Calculation S1. Mathematical solution to convert 2-dimensional (2D) observed velocities during swimming, jumping and prey capture to 3-dimensional (3D) velocities.

The velocity vector in 3D can be written (U*X,U*Y,U*Z) where U is the speed and (X,Y,Z) is a point on the unit sphere. The objective is to estimate the mean value of U, based on observations of the mean of the 2D-projection (U*X,U*Y). We assume isotropy, i.e. (X,Y,Z) is uniformly distributed on this sphere, independently of U. The speed of the 2D-projection is

$$V = U(X^2 + Y^2)^{0.5} \qquad (1)$$

To find the relationship between the mean 3-dimensional speed, E(U), which we want to know, and the mean 2-dimensional speed, E(V), which we have observed, we use the fact that each of the co-ordinates (X,Y,Z) is uniformly distributed between -1 and +1. The length of the 2D projection, $(X^2 + Y^2)^{0.5}$, can therefore be found as

$$E[(X^2 + Y^2)^{0.5}]=E[(1 - Z^2)^{0.5}] = \int_{-1}^{1} 0.5(1 - Z^2)^{0.5} dZ = \pi/4 \qquad (2)$$

so that

$$E(V) = E(U)\frac{\pi}{4}. \qquad (3)$$