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1 Introduction

When animals of the same species come into conflict, the incidence of unrestrained treated not as an end in itself, but as an adaptive phenomenon, with an adaptive purpose, such as to win or to defend a resource. (For a discussion of all these issues, see (Archer, 1988).)

The phenotypic traits that determine an animal's ability to win a fight are called its resource holding potential ('RHP'). An example of RHP would be size. Signals which are biologically correlated with RHP cannot be faked. For instance, only large toads have low-pitched croaks. A small toad cannot fake a low voice, and, hence, cannot 'lie' about its size with that style of signal (Davies & Halliday, 1978). However, other signals — such as signals of *aggressive intentions* — are not necessarily reliable. Cheats who consistently signaled high levels of aggressive intent, whatever their actual intentions, could well prosper when confronted by 'trusting' opponents. In considering this possibility, Zahavi (1975) has argued that the reliability of intention-signals could be increased if the animal concerned had to invest, in some way, in those signals. This idea — known as *the handicap principle* — is illustrated by the fact that a signal which is, for example, wasteful of energy is, as a consequence of that wastefulness, reliably predictive of the possession of energy; hence honesty is enforced (Grafen, 1990). To be reliable, signals of aggressive intent must be more costly in fitness terms than they strictly need be merely to communicate unambigup5mi3(Grafen,alIn are

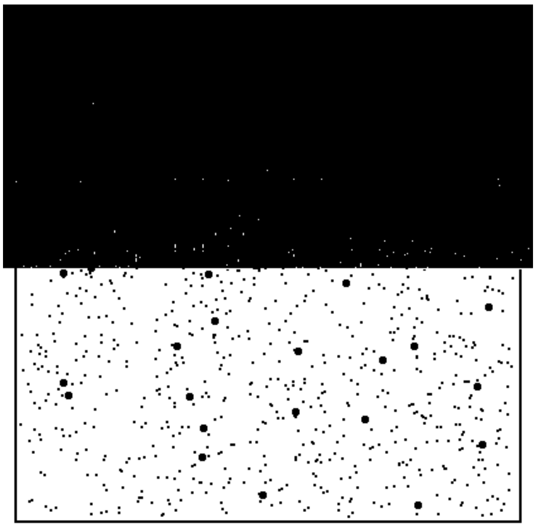

Figure 1: *The world at the start of a typical run. The particles of food are shown as dots, and the animats are shown as filled-in circles. Both food particles and animats are placed randomly.*

Animats pick up up energy from food, but they also pay a series of energy costs (including a small existence-cost deducted at every time step, and costs for fighting, moving, signaling, and reproducing — see below). If an animat's energy level sinks to 0, then it is removed from the world. In consequence, food-finding is an essential

5 he Introduction of Receiving Strategies

The conclusions from our first experiment constitute the beginning, rather than the end, of a story. To model more realistic signaling systems, we need to consider not only the behaviour of signalers, but also the behaviour of *receivers*. 'Receiver psychology' has become an increasingly important issue in the biological literature (e.g., Stamp Dawkins & Guilford, 1991; McGregor, 1993).

In the experiment described above, the threat values for the movement equation were simply the values of the incoming aggressive signals. However, we now extend the experimental model, so that each animat has not only a genetically specified signaling strategy, but a similarly specified receiving strategy. Each animat's receiving strategy is determined by an individual-specific constant, K that

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atively complex by the need for animats to forage, the probabilistic nature of the behaviour, the constantly changing aggression levels, and the fact that many different signaling and receiving strategies can coexist in the population at any one time. We believe that these features of the experimental model are crucial in ensuring that the results of the simulation are non-trivial. But these same features complicate the process of explanation. Thus, whilst we believe that our proposed explanations of the observed behaviour are fundamentally correct, our conclusions would be strengthened by further analysis. That is our next task. In particular, we need a more detailed understanding of the ways in which the system is sensitive to changes in the values of parameters other than the cost of signaling.

Aggressive communication is an adaptive phenomenon about which there are unanswered questions. We hope that our ongoing work in SBE will help to find some of those answers.

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