

## Defense motivational system: Issues of emotion, reinforcement, and neural structure

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There is a great deal of similarity between the conclusions of Masterson and Crawford's (M & C's) review and those of two recent reviews that I have published on the same topic, that is, a "defense motivational system." This is remarkable, because my own reviews were based upon totally different sets of data: brain research (Adams 1979); and field observations of behavior (Adams 1980).

Both formulations agree that there is a defense system that can be activated in unitary fashion along a continuum of activation and that as a result "defense responses are readied or excited as a group." In my formulation I distinguish a subset of the system as "submission" that occurs during encounters with conspecifics, but M & C do not concern themselves with this question.

The characterization of stimuli is dealt with differently. I agree with M & C that the old notion of releasing stimuli is not adequate. However, I do not think that we have a plausible alternative yet. Simply changing the name from "releasing" to "supporting" stimuli is not much help. M & C do not provide a terminology for motivating stimuli, although at one point they seem to refer to them as "triggering" stimuli: "animals engage in defense . . . for long periods after the triggering stimulus has terminated."

M & C's discussion of interactions among motivational systems is consistent with my own views (Adams 1980). In particular, I have suggested that the defense motivational mechanism inhibits exploration (patrol/mark) and offense.

Both formulations flirt with the possibility of calling the active state of the defense motivational system "fear," but then back away from the terminology. I back away because of the problems of generalizing from human introspection, where fear is a very real emotion, to animal research where it must be inferred as homology. In dealing with homologies between rat and monkey (Adams 1981) I have been tempted to extend the analysis to humans and to suggest that our emotions of fear correspond to defense activation, depression and weeping to submission, anger to offense, and excitement and jubilation to display. However, it is already problematic to deal with homologies of rat and monkey motivational states; adding a further complication by attributing human emotions to animals is perhaps too difficult to test at the present time.

A major difference between our formulations concerns the primacy given by M & C to reinforcement as a characteristic of a motivational system. In fact, they propose that motivational states have two kinds of effects: 1) making response patterns

more likely to occur and 2) activating reinforcement mechanisms in the event of "ideal" consummatory stimuli. I have not considered reinforcement as a necessary aspect of a motivational system (Author's Response in Adams 1979) because there is little evidence that reinforcement plays a major role in the motivational systems of offense or patrol/mark, or in the various motor patterns other than flight that are activated by defense. These include various vocalizations and warning signals, upright posture, and the lunge-and-bite attack.

There is one body of data that would suggest that reinforcement is a characteristic of the entire defense motivational system rather than only the motor pattern of flight. This is exemplified in the data of Clark & Galef (1977), who found that gerbils that have been given a chance to escape when young are much more likely to respond defensively to visual movement and sudden noise when they become adults. We have seen similar results in our laboratory rats. Not only flight, but also other motor patterns of defense are more likely to occur in these "wild-like" animals. Learning theorists have not yet commented on these findings; perhaps M & C could do so.

Ultimately, a valid theory of the defense motivational system must be based upon a physiological analysis of the brain structure involved. Progress in vertebrates has been very slow because of methodological difficulties. Recently, however, it has been possible to record from an analogous defense motivational system in the invertebrate *Aplysia* (Hawkins, Castellucci & Kandel 1981); it is remarkable how similar are L29 neurons (Adams 1968) that, I have suggested, belong to the defense motivational mechanism (Adams 1979). Both are normally silent and respond at high rates to a wide range of noxious stimulation. The L29 neurons, amenable to more exacting study than mammalian neurons, also show some characteristics that I have postulated for the latter: They are coupled together as a functional "pool," their effects are facilitative, and this facilitation outlasts the period of actual firing by the neuron. Finally, the facilitation occurs at the synaptic connection between sensory neurons (releasing stimulus) and motor neurons (motor patterning mechanism).