

# The Matching Law

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HiAk

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## Definitions

- The Matching Law states that responses are allocated to the richest reinforcement schedule(s).
- The Matching Law has been shown in both nonhumans and humans.

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## Herrnstein (1961)

- Concurrent VI VI schedules of reinforcement.
- 1.5 s COD (Change over delay)



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## The Matching Law

- $r_A$  be four reinforcers per min and
- $r_B$  be one reinforcer per min
- What will the pigeon do?
  - Switching between the schedules at random?
  - Spending all the time at A?
- The matching law predicts
  - $R_A/R_B = r_A/r_B = 4/1 = 4$ .
  - The pigeon should make Response A four times more than the Response B

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## Ulike formler

B = Behavior  
R = reinforcers

$$B_j / (B_1 + B_2) = R_j / (R_1 + R_2)$$

B = Behavior  
r = reinforcers

$$\frac{B_1}{B_1 + B_2} = \frac{r_1}{r_1 + r_2}$$

R = responses  
r = reinforcers

$$\frac{R_1}{R_1 + R_2} = \frac{r_1}{r_1 + r_2}$$

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## Why this is important?

- One of the goals of behavior analysis is to predict behavior
- Focus on functional relationship between environmental events and behavior
- Rate of reinforcement is an environmental event.
- Matching law is such a functional relationship
- Matching law could help to predict more complex behavior

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## Probability

- $r_A$  is 2 reinforcers per minute (VI 30 s)
- $r_B$  is 1 reinforcer per minute (VI 60 s)
- Calculation of a rough probability of responses
- $P(R_A) = R_A / (R_A + R_B) = r_A / (r_A + r_B)$   
 $= 2 / (2 + 1) = 2/3$   
 $= 0.66 = P(R_A)$ .

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Key	Schedule	R/h	Rsp/h	Relative reinforcement	Relative responses
A	VI 3-min	20.00	2000	0.50	0.50
B	VI 3-min	20.00	2000	0.50	0.50
A	VI 9-min	6.7	250	0.17	0.08
B	VI 9-min	33.30	3000	0.83	0.92
A	VI 1.5-min	40.00	4800	1.00	1.00
B	Extinction	0.00	0	0.00	0.00
A	VI 4.5-min	13.30	1750	0.33	0.31
B	VI 2.25-min	26.70	3900	0.66	0.69

**FIG. 9.5** A table of schedule values and data. Reinforcement per hour (Rf/h), responses per hour (Rsp/h), relative reinforcement (proportions), and relative responses (proportions) are shown. Adapted from Fig. 1 (bird 231) and text of "Relative and Absolute Strength of Responses as a Function of Frequency of Reinforcement," by R. J. Herrnstein, 1961b, *Journal of the Experimental Analysis of Behavior*, 4, 267-272.

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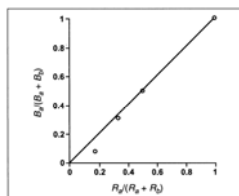
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**FIG. 9.6** Proportional matching of the response and reinforcement rates for bird 231. Figure is based on results from Herrnstein (1961b) and the data reported in Figure 9.5.

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## Ulike mønstre ved matching

- Matching
  - Proporsjonen av responser matcher eller er lik proporsjonen av forsterkere.
- Undermatching
  - Proporsjonen av responser er lavere en proporsjonen av forsterkere.
- Overmatching
  - Proporsjonen av responser er høyere en proporsjonen av forsterkere

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## Extension of the Matching Law

- Baum (1974)

$$\log(B_1/B_2) = a \log(r_1/r_2) + \log k$$

a= slope  
k= intercept

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Rt/h A	Rt/h B	(R <sub>A</sub> /R <sub>B</sub> )	X value log (R <sub>A</sub> /R <sub>B</sub> )	Slope (a)	Intercept (log k)	Y value log (B <sub>A</sub> /B <sub>B</sub> )
MATCHING						
5	5	1	0.00	1.00	0.00	0.00
30	5	6	0.78	1.00	0.00	0.78
100	5	20	1.30	1.00	0.00	1.30
600	5	120	2.08	1.00	0.00	2.08
UNDERMATCHING						
5	5	1	0.00	0.50	0.00	0.00
30	5	6	0.78	0.50	0.00	0.39
100	5	20	1.30	0.50	0.00	0.65
600	5	120	2.08	0.50	0.00	0.14
BIAS						
5	5	1	0.00	1.00	1.50	1.50
30	5	6	0.78	1.00	1.50	2.28
100	5	20	1.30	1.00	1.50	2.80
600	5	120	2.08	1.00	1.50	3.58

1.04

**FIG. 9.15** Application of log-linear matching equation (Equation 9.5) to idealized experimental data. Shown are reinforcements per hour (Rt/h) for alternatives A and B, the ratio of the reinforcement rates (R<sub>A</sub>/R<sub>B</sub>), and the log ratio of the reinforcement rates (X values). The log ratios of the response rates (Y values) were obtained by setting the slope and intercept to values that produce matching, undermatching, or bias.

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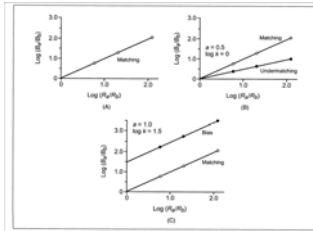


FIG. 8.18 (a) An X-Y plot of the data for "Matching" from Figure 8.15. The value of the slope is set at 1 ( $a = 1$ ), and the intercept is set at zero ( $b = 0$ ). The matching line means that a unit increase in relative rate of reinforcement ( $\log(R_p/R_n)$ ) produces a unit increase in relative rate of response ( $\log(R_p/R_n)$ ). (b) An X-Y plot of the data for "Undermatching" from Figure 8.15. The value of the slope is set at two ( $a = 2$ ), and the intercept is set at zero ( $b = 0$ ). Undermatching with a slope of 2 means that a unit increase in relative rate of reinforcement ( $\log(R_p/R_n)$ ) produces a half-unit increase in relative rate of response ( $\log(R_p/R_n)$ ). (c) An X-Y plot of the data for "Bias" from the data of Figure 8.15. The value of the slope is set at 1.5 ( $a = 1.5$ ), and the intercept is more than zero ( $b = 1$ ). A bias of this amount indicates that the new plotted data on X-Y coordinates are shifted 1.5 units from the matching line.

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## From Barrero and Vollmer (2002)

- They studied severe behavior problems in 4 individuals with varying degrees of developmental disabilities
  - Linda, a 14-year-old girl showing aggression and disruption.
  - Mandy, a 24-year-old woman with Stickers syndrome showing self-injurious behavior as head banging, nose punching, chin punching, and head hitting.
  - Max, a 7-year-old boy diagnosed with autism. He was showing aggression, consisting of hitting, slapping, and pulling hair of others.
  - Dan, a 9-year-old boy showing aggression and disrupting behavior which consisted of hitting and kicking others, bangig against walls, throwing materials and property destruction.

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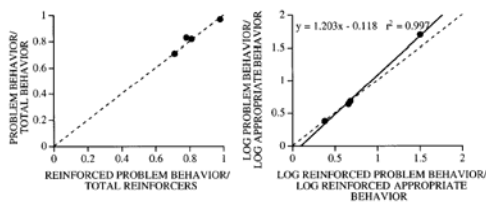
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## From Barrero and Vollmer (2002)



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### Vollmer and Bouret (2000)

- They studied basketball and two- and three-point shots.
- The results showed that players allocated responding in accordance with relative reinforcement rate for two-and three-point shots.

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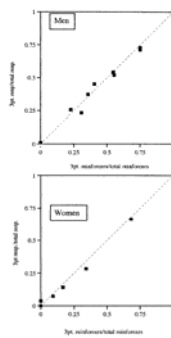


Figure 1. Scatter plots of predicted and actual three-point shot allocation for male (upper panel) and female (lower panel) players on an individual basis for those players who attempted more than 100 shots. Data used to calculate predicted and actual shot allocation are taken from the entire season. The data are plotted against a diagonal line representing perfect matching.

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$$\frac{R_1}{R_1 + R_2} = \frac{r_1(A)}{r_1(A) + r_2}$$

$$\frac{R_1}{R_1 + R_2} = \frac{r_1(1.5)}{r_1(1.5) + r_2}$$

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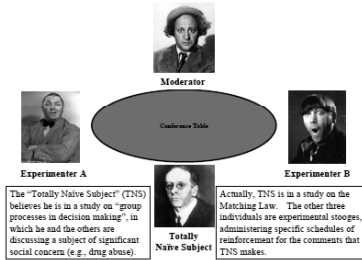
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# Conger and Killeen (1976)



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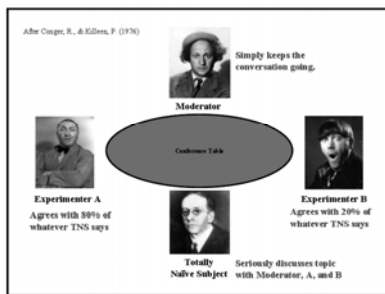
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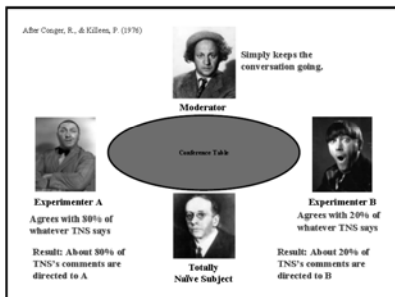
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### Questions about choice

Discuss the small and immediate and large and long term (delayed) consequences

- To study for the MALKA212 exam or watching "soap" on TV.
- To go jogging or watching a soccer match on TV.
- To get up when the alarmclock rings or sleep in

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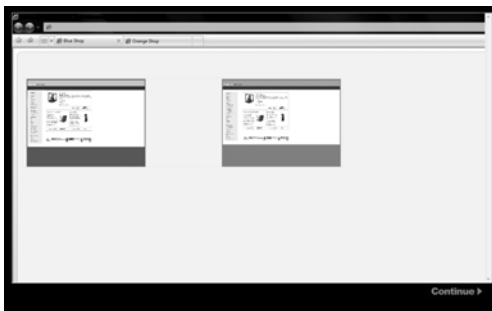
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### Self-control

**FIGURE 11-4.** A concurrent-chain procedure that synthesizes some properties of impulse-resistance and self-control. According to (1) 2 immediate pecks on white (W) initial-link keys are followed after  $T_1$  by terminal link A in terminal link A, red (R) and green (G) keys respectively make an immediate and a delayed large reinforcement available. In terminal link B the green key alone makes only the delayed large reinforcement available. (Adapted from Bostan & Green, 1972)

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**FIGURE 11-5.** Relative initial-link pecks producing terminal-link A (left initial-link pecks divided by total initial-link pecks) as a function of  $T$  the time to the onset of the terminal-link keys. (Cf. Figure 11-4; adapted from Bostan & Green, 1972, table 1)

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### Fra Pierce og Cheney (2008)

Barnets medgjørighet til mor = Sr fra mor  
 medgjørighet mor + medgjørighet til andre = Sr fra mor + Sr fra andre

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