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### The Free Operant Yields Both Frequency and Ratio Probabilities

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Presented in the Panel Discussion:  
Can We Measure the Probability of a Free Operant?

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### Malott's Question

"The pigeon pecked the key 60 times in 60 seconds. What's the response probability? Hint: it ain't 1.0, 0.1, or .01. Lots of luck."

### Lindsley's Clarification

Malott is confusing two very different kinds of probability here.

- First he gives us data on a Frequency Probability ( 60 / minute ).
- Then he asks us to assign a value to a Ratio Probability for which he has given us no data ( it ain't 1.0, 0.1, or .01 ).

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### Frequency Probability of Response

"Probability of response:

The probability that a response will be emitted within a specified interval, inferred from its observed frequency under comparable conditions."

..From Glossary in Ferster and Skinner, 1957, Schedules of Reinforcement, Appleton-Century-Crofts, Inc, New York. Page 731.

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### Ratio Probability of Response

"Probability of response:

The ratio between the occurrence of an event and the total average number of cases necessary to ensure its occurrence.

In describing the odds that a single card drawn from a playing deck will be the queen of hearts ( 1 in 52, or  $P = .019$  )."

..From Downie and Starry, 1977, Descriptive and Inferential Statistics, Harper & Row, New York. Page 70.

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### Comparison of Probability Types

	FREQUENCY	RATIO
Operant:	Free	Controlled
Psychologist:	Skinner	Thorndike, Tolman, Hull
Sample:	No. of minutes	No. of Trials
Formula:	No. / minute	No. / Total No.
Dimensions:	2	0
Statistics:	Descriptive	Inferential
Magnitude:	Continuum	Yes / no
Lay terms:	How often	What odds
Use:	Projection	Prediction

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### Calculating Ratio Probabilities from Frequency Projections

Carl H. Koenig, Doctoral Dissertation, Charting the Future Course of Behavior University of Kansas, April 1972.

- Charted Frequencies on Standard Celeration Chart ( Frequencies on multiply scale ).
- Projected a course of response frequencies out 10 to 14 days from 10 to 14 base days for 1186 behavior analysis projects.
- Calculated the ratio of frequencies that fell outside the projected courses.
- Calculated the ratio of cases (  $P = .40$  ) that met the criterion of 70% of frequencies within the projected course (  $P = .70$  ).

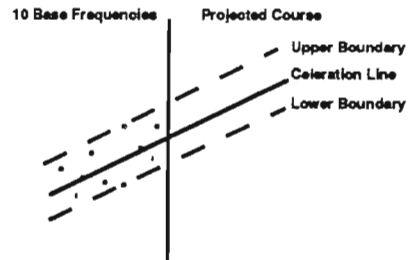
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### Projecting Frequency Course

- 1 Draw quarter-intersect celeration line through first 10 to 14 base frequencies.
- 2 Draw an upper course boundary line parallel to celeration line through frequency farthest above it.
- 3 Draw a lower course boundary line parallel to celeration line through frequency farthest below it.
- 4 Project the course enclosed by these two boundary lines 10 to 14 frequencies into the future.

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### Projecting Frequency Course



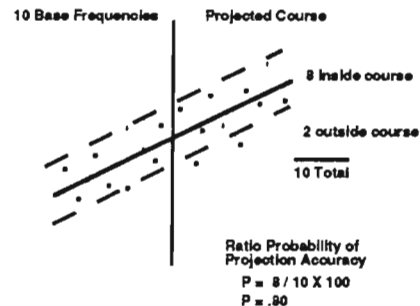
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### Measuring Projection Accuracy with Ratio Probability

- 1 Count frequencies inside projected course.
- 2 Divide by total frequencies that were to be projected.
- 3 Convert to a percentage or ratio probability

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### Measuring Projection Accuracy



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### Koenig's Results 1972

- Celeration lines fit on multiply scales better than add scales.
- Quarter-intersect celeration lines fit as well as least-squares lines and are easier to calculate and draw.
- Up bounce ( X2.5 ) is very close to down bounce ( X3.0 ).
- Projecting 10 to 14 frequencies from a base of 10 to 14 frequencies is 70% or more accurate in 40% of the 1186 cases.
- Projecting 5 to 7 frequencies from a base of 10 to 14 frequencies is 70% or more accurate in 50% of the 1186 cases.

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### Conclusion

#### Question:

Can we measure the probability of a free operant?

#### Answer:

Yes, we can measure both:

- its Frequency Probability and
- the Ratio Probability of the accuracy of projecting its frequencies.

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