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### Threat Displays are not Handicaps

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#### Abstract

Within a general framework of handicap signalling it was proposed that threat displays are handicaps, they can work only if they put the signaller at a disadvantage, which is only acceptable to honest signallers. The aim of the present article is to investigate this proposal with the help of a simple game-theoretical model. It was found: (1) that the use of cost-free signals is an ESS against the invasion of handicapped signals even if cheating is played as part of a mixed strategy in the population; (2) that the use of handicaps may be an ESS against cost-free signals but only if we assume that the invading cost-free signal is not accepted by weak individuals as a signal of strength; (3) that the establishment of a handicapped signal in the first place is an unresolved problem, because both cost free signals and negative-handicaps are evolutionarily stable against the invasion of handicaps; (4) that in contrast to handicaps the use of negative-handicaps can invade a population using cost-free signals (a negative-handicap is a signal which may serve other functions as well); (5) that negative-handicaps are ESS against cost-free signals as well as against handicaps; and (6) thus, the most likely evolutionary end point is

that the biggest negative-handicap would be used as a threat display. This is a posture, which prepares the animal most efficiently to fight; hence, most probably it is the initial position of the fighting technique of the given species. (7) Finally, the investigation of the threat displays of well-studied taxa (great tit, cats, dogs, and hoofed mammals) confirms that threat displays are indeed negative-handicaps. They do not put the user into a disadvantaged position, instead the initial position of the species specific fighting technique is used as a threat display as predicted by the present model.



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