SUPPORTING MOVIE LEGENDS

These two movies illustrate the ambiguity inherent in two-dimensional (2D) views of data from experiments on reward seeking. Performance in such experiments depends both on the strength and cost of rewards. Nonetheless, these independent variables are manipulated singly in typical experiments. The results are viewed typically in a 2D space, with the vigor of performance represented on the ordinate and the independent variable (strength or cost of reward) on the abscissa. The movies compare such 2D views to 3D representations of the relationship between reward pursuit, reward strength, and reward cost. Whereas the direction in which the mountain moves is evident in the 3D views, orthogonal movements can be indistinguishable in the 2D views.

Each movie consists of four short segments. The movie pauses after each one and resumes following a mouse click or right-arrow press within the movie window. Pressing the back arrow on the keyboard will play the current segment backwards.

Movie 1 (Movie1.mov)

Initial condition: The surface of the mountain is denoted by a purple mesh in panel A. An illustrative orange plane lies against the back of the mountain, parallel to the frequency axis.

Click 1: The mountain slides along the pulse-frequency axis (as denoted by the red arrow). The outline of the reward mountain in the plane defined by time allocation and pulse frequency (the variable that controls reward strength) is shown in

yellow against the orange plane. The initial position of the outline is shown in light blue and the final position in yellow.

Click 2 (or right-arrow press): The mountain returns to its initial position. A little green figure ("Flatman," Shutterstock Images LLC) drops in from above and stands viewing the mountain from the pulse-frequency axis. This observer perceives the world in only two dimensions. Thus, from Flatman's viewpoint, the price dimension does not exist. Flatman's 2D view is shown in the green bubble (panel B) as a conventional graph of performance (time allocation) versus a reward-strength variable (pulse frequency). This graph is analogous to a plot of data from a conventional "curve-shift" experiment (Edmonds and Gallistel, 1974, 1977; Miliaressis et al., 1986).

Click 3 (or right-arrow press): The mountain returns to its initial position and is displayed in 3D in panel C. It then slides along the price axis (as denoted by the blue arrow), moving in an orthogonal direction to the displacement that was shown in panel A following clicks 1 and 2. The face of the mountain includes a diagonally oriented segment. Thus, as the mountain slides along the price axis, its outline (dashed yellow curve against the orange plane) is displaced rightwards along the pulse-frequency axis.

Click 4 (or right-arrow press): The mountain returns to its original position in panel C. Flatman then reappears and the mountain again slides along the price axis. What Flatman sees from his 2D viewpoint along the pulse-frequency axis is shown

inside the green bubble in panel D. Note that the two orthogonal displacements of the mountain are clearly distinguishable in the 3D views (panels A,C) but are indistinguishable in Flatman's conventional 2D view (panels B,D)

Movie 2 (Movie2.mov)

Initial condition: The surface of the mountain is denoted by a purple mesh in panel A. An illustrative blue plane lies against the back of the mountain, parallel to the price axis. The outline of the reward mountain in the plane defined by time allocation and price is shown in yellow.

Click 1: The mountain slides along the price axis (as denoted by the blue arrow). The initial position of the outline is shown in light blue and the final position in yellow.

Click 2 (or right-arrow press): The mountain returns to its initial position. A little green figure ("Flatman," Shutterstock Images LLC) drops in from above and stands viewing the mountain from the price axis. This observer perceives the world in only two dimensions. Thus, from Flatman's viewpoint, the pulse-frequency dimension does not exist. Flatman's 2D view is shown in the green bubble (panel B) as a conventional graph of performance (time allocation) versus price (required work time to obtain a reward). This graph is analogous to a plot of data obtained in a progressive-ratio experiment (Hodos, 1961; Keesey and Goldstein, 1968).

Click 3 (or right-arrow press): The mountain returns to its initial position and is displayed in 3D in panel C. It then slides along the pulse-frequency axis (as denoted by the

red arrow), moving in an orthogonal direction to the displacement that was shown in panel A following clicks 1 and 2. The face of the mountain includes a diagonally oriented segment. Thus, as the mountain slides along the price axis, its outline (dashed yellow curve) is displaced leftwards along the price axis.

Click 4: (or right-arrow press) The mountain returns to its original position in panel C. Flatman then reappears and the mountain again slides along the pulse-frequency axis. What Flatman sees from his 2D viewpoint along the price axis is shown inside the green bubble in panel D. Note that the two orthogonal displacements of the mountain are clearly distinguishable in the 3D views (panels A,C) but are indistinguishable in the conventional 2D view (panels B,D).

References:

Edmonds DE, Gallistel CR (1974) Parametric analysis of brain stimulation reward in the rat: III. Effect of performance variables on the reward summation function. J Comp Physiol Psychol 87:876-883.

Edmonds DE, Gallistel CR (1977) Reward versus performance in self-stimulation: electrode-specific effects of alpha-methyl-p-tyrosine on reward in the rat. J Comp Physiol Psychol 91:962-974.

Hodos W (1961) Progressive ratio as a measure of reward strength. Science 134:943-944.

Keesey RE, Goldstein MD (1968) Use of progressive fixed-ratio procedures in the assessment of intracranial reinforcement. J Exp Anal Behav 11:293-301.

Miliaressis E, Rompre PP, Laviolette P, Philippe L, Coulombe D (1986) The curve-shift paradigm in self-stimulation. Physiol Behav 37:85-91.