The normal form equations for three-alternative forced-choice decision making are

$$\dot{x} = a\frac{I_1 - I_2}{2} + xy - c(x^2 + 3y^2)x + a\frac{\xi_1 - \xi_2}{2}, \tag{1}$$

$$\dot{y} = a\frac{I_1 + I_2 - 2I_3}{6} + \frac{x^2 - 3y^2}{6} - c(x^2 + 3y^2)y + a\frac{\xi_1 + \xi_2 - 2\xi_3}{6}. \tag{2}$$

Where I_1, I_2 and I_3 are the inputs to the three competing populations, and the original firing rates are $(r_1, r_2, r_3) = (r_0, r_0, r_0) + (x + y, -x + y, -2y)$.

If we define the potential

$$\psi(x, y) = -a(I_1 - I_2)x - a(I_1 + I_2 - 2I_3)y - (yx^2 - y^2) + c\Big(\frac{x^4}{2} + \frac{9}{2}y^4 + 3x^2y^2\Big), \tag{3}$$

then we find that the dynamics of the normal form equations are equivalent to the motion of a particle on this potential. Specifically,

$$\dot{x} = -\frac{1}{2}\frac{\partial\psi}{\partial x} + a\frac{\xi_1 - \xi_2}{2}, \tag{4}$$

$$\dot{y} = -\frac{1}{6}\frac{\partial\psi}{\partial y} + a\frac{\xi_1 + \xi_2 - 2\xi_3}{6}. \tag{5}$$