

## Book Review

### Stress: Conceptual and Biological Aspects

F. Toates (1995)

John Wiley & Sons, Chichester

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Frederick Toates has made extensive contributions to the application of control theory to the analysis of motivation. Over the years this has led to a stream of books (*Control Theory in Biology and Experimental Psychology* 1975; *Animal Behaviour: a systems approach* 1980; *Motivational Systems* 1986 - in the 'Problems in the Behavioural Sciences series) to which the present book might be seen as a logical extension but is also somewhat of a departure. It is a logical extension in its emphasis on the differences between open and closed loop processes. It is a departure in that it can be viewed as a bold attempt to obtain a coherent perspective on an inchoate area in which few agree on the definitions of terms and in which systematic application of control theory is hampered by both the complexity of the systems involved and the incompleteness of the available data.

Toates himself says that "any attempt at a synthesis of stress research could only be undertaken by a masochist. The area is one of notorious conceptual difficulty; even by the standards of the behavioural sciences" and he warns that, for the crossword puzzle that is stress research, "I cannot claim to have given a solution. What I hope that I can honestly claim is to have filled in a few tentative overlapping clues so that others may fill in the remainder ... I make no claim to

comprehensiveness".

In terms of coverage of the data this disclaimer is too modest. The book involves an extensive (300 pages and 700 references) discussion of a wide range of stress-related topics including differences in types of stressor, hormonal systems involved in stress, neurotransmitter systems specifically involved in stress, applications of stress research to animal welfare, the role of stress in physical pathology and many more arcane issues. This prompted one reviewer quoted on the jacket to say "it is a goldmine of information" and as a source, particularly for those starting work on stress, this is an important and useful book. However, the goldmine analogy may be particularly apt for those who wish understanding as opposed to facts - they are going to have to dig quite hard for this.

To some extent this problem is inherent in the subject matter rather than in the author's treatment. However, given that Toates acknowledged the fact that "stress" means many things to many people, I was disappointed that his treatment of a substantial proportion of topics simply perpetuated the implicit ambiguity by lumping the different meanings into the term rather than separating the meanings and having independent discussion of each. I admit that it might have been cumbersome to approach each topic from the point of view of each of a number of distinct well-formulated definitions of stress. But I suspect it would have led to a greater tractability of the subject matter.

So, I feel less able to agree with the second reviewer quoted on the jacket who says "the author has integrated in beautiful fashion a bewildering and diverse scientific literature into an organised and compelling presentation". But then, Toates, himself, does not claim to have provided such an integration nor, in the present state of the literature is it, perhaps, reasonable of me to ask for one. Nonetheless, my impression is that a failure to keep definitional possibilities distinct has led to a somewhat confusing organization both within and between chapters.

It may be that I have missed some crucial point but I have the feeling that Toates has actually, in one major case, created confusion (or perpetuated the confusion of the current literature) where there need be none. Toates (page 8-10) says "In the classic writings of Hans Selye (e.g. Selye 1973) an elevation in corticosteroids is synonymous with stress. ... Thus, in such terms, presumably one would not say that stress *causes* elevated corticosteroid levels as stress *is* the elevated level. ... According to Selye, seen as a stressor, 'a passionate kiss' might qualify equally well as electrical shock. ... However, to most of us, the term stress usually implies negative events and that is the use to which it will be put here. The present author has difficulty with the notion that a kiss can usefully be described as a stressor."

Other than the fact that the popular media and some researchers interested in animal welfare now use stress in a purely pejorative sense, I cannot see why Toates comes to this conclusion. It fits with neither what Selye originally said, nor the conventional non-psychological usage of the word stress, nor, indeed, with the way hormonal systems by and large work. I will deal with each of these aspects separately.

Selye (1957, p3) originally said that "in its medical sense, *stress is essentially the rate of wear and tear in the body*. Anyone who feels that whatever he is doing – or whatever is being done to him – is strenuous and wearing, knows vaguely what we mean by *stress*." But, "no one can live without experiencing some degree of stress all the time. You may think that only serious disease or intensive physical or mental injury can cause stress. This is false. Crossing a busy intersection, exposure to a draft, or even sheer joy are enough to activate the body's stress-mechanisms to some extent. Stress is not even necessarily bad for you; it is also the spice of life, for any emotion, any activity causes stress. But of course your system must be prepared to take it. The same stress which makes one person sick can be an invigorating experience for another" (op.cit. p xi). "The *nervous system and the endocrine (or hormonal) system* play particularly important parts in maintaining resistance during stress. They help to keep the structure and function of the body steady, despite exposure to stress-producing or *stressor agents*" (op. cit. p3).

Why is this clear and logical view such anathema to Toates? The passionate kiss is usually a prelude to extreme physical exertion (and, even if that exertion does not follow the kiss, the passionate kiss itself will have had significant effects on heart rate). However enjoyable and however evolutionarily advantageous sexual behaviour is, why can it not be seen as sharing

with aversive and evolutionarily disadvantageous behaviours the capacity to "increase the rate of wear and tear in the body"?

Let us now turn to the conventional non-psychological use of the term 'stress'. The 7th edition of the Concise Oxford Dictionary defines stress as "force per unit area exerted between contiguous bodies or parts of bodies". As with the psychological use of the term this has the implication that high levels of stress are bad (with sufficient stress the body will disintegrate) but also that not all stress is bad (which is why we pre-stress concrete beams and why broken bones are put under stress when they are mending). It also has the implication that the level of stress within a body can result from the imposition of force (a stressor) from outside and that many different factors (load, temperature etc) can affect the resultant amount of stress within the object. Yet the physicists have been happy to keep to the original definition of stress and have not wished (following Toates's model) to redefine stress as sufficient force to disintegrate bodies or only that force which is produced by an imposed load.

Finally, let us consider the hormonal aspects of stress. In Selye's original conception, corticosteroid release is not identical with stress. Rather, it is one of the consequences of stress (and indeed the same corticosteroid release can occur as the result of a variety of different stresses, e.g. cold, immune system activation, each of which can be imposed by a variety of different physical stressors, e.g. wind or cold water in the case of cold and different types of micro-organism in the case of the immune system). The most important part of Selye's contribution was the recognition that "only a few signs and symptoms are actually characteristic of any one disease; most of the disturbances are apparently common to many, or perhaps even to all, diseases" and that, in turn, these common signs and symptoms are a "single nonspecific reaction of the body to damage of any kind". It is the evolutionary desirability of this single non-specific reaction which has led to the capacity of corticosteroids to produce their effects. It is the fact that, whatever their stimulus, corticosteroid responses have a fixed set of consequences that makes them ideal markers for stress. To say that corticosteroid release is always the immediate consequence of stress and that it is never the consequence of anything else does not entail that corticosteroid release *is* stress. Rather, consider the situation when the body is stressed (i.e. there is an increased "rate of wear and tear in the body") and there is *no* corticosteroid release – there are many cases where this would lead to even greater dysfunction.

Corticosteroid release, then, is such an excellent marker for what Selye defined as stress because it is, in a sense, the antithesis of stress. It is part of the "general adaptation syndrome" – an attempt of the body to retrieve homeostasis. But note that there would not be such a syndrome if its consequences were universally beneficial – we would have, say, high levels of corticosteroids at all times. Rather, the general adaptation syndrome creates conditions which are usually advantageous given that there has been a significant increase in wear and tear (mental or physical) but are disadvantageous at other times.

Failure to keep this clear has led Toates to say, e.g. "using a corticosteroid index, one would end with a paradoxical situation of there being a greater stress at a time when the stressor has not yet arrived" (p 10); "stress represents a state of maladaptive stretching of these central processes"; "The stress-response ... is an ideal system for allowing an organism to deal with short-term physical stress" (p78); "depriving a rat of food and exposing it to cues associated with food is potentially stress evoking by the criterion of [corticosteroid release]" (p 196); "hard physical exercise, which is not necessarily perceived as being stressful by human participants" (p286). These statements involve either paradox or mutual incompatibility which, I believe, would have been avoided by a closer adherence to Selye's original definition of stress.

I have dealt with this issue at some length because I believe that the perspective I have presented will allow readers of Toates's book to more easily integrate the many valuable details he reviews. I suspect that one important group of such readers will be those (like both Toates and myself) who are concerned to ensure that laboratory and farm animals are treated in ways which optimise their welfare and a second important group will be those interested in the relationship between stress and the welfare of the human animal. Toates devotes 50 pages (17% of the book) to the former topic and 30 pages (10%) to the latter – in what are useful and comprehensive reviews. These are only slightly marred by the effects of earlier rejection of Selye's definition of stress as he is careful to distinguish the implications for health of acute, mild corticosteroid elevation as compared to chronic, extreme elevation. However, I believe he, again, unnecessarily confuses the issue when he says "there is, however, a paradox in the use of corticosteroid levels as a frame of reference for good welfare in that rats will learn an operant response task for their administration and prefer to drink a corticosteroid-containing fluid over pure water". Of course, if corticosteroid release is part

of the general adaptive response to stress, then there is no paradox in an animal choosing to increase such adaptation. Likewise, an excessive or chronic corticosteroid release can non-paradoxically be viewed as an index of poor welfare as, in the vast bulk of cases, it will be a consequence of excessive (in magnitude or duration) "wear and tear". The value, then, of corticosteroid release as an index would be precisely that it is not stress itself (there being many unique stresses, each requiring its own measure) but is rather part of the *general* adaptation syndrome and hence is a general index of the presence of stresses of many different kinds. This is not, of course, to argue that it should be the only index of welfare – but, viewed correctly, it can clearly provide useful information from which at least some aspects of welfare can be judged.

In sum, I found "Stress: conceptual and biological aspects" a much stronger book on the biological than conceptual side. But I think its conceptual failings can be overcome by the suitably prepared reader who can supply their own integration of what is a broad ranging and detailed coverage of research on stress and on its implications for welfare of both human and non-human animals.

## References

- Selye, H. (1957) *The Stress of Life*. Longmans Green and Co, London