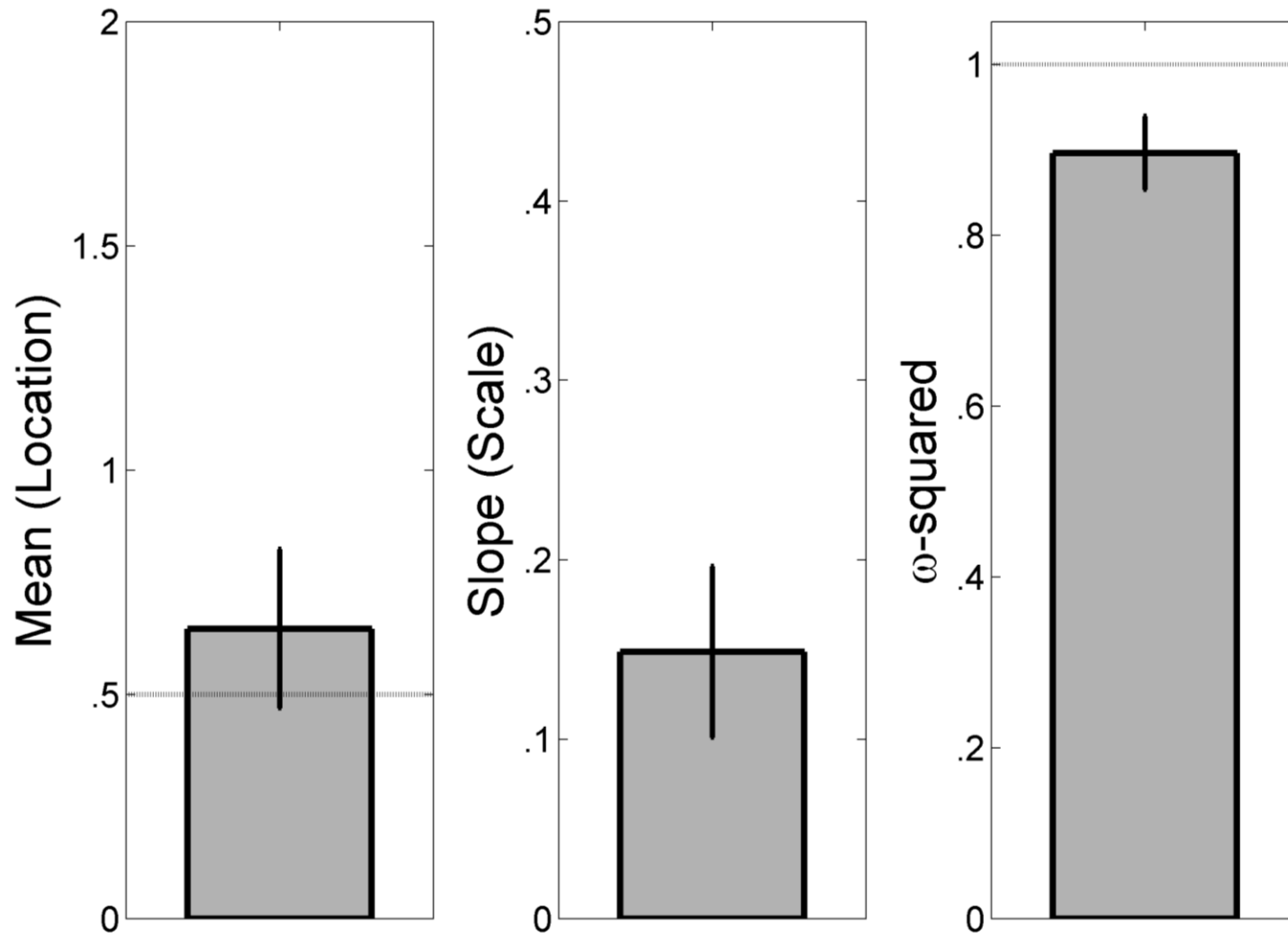
$$\frac{1}{1 + e^{\frac{-(x-a)}{b}}}$$

Higher mean, more risk averse

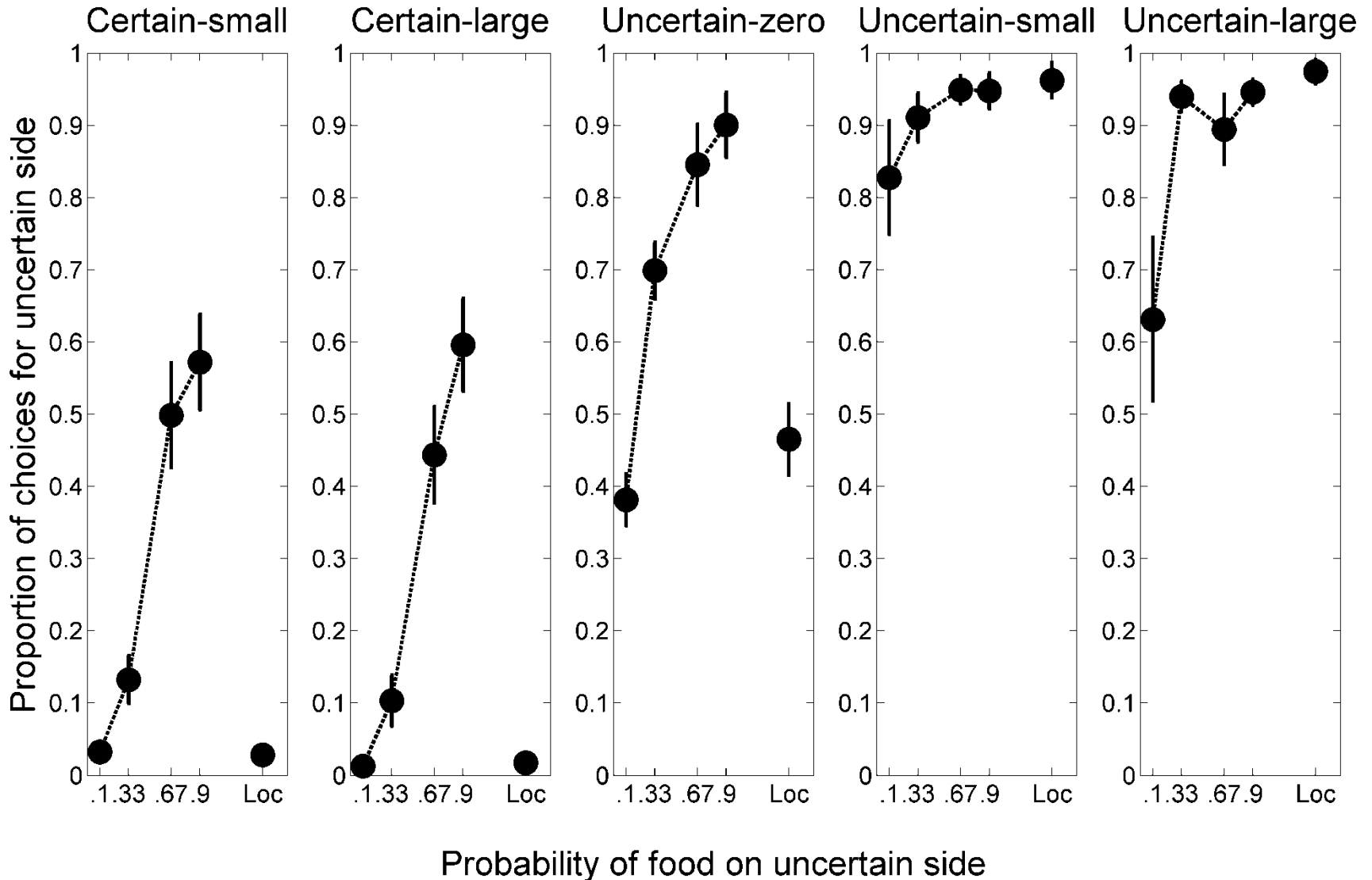
Overall choice behavior: Data



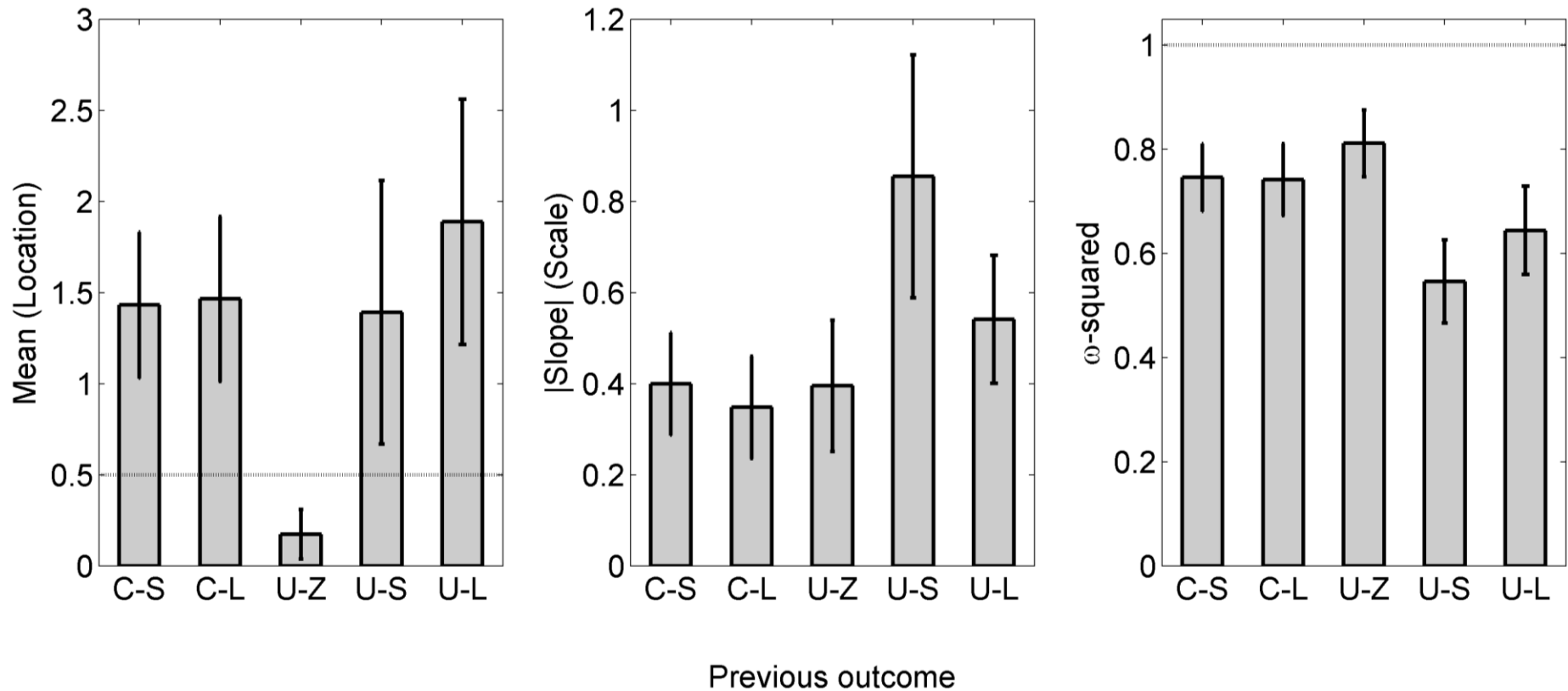
Overall choice behavior: Parameters



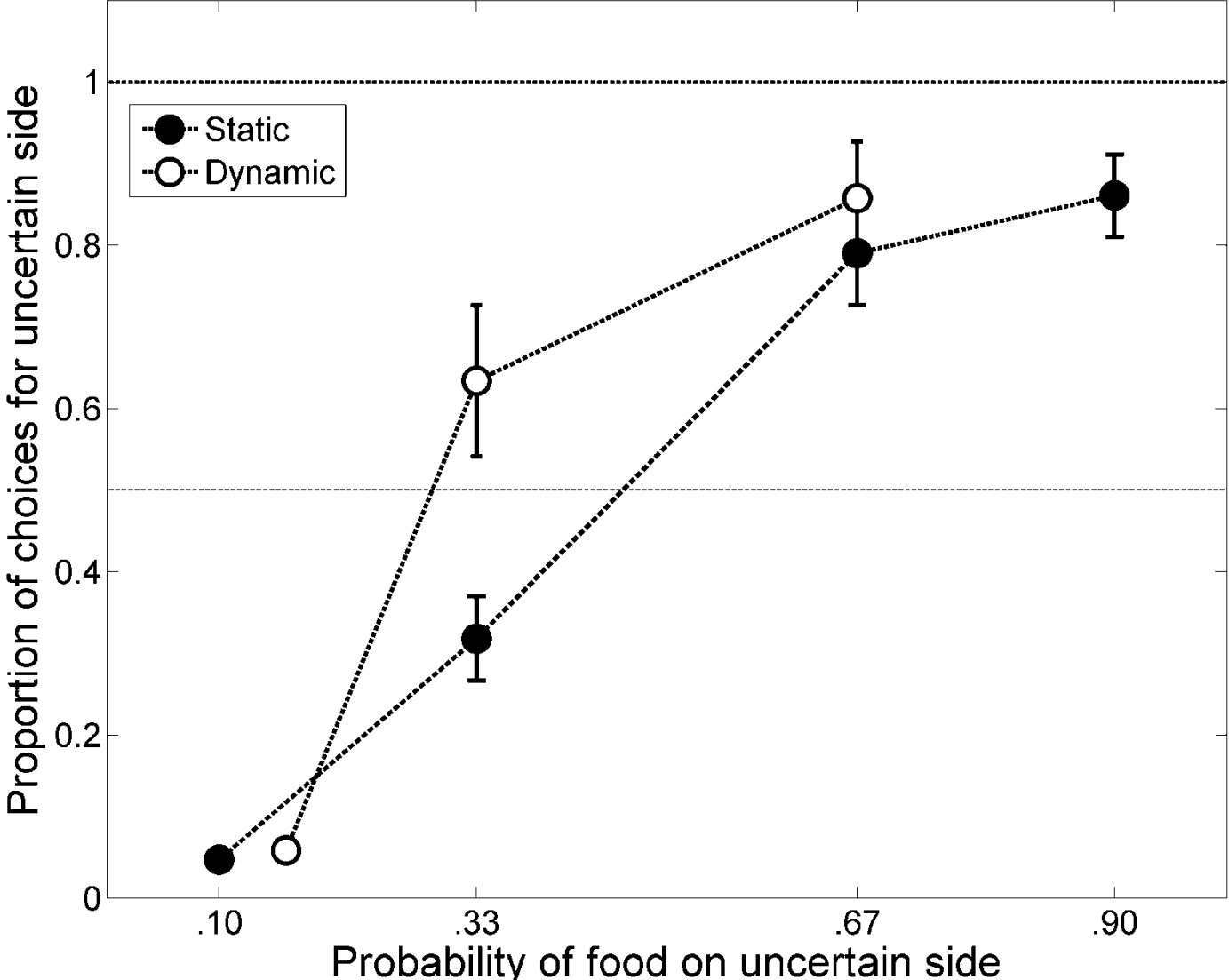
Post-outcome behavior: Data



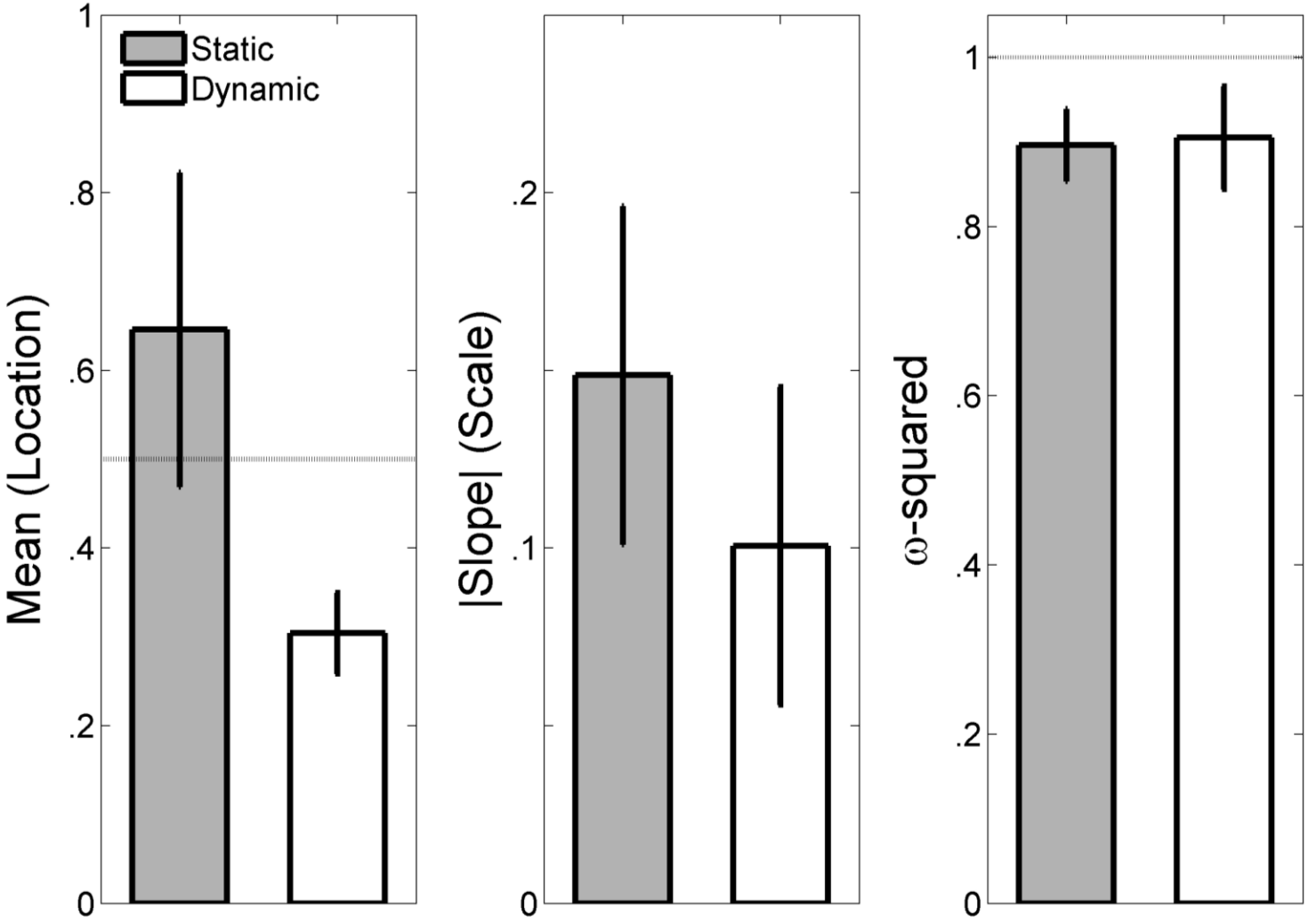
Post-outcome behavior: Parameters



Overall choice behavior: both manipulations



Overall choice behavior: both manipulations



Conclusions

- Risk prone following reward omission
- Risk aversion following reward delivery
- Sensitivity to the probability of food delivery
 - ▣ Static vs. dynamic probabilities
 - ▣ Informative for theories of choice behavior

Acknowledgements

- Drs. Kimberly Kirkpatrick and Tiffany Galtress
- Patricia Gooldy, Jacob Clarke, Marina Vilaro
- My rats

Questions?