A theoretical result on what must be done to conserve observed sound signal intensity can inform out experimentation.

We'll use R to denote the distance between the two flies, and r_m to denote the distance from a fly to a microphone.

From physics, $I = k\frac{P(R)}{R^2}$. Because of the dependence of P on R, we can differentiate wrt to R and observe conservation of intensity, $\frac{d}{dR}I = 0$, when $P \neq 0$.

$$\frac{d}{dR}I = k\frac{P'(R)}{R^2} - 2k\frac{P(R)}{R^3} = 0$$

this comes to a differential equation

$$\frac{dP}{dR} = 2\frac{P(R)}{R}$$

whose solution is

$$P(R) \propto CR^2$$

Equation (3) must hold if intensity is to be conserved.

Now suppose there is some optimal intensity for fly communication call it I_{opt}. If two flies are of distance r apart, the pressure at that distance is be $P(r) = I_{opt}\frac{^2R}{k}$. If we can get the pressure at that point to have the given intensity then intensity is conserved. Well pressure drops off $P = \alpha 1/r$ where α is a constant of proportionality. So we have

$$P = \frac{P_0}{R} = kI_{opt}R^2$$

yielding explicitly

$$P_{0,opt} = kI_{opt}R^3$$

Checking equation (3) confirms equation (5) does in fact make sense.

We are not done yet, however, as we must still calculate actual P_0 from observed intensity. If the microphone is at distance r_m from the fly, then $I_{observed} = k\frac{P_0}{r_m^2}$, yielding

$$P_{0,observed} \propto I_{observed}r_m^2$$

We should then expect $P_{0,observed} \propto R^3$ if our assumptions are correct. It would be instructive if they are not correct and will give us insight into what the fly is actually doing.