SIGNALLING OF RESOURCE HOLDING POTENTIAL (RHP)

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Behavioural ecologists have for many years been concerned with the mathematics of ritual agonistic behaviour (RAB), or pairwise contests, and the selective forces acting on the strategies used in them (Maynard Smith, 1982). They have introduced an intervening variable which they call Resource Holding Potential (RHP) to assist in the mathematical analysis of such contests (Parker, 1974, 1984). RHP is a measure of fighting capacity and on the input side it is determined by such factors as age, size, weapons, previous success and availability of allies. On the output side it determines probability of fighting (rather than submitting or withdrawing) in a contest, and also duration and intensity of fighting once a contest has begun. All the attack components of agonistic behaviour, including dominance display, threat display, challenge, attack and chasing, are looked on as signals of RHP.

There is, to my knowledge, no concept currently in use in psychology which expresses the equivalent of RHP; it is related to the idea of self-confidence, but the latter term is poorly defined and in any case refers to confidence in other areas in addition to fighting ability; it is also related to the "dominance feeling" described by Maslow (1937) but this term has not been in use since the last war. I think RHP is a helpful term in the conceptualisation of RAB and I hope that in extending it somewhat in its psychological meaning I am not distorting the meaning it already has in behavioural ecology.

The Calculation of Relative RHP

In a contest, or ritual agonistic encounter, we are concerned with each contestant's evaluation of his own RHP compared with his assessment of his adversary's RHP - what Parker (1982) has called relative RHP. This is a somewhat complex evaluation, and it might be useful to recognise the following subdivisions of RHP:

1. Absolute RHP. Each individual has some general idea of his own fighting capacity in relation to other individuals, regardless of who may be his specific adversary on any one occasion. This value of RHP determines any undirected dominance display which the individual signals to the world at large, and the directed dominance display (challenge or threat) which he makes to a potential adversary at the beginning of an encounter, before he has had time to assess the other's RHP.
2. Signal of absolute RHP. This is the signal given in the dominance displays mentioned in the preceding paragraph. Such a signal can obviously be faked, but I will assume here that it is an accurate reflection of absolute RHP, in order not to complicate further an already sufficiently complex subject.
3. Estimate of adversary's RHP. I will assume that this is an estimate which reflects the information received from the adversary's "signal of absolute RHP", but, if faking is suspected, the estimate could be revised up or down.
4. Estimate of relative RHP. This is derived from a comparison of (1) and (3) above. We do not know how this comparison is made, but in the simplest case it must give a result which is either favourable or unfavourable, in order to determine the choice between two possible courses of action: escalation and submission. These actions then become signals in the next round of the conflict.
5. Signal of relative RHP. A contest is an iterative process which may last for several "bouts", so that, at each stage, each contestant is estimating his adversary's relative RHP, comparing this estimate with his own absolute RHP to calculate his own relative RHP (which may be either favourable or unfavourable), and signalling this relative RHP by either escalating or submitting. For simplicity I will assume a two stage contest in which a period of mutual assessment is followed either by the submission of one contestant or by a period of engagement in which there is mutual attack. During the assessment stage, either contestant may submit by giving a signal of unfavourable relative RHP, and thus leave the encounter in a subordinate role but without loss of RHP - what Sloman and Price (1987) called "voluntary yielding"; or the contestant may enter the engagement stage by giving a signal of favourable relative RHP and thus have a chance of winning, but at the risk of losing and being forced into what we called "agonistic yielding", with associated loss of RHP.

The Two Components of the RHP Signal

Although it may be convenient to amalgamate them for mathematical purposes (Parker, 1984),

from the psychological point of view "signal of absolute RHP" is very different from "signal of relative RHP". The two differ in the following ways:

1. Stage of assessment versus stage of engagement. Signal of absolute RHP is saying "This is what I am like; examine me and assess my power", and it occurs in the assessment phase of the agonistic encounter, when the adversaries are confronting each other or circling round each other in mutual appraisal. Signal of relative RHP is saying "I am better than you and I will prove it", and it occurs in the engagement phase in the encounter, when the adversaries are engaged in some very ritualised and species-specific activity such as repeatedly charging at each other head on.

2. Semantic versus Shannon information. In signalling absolute RHP, the adversary is presenting himself for examination in all his aspects, having little control over what aspects are attended to; therefore the information offered to the adversary is very extensive, even infinite, and is what Krebs and Dawkins (1984) have called Shannon information, and what Lockard (1980) has called a composite signal. In signalling relative RHP, on the other hand, he is offering only one "bit" of information (namely, whether he is escalating or not) and the nature of the signal insists that the adversary pay attention it and to no other. If the signal varies, it varies in quantity rather than in quality. This is what Krebs and Dawkins call semantic information, and what Lockard calls a graded signal.

The difference between the signals of absolute and relative RHP is probably due to the fact that in the process of sender/receiver co-evolution the exchange of signals of absolute RHP has been a co-operative matter, in that, if there is a real disparity between the RHP of the contestants, it is in both their interests that the one with lower RHP should rapidly and efficiently identify the disparity and submit. In contrast, the exchange of signals of relative RHP has been a competitive matter during sender/receiver co-evolution, because it occurs only if there is no great difference in absolute RHP and each contestant has a fair chance of winning; each is interested not only that the winner should be decided quickly but also that they should be that winner.

3. Species similarity versus species specificity. Signals of absolute RHP tend to be common across species, such as upright posture, confident gait, display of weapons and large size. Exceptions such as the blue colouring of the rainbow lizard (Harris, 1964) are rare. Signals of relative RHP, on the other hand, tend to be highly species-specific in that each species has its own form of "combat"; some, like the head charging of the bison involve bodily contact whereas others such as the gill erection of the Siamese fighting fish do not, and consist entirely of an exchange of signals at a distance; within these categories the signals are similar in general form but highly specific in detail.

4. Different effect on allies. The signalling of absolute and relative RHP can be further differentiated if we postulate the presence of an ally. Display of absolute RHP is received by allies, and it boosts rather than lowers their RHP. However, allies do not signal relative RHP to each other, except in mock fights for practice.

Catathetic Signals

Because "signal of favourable relative RHP" is a cumbersome phrase, and because there is no exact ethological equivalent, I propose the term catathetic to describe the signals that are exchanged during the engagement phase of the agonistic encounter(and at other times to reinforce dominance). Catathetic comes from the Greek words for "put" and "down", expressing the function of catathetic signals which is to put the other individual down, in the sense of making him yield and/or lowering his RHP. (I am aware that "cathairetic" would be more correct from the etymological point of view, but "catathetic" is easier to use).

Considering the species-specificity and the low information content of catathetic signals (illustrated by the analogy of the remote control TV button) it is likely that some very specific neural structures have co-evolved for the sending and receiving of these signals. Ethologists I have consulted are not happy to accept that catathetic signals are sign stimuli acting on an innate releasing mechanism to release the fixed action pattern of the yielding subroutine; but something similar to this classical ethological process seems likely.

Catathetic Signals in Man

Human beings are unique in the animal kingdom in being able to verbalise the signal of favourable relative RHP (catathetic signals). The message of the signal is "I am better than you", and whereas other species need to indulge in various pushing and pulling contests in order to get the message across, human beings can simply say it. Of course, if both say it, they are in a contest, and they have to keep on saying it until one gives up or escalates to the next stage which is physical attack. Therefore human ritual agonistic encounters take the form of slanging matches in which each contestant continues verbally to

assert his superiority over the other, with varying degrees of imagination and sophistication. This verbal interchange is the human species-specific form of catathetic signalling. Since it appears to be generally true that the structures responsible for catathetic signals (such as the stag's antlers) tend to become hypertrophied due to sexual selection, the same argument must be one reason for the development of the richness of human language.

Human catathetic signals may consist of a simple comparative statement (e.g., I am cleverer than you), or, rarely, a statement of the speaker's RHP (boasting) but more usually it is a statement emphasising or implying the other's low RHP, such as criticism, sarcasm, insult, disparagement (of the other and his/her allies) or even silence, implying "you are not worth speaking to". Escalated catathetic signals involve physical contact such as hitting, scratching, biting, caning, flogging, etc.

Raush et al. (1974) were able to reproduce this phenomenon in married couples put in a situation of artificial conflict. When told to choose between a baseball match on TV and a programme on naming a baby, some couples discussed the matter rationally and came to a decision; some avoided conflict altogether, but a third group generalised the conflict into what was clearly a ritual agonistic encounter. In the latter group the verbal content typically included criticism of the spouse's mother, and complaints about ill-deeds committed many years ago; the content had a stereotyped quality and was reproduced on subsequent occasions.

McLean (1976) has used the term "microstressors" for repeated slight stresses such as the receipt of catathetic signals from one's spouse. He thinks these may be more important in causing depression than large events. The sender was often unaware of the catathetic nature of the signals he was sending; for instance, the comment "you'd feel much better if you didn't cry all the time" was intended as helpful and supportive but was received as criticism.

The concept of catathetic signals gives us an opportunity to tackle the definition of the term "mental pain" which is often used loosely in connection with depression. We can say that, whereas physical pain is felt on receipt of "contact" catathetic signals (such as hitting), mental pain is felt on receipt of non-contact catathetic signals (such as criticism). Of course, the situation is not so simple, and mental pain may be experienced in other circumstances, such as the receipt of bad news (e.g. loss of an ally); but it may be that such pain-inducing circumstances share with catathetic signals the property of lowering RHP.

Anathetic Signals

One advantage of the concept of catathetic signalling (whose function is to lower RHP in the recipient) is the facilitation of the opposite concept of anathetic signalling whose function is to raise RHP in the recipient. I think it is true to say that much of social life which is not devoted to justifying our position on various matters (Totman, 1986) and thus, incidentally, reinforcing our own RHP, is actually devoted to manipulating other people's RHP, either lowering it with catathetic signals or raising it with anathetic signals. As far as the precipitation of depression goes, it may be that reduction in anathetic signals has the same effect as increase in catathetic signals, and this raises the possibility of a bridge between the social competition model and the loss model of depression; if we allow that anathetic signals can operate in the hedonic mode, they would include the "narcissistic supplies" of classical psychoanalysis (Gaylin, 1983) whose withdrawal is thought to lead to depression, and also the sociological concept of processual status, whose cessation Kemper (1978, and this volume) has postulated as a cause of depression. It is possible that anathetic signals evolved as negative catathetic signals, allowing a functional connection between the new mammalian brain subserving affiliation and the old reptilian brain subserving agonism (MacLean, 1986). But it is beyond the scope of the present discussion to ask whether RHP can be manipulated in the hedonic mode, or how RHP, which could be described as confidence in one's power over people, fits in with the broader concept of self-esteem, which also includes confidence in one's power over things, knowledge of one's popularity and a sense of the integrity of one's honour and virtue (Coopersmith, 1967).

In the same way that catathetic signals may be, variously, a glorification of the self, a disparagement of the other, or a comparative statement asserting the self's superiority over the other, so also anathetic signals may take different forms. The most common form is praise or glorification of the other; but denigration of the self is also an anathetic signal, a fact which may be useful in conceptualising the self-denigratory speech of depressed patients. Anathetic signals may also take a comparative form, such as "You are better than/superior to/more powerful than me". This is the message of submission; in other words, the signal of unfavourable relative RHP. Thus we have defined escalation and submission in terms of the signals which act on the adversary's RHP: escalation = signal of favourable relative RHP = catathetic signal = lowering influence on adversary's RHP;

and submission = signal of unfavourable relative RHP = anathetic signal = boosting influence on adversary's RHP.

Down-hierarchy Catathetic Signals

The discussion above has been concerned with the exchange of catathetic signals between individuals of equal rank. However, catathetic signals are also exchanged between individuals in asymmetrical relationships. They are usually directed from the dominant to the subordinate, and have the function of confirming and reinforcing the dominance. If they are directed from the subordinate to the dominant, they suggest a rebellion against the existing rank structure. It is an interesting fact that the quality of catathetic signals is similar whether they are directed to an equal, a subordinate or a dominant. It is the quantity which varies and which differentiates symmetry from asymmetry, and dominance from subordinacy. In fact, it is the relative quantity of catathetic signals which is used to define dominance in many studies; and it is the consistency over time of this relative quantity, and its correlation with other measures such as supplanting, precedence and advertence which gave rise to the concept of dominance/subordinacy in the first place (Deag, 1977; Richards, 1974; Kauffmann, 1983); a concept which has stood the test of time in spite of a suggestion that it might be an artifact of captivity (Rowell, 1974).

At least in human beings, however, catathetic signals may differ in quality, depending on whether they are directed up or down a hierarchy. To take an extreme example, a pupil may be cheeky to his teacher, and a teacher may cane his pupil; but we cannot imagine the pupil caning the teacher or the teacher being cheeky to the pupil.

The down-hierarchy catathetic signal contains two messages at different logical levels. First of all it is a straightforward catathetic signal which causes mental or physical pain in the usual way. But, secondly, it contains the message "I am in a position to give you a signal which is only given by dominant people to subordinate people". This higher level message also causes mental pain (humiliation). Thus the pupil receives pain from the caning and pain in the form of humiliation from the fact of being caned.

Asymmetrical Anathetic and Neutral Signals

Like catathetic signals, most anathetic signals are similar whether directed up- or down-hierarchy; but, likewise, some are not, such as patronising behaviour (e.g., tipping). Equally, some RHP-neutral signals, such as those related to the task in hand, may be asymmetrical; for instance, to give certain types of order in certain tones of voice may only be appropriate to the one who is dominant (in the agonic mode) even though the pair or group may be operating in the hedonic mode and the subordinate individual may be in the role of leader.

It seems likely that the receipt of such an asymmetrical anathetic or neutral signal has the same effect as a catathetic signal, in that it is a threat to the recipient's RHP and challenges his dominance (or equality). Thus an asymmetrical anathetic signal boosts the recipient's RHP at one logical level and lowers it at another. The net effect may be to lower RHP and/or trigger a yielding subroutine.

(References in the original, or may be obtained from the author)

Comment in 1998

By and large I would stand by the above, with the following provisos:

1. While we can say that the function of catathetic signals is to lower RHP in the recipient, they only do so if they are not returned. The function of the RHP signalling system is to break symmetry. A fight in which equal blows are traded does not lower the RHP of either contestant. Only when one contestant fails to return the blows of the other is there a lowering of his RHP and a break in symmetry.

This may be important in the training of children not to fight. If the child does not return a blow because of high moral standards, his RHP adjustment mechanism may not have access to this information, and may assume that the blow has not been returned because of weakness, and so lower his RHP.

2. The fact that one attacks (rather than submits) is a signal of favourable relative RHP. The strength of the attack is a signal of absolute RHP, so that absolute RHP continues to be signalled during a fight, often in different ways, as the fight escalates from, say, roaring, to parallel walking, to locking of horns.

3. Although I still think it is useful to look on the catathetic signal as a signal of

favourable relative RHP, it is also influenced by two other variables.

Resource value is a measure of how valuable a resource is to a particular individual, and the higher the resource value, the more likely the individual is to attack. For instance, in certain territorial cichlid fish, a territory becomes more valuable when the fish is in breeding condition; and success in territorial disputes was found to be more related to relative gonad size than to relative body size (2). Resource value expresses the motivational element in fighting. The message is, "I can and will defeat you!": RHP provides the "can", and resource value provides the "will".

Ownership is another variable that determines the likelihood of attack rather than submit. It is an almost universal convention among vertebrates that a resident or owner attacks an intruder, and is likely to be victorious.

When an encounter occurs on neutral territory, and concerns a resource which is of equal value to both contestants, the catathetic signal is a true signal of favourable relative RHP.

We have pointed out (1) that lowering of RHP, resource value and sense of ownership can account for a lot of the clinical features of depressive states. This is in accord with our view that the capacity for depression evolved as a component of ritual agonistic behaviour.

1. Neat, F.C., Huntingford, F.A. & Beveridge, M.M.C. (1998) Fighting and assessment in male cichlid fish: the effects of asymmetries in gonadal state and body size. Animal Behaviour, 55, 875-882.

2. Stevens, A. & Price, J. (1996) Evolutionary Psychiatry: A New Beginning. London: Routledge (pages 81-82).