APPENDIX B: SOLVING THE MODEL

To find the stable levels of conflict efforts $x$ and $y$, we are interested in whether a monomorphic population characterized by given values of $x$ and $y$ can be invaded by an initially rare mutant expressing a slightly different value $x^*$ and/ or $y^*$. Since any change in $x$ is expressed only by dominants, we can determine the effect of a small mutation with respect to $x$ ($x^*$) by deriving the selection gradient $\frac{\partial W_D}{\partial x} + r(\frac{\partial W_S}{\partial x})$ at $x = x^*$. Likewise, because any change in $y$ is expressed only by subordinates, we can determine the effect of a small mutation with respect to $y$ ($y^*$) by deriving the selection gradient $\frac{\partial W_S}{\partial y} + r(\frac{\partial W_D}{\partial y})$ at $y = y^*$. Because we cannot derive the stable conflict efforts analytically (i.e., by setting the above selection gradients equal to zero and solving for $x$ and $y$), we use a numerical, iterative procedure, in which we proceed as follows: First, for a given combination of model parameters ($S_B$, $a$, $b$, $r$, $\lambda$), and an arbitrary combination of $x$ and $y$, we calculate the above selection gradients numerically to determine the direction and strength of selection on $x$ and $y$. Second, we update these initial values of $x$ and $y$ by adding to each the value of the relevant selection gradient, multiplied by a small coefficient ($10^{-4}$, such that evolution proceeds in small steps in the direction indicated by the sign of the relevant selection gradient). We then calculate the selection gradients for the updated values of $x$ and $y$, and repeat the above steps until the system converges towards a stable state (which was defined as when the largest difference in values of $x$ and $y$ between two consecutive time steps was $<10^{-7}$).