

BASKETBALL AND THE MATCHING LAW

Jason Bourret
Timothy R. Vollmer
The University of Florida

Much of what we do in everyday life can be conceptualized as choice. At any given moment, we could work or watch television. We could go to the store or go to the beach. We could deposit money at the bank or play the lottery. A number of variables can exert control over responding in choice situations (e.g., reinforcement rate, reinforcer quality, reinforcement magnitude, and reinforcement delay). For example, if our favorite television show (i.e., a powerful reinforcer) is on right now, and the deadline for a paper is not for another two weeks, we may be more likely to watch television. If the deadline for the paper was tomorrow, we may be more likely to write than watch television due to the greater magnitude, or qualitatively more potent, reinforcer (e.g., passing a class). If we were paid \$1000.00 for every page written, we almost certainly would spend most of our time writing and relatively little time watching T.V.

“Choice” situations arise when concurrent schedules of reinforcement are available in an organism’s environment. Depositing money into the bank results in an accumulation of interest, and a gradual increase in available money. Buying a lottery ticket results in the loss of a dollar and a very small chance of a drastic increase in available money. Each of these responses (depositing money in the bank, buying a lottery ticket) operates on its own schedule of reinforcement, but there is a choice between those response alternatives.

One extremely general phenomenon, which was initially identified in laboratory studies using nonhumans, is the “matching law.” The matching law posits that given two concurrently available response alternatives the relative rate of responding equals the relative rate of reinforcement. In other words, suppose there are two response options. Option A provides two times the rate of reinforcement provided by option B, so there will be two times the rate of responding on option A as for option B. For example, consider the possibility that you need to speak to a friend, and there are two telephone numbers (e.g., home and work) available that you might call to reach that friend. If in your experience you are twice as likely to get through to your friend on one telephone number as you are on the other at a given time, you are likely to call one number twice as often as you would the other number. This phenomenon is known as matching (Herrnstein, 1961, 1970).

AUTHORS’ NOTE: Please address all correspondence to Timothy R. Vollmer, Psychology Department, The University of Florida, Gainesville, FL 32611. Email: vollmera@ufl.edu. Phone: (352) 392-0601, ext. 280.

MATCHING LAW

The matching law can be expressed as a simple equation.

$$\frac{R1}{R1 + R2} = \frac{r1}{r1 + r2}$$

In this equation R1 and R2 are the rates of two responses and r1 and r2 are the rates of reinforcement for those responses. Coefficients can be added to this equation to account for other variables such as delay to reinforcement and magnitude of reinforcement (Baum, 1974). The matching law has been demonstrated repeatedly in laboratory settings. Usually, the matching law is studied using variable interval (VI) schedules. In VI schedules, reinforcement becomes available following varying periods of time. For example, if lever pressing by a rat were reinforced on a VI 30 second schedule, reinforcement might be delivered following the first lever press after 5 seconds, then 40 seconds, then 15 seconds, then 70 seconds, and so on (revolving around an average of 30 seconds). Only a handful of studies have evaluated the matching law in natural environments with humans.

To test the generality of the matching law in natural environments, we evaluated the 3- and 2-point shooting of a division IA men's and a division IA women's basketball team during games over the course of the season (Vollmer & Bourret, 2000). Three-point and 2-point shots were the targeted responses, thus shooting could be considered to be a choice, reinforced on a concurrent schedule with two response alternatives available.

Points were the presumed reinforcer for shooting. In other words, the goal of shooting is to make a basket and score points. Successful 3-point shots resulted in 3 points while successful 2-point shots resulted in 2 points. The identifiable difference in reinforcer amount allowed us to take reinforcer magnitude into account as part of the matching equation. Specifically, we were able to examine the relative effectiveness of a "concatenated" form of the matching equation, which contains coefficients for differing magnitudes of reinforcement (Davison, 1988; Davison & Hogsden, 1984; Davison & McCarthy, 1988), like this:

$$\frac{R1}{R1 + R2} = \frac{r1(A)}{r1(A) + r2}$$

Where R1 and R2 are the rates of two responses, r1 and r2 are the rates of reinforcement for those responses, and A is a coefficient reflecting the relative amount of r1 in comparison with r2. In the case of r1 being points delivered following a made 3-point shot and r2 being points delivered following a made 2-point shot, the magnitude of r1 is 1.5 times that of r2 and A equals 1.5.

One limitation of our evaluation of matching using points-scored as the putative reinforcer for 3-point and 2-point shots was that the reinforcing efficacy of points, or other events that follow made shots during a basketball game, was never experimentally demonstrated. It is possible, for example, that shooting is at least

partially maintained by crowd reaction, praise from teammates, or praise from the coach. Nevertheless, it seems reasonable to assume that the principal reinforcer for shot taking is gaining points.

Three- and 2-point shots occurring in a basketball game have the advantage, in terms of amenability to a matching analysis, of occurring on schedules of reinforcement that deliver differing rates of reinforcement. Furthermore, the analysis of 3- and 2-point shooting over the course of a season allowed us to take repeated measures of responding. An advantage of evaluating matching using basketball shooting was that the collegiate-level players likely had extensive histories shooting basketballs, thus their behavior was likely already at a reasonably steady state of performance.

We found that for a NCAA division IA men's basketball team and women's basketball team, the relative rate of reinforcement described the relative rate of 3-point and 2-point shots. For both male and female individual starters on their respective teams, the relative rate of 3- and 2-point shots closely matched the relative rates of reinforcement. That is, the players took shots from areas of the court at a proportional rate that was comparable to the proportional rate of reinforcement (points) for those shots. These relations are displayed in Figure 1.

The study extended the generality of the matching law by showing that the relative rates of 3- and 2-point shots taken by a NCAA division IA men's basketball team and women's basketball team, matched the relative rates of reinforcement those responses produced. This finding held for entire teams and for individual players. The generality of the concatenated matching equation was extended in that, by including coefficients to account for differing reinforcer magnitude, the relative rate of reinforcement better predicted the relative rate of responding.

In a follow-up study with one of our students, Romanowich, Vollmer, and Bourret (2001) examined the relative rates of 3-point and 2-point shots taken by National Basketball Association (NBA) players. It turns out that the NBA at two times changed the distance to the three-point line and hence changed the rate of reinforcement for taking 3-point shots. Data were evaluated during the 3-year period prior to the NBA moving in the 3-point line, during the 3-year period when the 3-point line was moved in, and during the 3-year period following the return of the 3-point line to its' original location. This allowed observation of relative response rates under differing reinforcer rates for individual players, because the rate of reinforcement for 3-point shooting should increase as the line is moved in. As with the first study, relative response rates closely matched relative reinforcement rates even when reinforcement rates changed by moving the 3-point line in and out. Future research could identify other settings that might be amenable to an analysis of the generality of the matching law. Athletic activity seems to be one good forum because games are usually reasonably well-controlled environments and lots of data are collected on an athlete's behavior.

MATCHING LAW

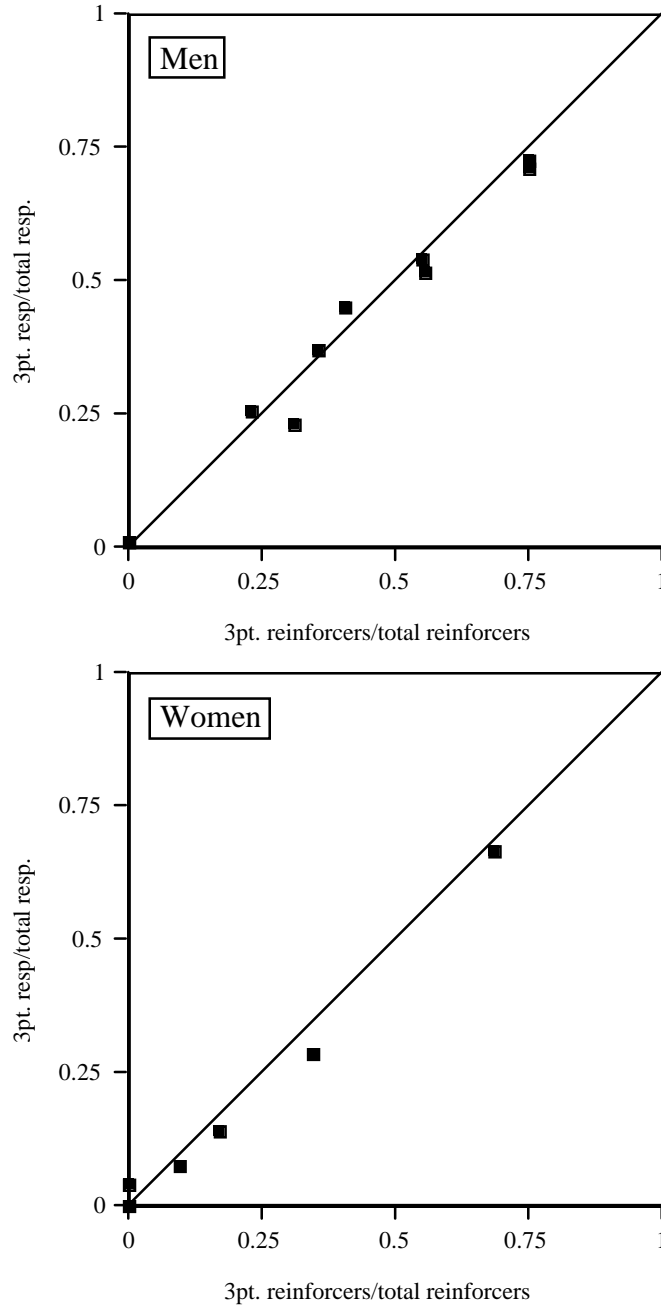


Figure 1. The proportion of shots taken from beyond the three-point line for male (upper panel) and female (bottom panel) players for the entire season. The diagonal line indicates perfect matching. Reprinted with permission from the *Journal of Applied Behavior Analysis* 33: 137-150.

References

- Baum, W. M. (1974). On two types of deviation from the matching law: Bias and undermatching. *Journal of the Experimental Analysis of Behavior*, 22, 231-242.
- Davison, M. (1988). Concurrent schedules: Interaction of reinforcer frequency and reinforcer duration. *Journal of the Experimental Analysis of Behavior*, 49, 339-349.
- Davison, M., & Hogsden, I. (1984). Concurrent variable-interval schedule performance: Fixed versus mixed reinforcer duration. *Journal of the Experimental Analysis of Behavior*, 41, 169-182
- Davison, M., & McCarthy, D. (1988). *The matching law: A research review*. Hillsdale, NJ: Erlbaum.
- Herrnstein, R. J. (1961). Relative and absolute strength of response as a function of frequency of reinforcement. *Journal of the Experimental Analysis of Behavior*, 4, 267-272.
- Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior*, 24, 107-116.
- Romanowich, P., Vollmer, T. R., & Bourret, J. (2001). *The allocation of two- and three-point shots in N.B.A. players with distance of three-point line as a manipulated variable*. Poster presented at the annual conference of the Association for Behavior Analysis, New Orleans, LA.
- Vollmer, T. R., & Bourret, J. (2000). An application of the matching law to evaluate the allocation of two- and three-point shots by college basketball players. *Journal of Applied Behavior Analysis*, 33, 137-150.