Cognitive Activation Theory of Stress (CATS)

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SUMMARY

This is a brief review of the Cognitive Activation Theory of Stress (CATS) (Ursin and Eriksen 2004), which offers a systematic formal theory of the relationships between challenges and the way humans as well as animals handle such challenges. The theory is based on basic science and clinical data from human and animal research. It offers systematic definitions of the psychological responses to challenges, and the expectancies that are acquired by each individual. This forms the psychobiological foundation for somatic and mental health, for military personnel or civilians, for animals as well as for humans, across species and cultures (Ursin and Eriksen 2004, Ursin 2009). This bridge between data sets from research on animals as well as from humans is obtained by systematic logical formulations for the expectancies acquired by the brains, following principles from learning theory. CATS is a cognitive theory since the physiological and psychological consequences of "stress" all depend on cognitive evaluations of the situation and the consequences. A crucial concept is "expectancy", the knowledge we acquire when dealing with challenging situations. CATS is a psychobiological theory, the psychobiological consequences of the cognitive activity is explained by increases in brain activation (arousal - wakefulness), and the psychological and physiological concomitants of arousal. CATS is a theory in that all concepts are given formal symbolic definitions, and that it claims to be compatible with the empirical basis in this area of psychobiology (Ursin and Eriksen 2004).

STRESS AS A HEALTHY ALARM

The effects of stress are manifest in four distinct domains; physiology, behaviour, subjective experience, and cognitive function (Levine and Ursin 1991, Steptoe et al 2008). The term "stress" is used for four aspects of "stress"; stress stimuli, stress experience, the non-specific general stress response, and the experience of the stress response (Levine and Ursin 1991). The stress response is conceptualized as a general alarm in a homeostatic system, producing general and unspecific neurophysiological activation from one level of arousal to a higher level of arousal.

This alarm or stress response is healthy and necessary whenever there is a discrepancy between what should be (set value (SV)), and the real value (actual value (AV)) of the same variable. The response is necessary for performance whenever we are faced with a potentially dangerous situation, but it is also a necessary for our everyday dealing with small and not so small problems. There are circumstances where the arousal level becomes too high for adequate performance, known as the "lamp fever collapse", or from anecdotal evidence from university exams. Little is known as to whether this really happens under military operations. A more likely threat to performance requiring high levels of arousal is lack of rest and sleep under prolonged activity, as may happen under operations requiring several days, or simply under prolonged periods of wakefulness required under long haul transports (Bowles et al 2000). The present position is that high levels of arousal become incompatible with high levels of performance only in situations involving a high level of information load.

In the scientific debate a current problem is to what extent this arousal response may lead to illness and disease if sustained or if repeated "too often". The original version of CATS postulated that activation

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may lead to pathology through well established pathophysiological mechanisms, however, only if sustained. Later research has proven it difficult to establish sustained activation; homeostatic mechanisms take over and bring the system back to equilibrium. It still appears to be a possible hypothesis if one is accepting disturbances in diurnal rhythms and sleep as a pathophysiological risk factor (Akerstedt and Nilsson 2003). From a mental health point of view the most elaborate development of the CATS hypothesis is the perseverative cognition hypothesis of Brosschot et al (2005, 2006). Patients with complex and unspecific health complaints tend to ruminate over their situation, directing their attention to their problems, and keeping a central, cognitive activation. Within CATS, this may lead to a sensitisation to signals from the body, which may be par and parcel of the normal feedback from the body. However, the signals may acquire an increased value and increase attention to the extent that fairly normal somatic feedback become overwhelming somatic complaints, for instance as muscle pain and fatigue.

The second possibility is that repeated taxing of the homeostatic mechanisms may represent some sort of strain, through non-defined mechanisms. The most quoted is the assumption of an "allostatic load" (Sterling and Eyer 1988, McEwen 2007). Allostasis means "to stand in variability", introduced as an antonym to the well-spread term homeostasis meaning "to stand equally". The argument is that the term homeostasis may be misleading since it may imply that different systems are kept constant at a "normal level". An insufficient restitution leads to a sustained arousal, much in the same way as the CATS hypothesis. McEwen has developed the concept further. Allostasis is regarded as a necessary process to support homeostasis with a particular emphasis on systems essential for life such as maintenance of body temperature, pH, and oxygen tension. It remains unclear at least to the present author why this should lead to strain and what pathophysiological processes may be involved.

STRESS DAMPENING MECHANISMS

The level of alarm depends on the expectancy of the outcome of stimuli and the specific responses available for coping.

Stimulus expectancies may be positive or negative, or simply based on a lack of information. An alarm response based on uncertainty or expectancies of negative events may be dampened by psychological defence mechanisms which, in CATS, are defined as distortions of stimulus expectancies (Olff et al 1991, Ursin and Eriksen 2004). Defence is an important dimension, but difficult to measure. The consequences of high defence mechanisms are controversial. In some data sets high defence may help to reduce fear, however, the price may be high; it may interfere with performance when life depends on accurate perception of dangerous situations (Olff et al 1991). This perceptual defence mechanism described by Olff et al may be relevant for military operations. It may differ from the concept as used in psychodynamic thinking. In analyses of event related potentials personnel with high defence mechanisms appear to use more time to analyse even the quite simple stimuli that are used in these experiments. The authors suggested that this may a psychobiological mechanism for their difficulties in perceiving threatening stimuli correctly (Eriksen et al 2000).

Response outcome expectancies are defined as positive, negative, or none, to the responses available to that particular individual (Levine and Ursin 1991, Ursin and Eriksen 2004). These definitions are the basis for formal definitions of coping, hopelessness, and helplessness. The advantage of such definitions is not only precision, it also makes it much less interesting to discuss the relative virtues of words (coping, control, mastery, and efficacy) which may in reality cover the same dimensions. Another advantage is that these formulations make it possible to operationalise the dimensions in man and in animals. Finally, when "coping" is defined as positive outcome expectancy and related to psychophysiological activation, the concept acquires predictive power for physiology, pathophysiology, and relations to health and disease (Levine and Ursin 1991, Ursin and Eriksen 2004).

The starting point for the development of CATS was observations of the behaviour of intact cats that have learned avoidance behaviour. The bahaviour is a remarkable contrast to that of a cat before it has learned the correct behaviour. During the early acquisition trials in an avoidance experiment, there is a high level of arousal with the accompanying "autonomic" and behavioural phenomena. Once the habit is acquired, all this is gone. The cat jumps willingly into the test box, sits quietly between trials, purrs, grooms itself, and jumps graciously and in great calmness to the safe side of the apparatus.

Why does an animal motivated by fear not look frightened? Even more important: do these data transfer to humans? What happens in humans, faced with a frightening and potentially dangerous task, once the proper behaviour has been established?

Ursin, Baade, and Levine (1978) tested this in an experiment with parachutists. In a training tower situation, the subjectively reported fear and the vegetative and endocrine responses to the jump were reduced after the first training sessions, long before their performance had reached any acceptable level. It was not the performance, or the feedback from evaluation of the performance, that mattered, it was the subjective feeling of being able to master the task that reduced the stress responses.

CATS define coping as positive response outcome expectancies. This means that the individual has established the expectancy that he or she or it will be able to handle the situation with a positive result. The definition is applicable to animals as well as humans. In these situations, there are low levels of psychophysiological, psychoendocrine, and psychoimmune arousal.

On the other hand, when the individual learns that there are no relationships between anything the individual can do and the outcome, the acquired expectancy is referred to as helplessness. Helplessness occurs when the perceived probability of avoiding the aversive stimulus with a response is the same as for no response. In other words, the response is without any perceived consequence for the occurrence of the aversive event. The organism has no control. This expectancy has been accepted as a model for anxiety and depression. Since the CATS formulations are valid for animals as well, this is a useful theoretical basis for animal models for depression and anxiety.

Things may be even worse. When the individual has learned that most or all responses lead to negative results, the acquired expectancy is referred to as hopelessness. Hopelessness is more directly opposite of coping than helplessness, since it is a negative response outcome expectancy. There is control, responses have effects, but they are all negative. The negative outcome is his or her fault since the individual has control. This introduces the element of guilt, which may make hopelessness a better model for depression than helplessness (Abramson et al., 1989).

The reference to expectancies is crucial for the CATS arguments. Learning is regarded as acquisition of expectancies; this eliminates some of the difficulties in the comparison of data from animals and humans. This approach makes it easier to understand why a rat decreases arousal from the presentation of food or water; it is not the consummation, the signal that food or water is coming is enough (Coover, et al., 1984). A fish brought into a new environment shows very high levels of arousal; however, the presence of bottom material where the fish may hide is enough to reduce this arousal (Höglund et al., 2005).

THE POTENTIAL PATHOPHYSIOLOGY OF "STRESS"

The short lasting activation phasic arousal when individuals handle a difficult task has no ill effects in the healthy organism. The real concern is sustained arousal occurring when there is no solution. For the traditional psychosomatic diseases, sustained high levels of arousal may contribute to the development of pathology, interacting with genetic and environmental factors. The main contribution to illness and impaired social and working life is the effects on subjective health complaints where there is no or

minimal organic change, as muscle pain, fatigue, or gastric complaints (Eriksen & Ursin 1999). For these conditions it is necessary to go beyond traditional psychosomatic theory.

Muscle pain, fatigue, mood changes, and gastric complaints are very common, so common that the plurality of the Norwegian population has had several such complaints over the last 30 days (Ihlebæk et al., 2002). The transition from the "normal" complaint to serious conditions requiring medical assistance seems to be a continuous process, with no clear or objective thresholds to indicate a distinction. This gradual transition suggests a sensitisation process (Eriksen & Ursin 2004).

The striking comorbidity for the subjective health complaints also indicates a common, underlying mechanism. For instance, patients referred to a back pain clinic for low back pain do not have back pain only, they also complain about general pain, headaches, tiredness, anxiety and depressed thoughts (Hagen et al., 2006). This is explained within the cognitive perseveration hypothesis of Brosschot et al. (2005, 2006). An attention bias gives priority to thoughts and information related to fears and somatic complaints. Patients with subjective health complaints show sensitisation and extensive activation of cognitive networks related to illness and pain. Brosschot refers to this as the "night and day watch" of the sensitised organism. We use this idea as an important element in our present cognitive treatment programs for muscle and back pain, as well as for fatigue (Reme & Chalder, 2008).

COMPARISON WITH OTHER THEORETICAL POSITIONS:

Karasek and Theorell

In the analyses of potential psychosocial factors as modifiers or direct causes of ill health, there are essentially two overlapping traditions. One tradition emphasizes the formal or "objective" work conditions, and the other focuses more on the stress management potential of each employee. CATS is probably the most extreme in its emphasis on individual factors, the best known and most influential "objective" model is the demand-control model of Karasek and Theorell (1990). There is a strong consensus that it is the combination of psychological demands, task control and skill use at work that predicts stress-related ill health and behavioural correlates of work. Jobs with high demands, low control, and low social support carry the highest risk of illness and disease. Low psychological demands and high levels of control carry the lowest risk. Jobs with high psychological demands and high control, and low psychological demands and low control, carry an average risk. A considerable amount of data demonstrates significant relations to disease, in particular to cardiovascular disease (Theorell and Karasek 1996).

In later developments Theorell has much more emphasis on individual stress management, coping abilities, and subjective feelings of being in control or being able to cope . One important aspect of coping, locus of control , relates to the individual's attitude to his/her own possibility to exert control over his/her environment. An external locus of control means that the individual expects the environment to solve his/her problems while internal locus of control corresponds to the attitude that the individual has to take care of the problem himself/herself. Neither the extreme internal nor the extreme external locus is recommendable in all situations.

In recent works, Theorell has defined "*covert coping"* (Theorell et al 2000). When meeting difficulties that cannot be dealt with one possible strategy is to establish success in other fields of life. This relates to depression, passive avoidance, and defensive behaviours, and are related to illness and disease risks. One particularly unfortunate strategy available to humans is to "take it out" on family members when the job situation is intolerable. This is similar to "displacement" strategies in animals. Frustrating important behaviour patterns may lead to strange or inadequate responses like meaningless pecking on the cage (Toates 1995). Within CATS, this shift from one motivational system or behaviour to another is related to

the hierarchy of motivational systems, which, in CATS, is related to the probability of correcting the set value/actual value imbalance attached to each motivational system (Ursin and Eriksen 2004).

In order to find out how important the individual expectancy is for subjective health complaints, a study was conducted by Eriksen et al. comparing two questionnaires, one based on the CATS position and one on the Karasek Theorell model. One set emphasized the more "objective" control mechanisms available to the individual, and the other the more "subjective" type of response outcome expectancies. In both models the health effects depend on the combination with the psychological demands. In the classical demand-control model, high demands may cause illness and disease if the individual does not have control in the work situation. The results showed that in this study "coping" had more impact on all subjective health complaints than "control". The combination of high demands and low coping turned out to be the worst combination (Eriksen and Ursin 1999).

Siegrist's Effort-Reward model

Another theoretical model of work stress that has received much attention is the effort-reward imbalance model, where the focus is on reward and contractual fairness in employment (Siegrist 1996). This model builds on the notion of contractual reciprocity that lies at the core of the work contract, with respect to which accomplished tasks are reciprocated by adequate rewards (money, esteem and career opportunities, including job security). The model claims that lack of reciprocity occurs frequently under the following three conditions: (i) "dependency" (due to a lack of alternative choice in the labour market); (ii) "strategic choice" (anticipatory investments in order to increase future promotion prospects); (iii) "overcommitment" (a motivational pattern of excessive work-related performance and achievement that may be part of a person's psychological profile or result from competitive work environment). The model further suggests that failed reciprocity in terms of "high cost" and "low gain" elicits strong negative emotions and sustained stress reactions.

The potential contribution from CATS is to offer a pathophysiological model for these findings. Within CATS, the effort-reward imbalance is clearly a discrepancy between set values and actual values, resulting in sustained activation which, again, may result in pathophysiological consequences. No pathophysiological consequences are to be expected if this imbalance is of short duration, it is the long lasting imbalance that matters, and only if the reward has a high affective value.

Other stress models

Coping is often defined as the acts or strategies chosen ("Ways Of Coping", a very important questionnaire (Lazarus and Folkman 1984). However, the strategy chosen does not predict the result or the internal state; it may be executed in high as well as low arousal, therefore, it does not predict health effects (Ursin and Eriksen 2004).

The concept of "control" is found in many other models than the original demand-control model. The generalization of the expectancy from one situation to all situations is an important aspect, for the response outcome expectancies in CATS (Levine and Ursin 1991, Ursin and Eriksen 2004), and in the Rotter "locus of control" (Rotter 1975). Self efficacy (Bandura 1982) is another related concept, defined as the belief that an individual can act in a way that leads to a particular goal. When this expectancy is generalized and related to an event with high affective value, it becomes close or even identical with the CATS coping concept. The generalized self-efficacy (and coping) concept relates to self esteem and neuroticism, as measured with standardized questionnaires (Judge et al 2002). There are also other related and overlapping terms. Toughness, an increased ability to deal with the stressor (Dienstbier 1989), develops through repeated exposures to a variety of stressors. Other related concepts are hardiness (Kobasa et al 1982), high self-esteem, affective stability (Zorilla et al 1995), mastery Pearlin et al 1981), sense of

coherence (Antonovsky 1987), and older concepts like the “instinct of mastery” of Hendrick 1943), and the effectance concept of White(1959).

Interventions based on individual coping models: Rehabilitation

There is an increasing concern in Norway as well as in other Western countries about the ever increasing number of disability pensioners falling out of work before the time of retirement. In the years to come, a decreasing number of employees will have to carry the increasing expenses of the pensions, to a point where these costs will no longer be possible to fulfil after the year of 2050.

In Norway, one third of all disability pensions (DP) is due to disorders in the musculoskeletal system. Magnussen et al. (2007 a) conducted a study where the main goal was to investigate the effect of a brief vocational-oriented intervention, aiming to help disability pensioners with low back pain back to work. Primary outcome measures were return to work or having entered a return to work process. The intervention had no significant effect on these outcome measures. Magnussen et al. also explored the issue of perceived barriers for returning to work through a focus group based qualitative study. The barriers appearing were related to earlier negative experiences, poor self-judgement of work ability and low self-esteem, lack of support from social security authorities and unsuitable economic arrangements (Magnussen et al 2007 b).

The studies conducted by Magnussen et al. confirm that the attempt to return disability pensioners back to work is a challenging task. Due to the large economical implication of returning disability pensioners to work, the modest effect of the intervention used in her studies may still be of clinical and economical relevance, at least for a selected group of pensioners.

CONCLUSION

CATS differs from many other approaches to "stress" in the emphasis on the positive health consequences of the normal alarm response, occurring whenever the organism is lacking an essential factor. The CATS theory is an expansion of general arousal and activation theory from neurophysiology. The stress responses are normal activation responses leading to an increase in arousal, and corresponding changes in behaviour as well as in most or all parts of the body. These somatic changes are mediated through well described and well understood mechanisms in psychophysiology, psychoendocrinology, and psychoimmunology.

CATS differs from more organisational and social theories in the extreme reliance on individually acquired expectancies to future events. When these expectancies are positive, there is no health risk in a healthy organism. Ill effects occur only when there is a lack of positive outcome expectancy (coping). CATS offers strict definitions of two different expectancies occurring when there is no coping: Helplessness and hopelessness. Both states may lead to somatic disease through sustained arousal. Both states may also lead to somatic disease and illness through a lack of motivation to engage in positive life styles. CATS, therefore, offers a new and alternative explanation for social differences in health, based on social differences in the reinforcement contingencies for the development of coping.

It seems to be a fair statement that psychology and psychiatry often appears as controversial and with a low level of consistent terminology. At least some of this is due to inconsistent use of language, with one term covering many dimensions, or one dimension covered by many terms. CATS offers formal definitions that may be expressed in symbolic terms which makes it possible to arrive at clear definitions and consistent use of language. The formal definitions also permits comparisons across species, without referring to non-verifiable assumptions of "mental" activities beyond the assumption that brains handle information according to basic logic principles.

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