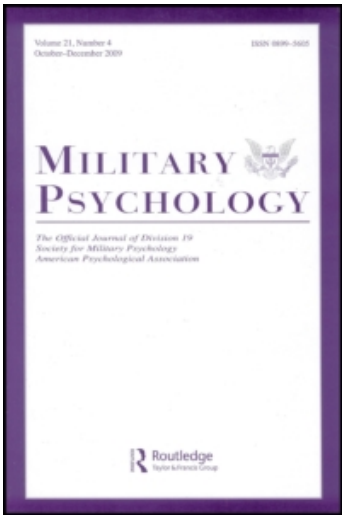

Military Psychology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t775653681

Performance on the Very Edge

P. A. Hancock[a]
[a] University of Central Florida, Orlando, Florida

To cite this Article Hancock, P. A.(2009) 'Performance on the Very Edge', Military Psychology, 21: S1, S68 — S74
To link to this Article: DOI: 10.1080/08995600802554680
URL: http://dx.doi.org/10.1080/08995600802554680

MILITARY PSYCHOLOGY, 21:(Suppl. 1)S68–S74, 2009

ISSN: 0899-5605 print / 1532-7876 online
DOI: 10.1080/08995600802554680

Performance on the Very Edge

P. A. Hancock
University of Central Florida, Orlando, Florida

Functions that have traditionally related stress to capacity show a graceful degradation in performance as stress level ascends above an optimal point. In contrast, this work advocates for a threshold model in which performance stays relatively stable up to a critical point. This article focuses on capability in and around this point and thus performance on the very edge of failure.

PREAMBLE

Our military forces today are engaged in fuzzy conflicts. They must seek to suppress a largely urban-based guerrilla form of insurrection while simultaneously engaging in putative nation-building involving the indigenous populace who may often be portrayed as, or confused for, potential enemies. These highly uncertain and often ambiguous missions must be performed against the background of often significant levels of environmental stress and, of course, in a cultural milieu far removed from the familiarity of home. That the forces succeed, even to the degree they do, is testament to their professionalism and adaptability, but what are the short-term, acute effects on their performance and response capabilities and what of the long-term, chronic effects on their levels of resilience and rebound from multiple deployments? For it is the integrated sum total of sources of stress, expressed over either a few seconds of mayhem, or many months of monotony, that dictates the potential for soldier systemic failure or the continued success in sustained operations. Here, I will argue against the traditional formulation that describes the etiology of such failure and will offer a more veridical alternative. What this latter description means for sustained operations will be articulated in the conclusion of the work.

Correspondence should be addressed to P. A. Hancock, Department of Psychology, and Institute for Simulation and Training, University of Central Florida, Orlando, FL 32826. E-mail: phancock@pegasus.cc.ucf.edu.

THE FALLACY OF GRACEFUL DEGRADATION

Exactly 100 years ago, an experiment conducted by Yerkes and Dodson (1908) provided the foundation for what is still considered the modal description of performance variation under stress today. I shall not articulate all of the reasons why this extrapolation into a "law" of stress and performance is so flawed since both I and others have repeatedly done so before (Baumler, 1994; Brown, 1965; Hancock, 1987; Hancock & Ganey, 2003; Holland & Hancock, 1991). All that I will note is that the inverted-U continues to be promulgated today and dominates undergraduate texts and explanatory discussion sections of many scientific papers. Part of its appeal is that the inverted-U never saw a data set it could not explain (Teigen, 1994). It is hard to exterminate a myth, especially when it has such a strong and profound appeal to what is euphemistically known as "common sense" and it is well known to anyone who tries that such formulations can never be countermanded by data, however powerful their empirical foundation (see Hockey, 2008; Hockey & Hamilton, 1983). Further, I should note that the end-points of the inverted-U continuum are perfectly accurate representations at the very terminus of response capacity and also the central locus must indeed lie above these end-point failures. What is at issue is the morphology of the curve itself. Is it indeed a curve with a single, optimal point, or is it rather a much more extended-U with a strong and consistent plateau of performance at its peak? At first, this might appear to be a very esoteric and indeed academic question and one that greybeards can debate to their heart's content high in their ivory towers. However, in reality it is a deadly issue and one upon which the fate of many lives turn. This is particularly true for performance in extremis, which often characterizes military circumstances. Why should the shape of this curve be of such concern? The simple reason is that the inverted-U implies that you can see, and thus anticipate, incipient performance failure by the slow and systematic breakdown of someone's capacity as the stress level increases. It implies that if you watch carefully enough, you can observe this process of failure and thus pull them out of the situation before they collapse, endangering themselves and others around them. But this idea of graceful degradation simply is not true. It fosters a false sense of security that you can predict when your forces are reaching, but have not yet encountered, their very limit. It provides commanders and supervisors with an unfounded sense of confidence when incipient collapse is actually about to occur. The reason I dispute this curve is that its implications can be deadly.

FROM THE INVERTED-U TO THE EXTENDED-U

However, if the inverted-U is not correct, exactly how do people behave across the continuum of stress? The answer is to be found in the extended-U shaped formula-

tion that I and my colleague Joel Warm have presented (see Hancock & Warm, 1989). This description, based upon both physiological and behavioral changes in response capacity, argues that there is a platform of performance across which response stays relatively stable (see Figure 1). In contrast, in the inverted-U there is no obvious, graceful degradation. Rather, when adaptive capabilities begin to reach the edge of exhaustion, there is a rapid and precipitate drop-off in capacity. Symptoms that characterize this phase change are not found primarily in the mean of performance but rather become more evident in the variability of performance.

It should be further noted that the artificial separation between physiological and behavioral aspects of adaptability is largely dictated by scientific convention and is, in reality, merely different discipline-based reflections of the same fundamental capacity. Thus, changes in levels of behavioral comfort, levels of task-response performance, and levels of physiological compensation are all expressions of the way the body deals with the proximal and distal sources of stress presented to it. Consequently, this is a theoretical formulation and capacity description that goes beyond task performance alone. The driving forces of hypostress (the extreme boredom of have little or nothing to do or the rote repetition of an unchanging round of duties) and hyperstress (the overwhelming avalanche of demands) each drive the individual toward their response limits. Most often, the chronic

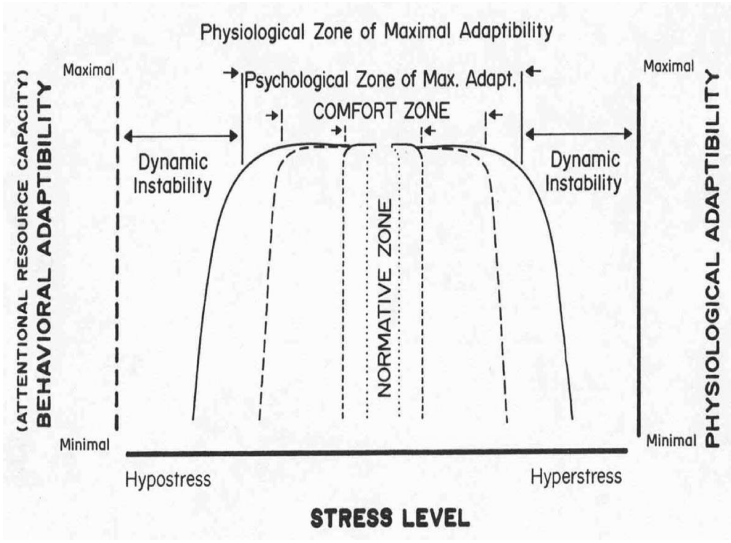

FIGURE 1 The extended-U description of capability under stress by Hancock and Warm (1989). The central regions provide an extensive region of relatively stable performance capacity bounded by regions of dynamic instability. Unlike the inverted-U there is no graceful degradation but rather a rapid and distinct precipice of performance failure at the extremes of stress. Changes in capability and response at these thresholds are described in Figure 2.

effects of underload and boredom are underestimated because the individual can appear to have "little or nothing to do." However, as we know from sensory and perceptual deprivation studies, this can be a hidden but deadly form of stress imposition. One critical question becomes what characterizes these very edges of response failure, and it is to this I now turn.

If we look at the Hancock and Warm (1989) model as illustrated in Figure 1, we can see regions denoted by the limits of maximal adaptability. At these limits, there is a sudden, precipitate decrease in capacity and it is these "shoulders of failure" that are now considered in detail. In Figure 2, there is a magnified illustration of these phase transitions of failure.

As can be seen from Figure 2, the edge of stability is characterized by a twin change of behavioral capacity. Most evident is an increase in response variability. Expressed as the second moment of a response distribution, this measure is a reflection of entropy. For the commander on the ground, this will be observable as "erratic" behavior (e.g., shooting without aiming, improper individual movement techniques, disregard of collateral damage, etc). The absolute level of capacity

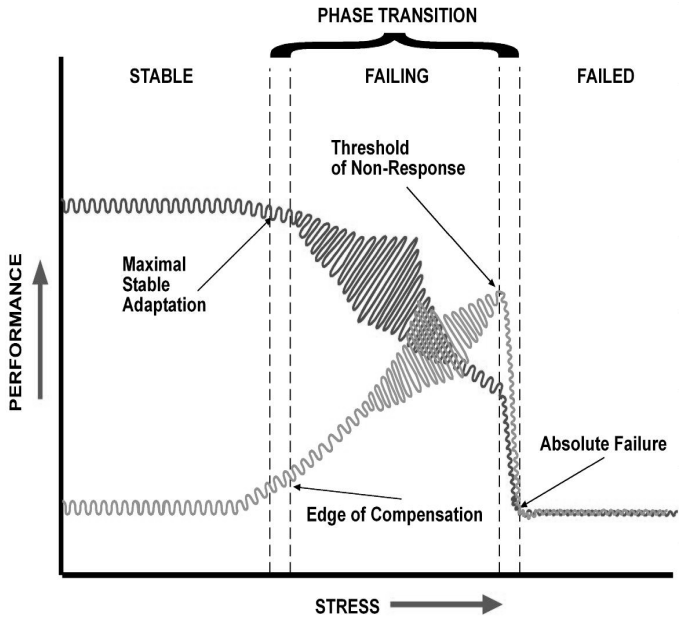

FIGURE 2 Performance capacity failure at the edge of adaptability. The extended-U description indicates that performance remains relatively stable for extensive ranges of stress (expressed at the left of the illustration and extending well out to the left as shown in Figure 1). As failure begins to be expressed, we see an increase in the variability of speed of response (upper line) and error of response (lower line). These are symptoms of a phase transition.

may not immediately change but the fluctuation in that capacity will begin to become more and more obvious. If one is able to observe both the speed of response and the accuracy of that same response, then this trend will become evident in both aspects of response. Initially, it resembles a beta change in signal detection theory (see Hancock, Masalonis, & Parasuraman, 2000). However, this is only a surface appearance because the actual phase change into an incipient failure mode is in the process of occurring. It should be understood that since comfort, performance, and physiological adaptation are all expressions of the same basic capacity, these self-same failure transitions will be seen as the individual crosses each sequential threshold. In military operations we are seldom vitally concerned with comfort, much more so with performance and crucially involved with physiological survival. However, the same emergent failure properties in the face of stress are experienced in all three sequential failures, although, of course, comfort is fractured well before performance exhibits any change and physiological failure is, at that stage, far down the road.

STRESS IN THEORY, STRESS IN PRACTICE

It is a long way from the groves of academe to the mountains of Tora Bora. What scientists discuss in their crowded conference rooms must be translated to real-world implementation in wild and lonely places where it is frequently kill or be killed. Unlike the ubiquitous undergraduate student, the soldier on the ground cannot "give up," forfeit his extra credit, and retire to a warm and comfortable dorm room. Often they must "gut it out" in conditions in which surrender is simply not an option. What then of the results of our careful and meticulous experiments predicated upon the protective principles of risk-averse human subjects review committees? We must collectively acknowledge that often our understanding is derived from conditions in which the imperatives to action vary so widely that it is perhaps even dangerous to extrapolate the understanding derived from the one circumstance and apply it to the other. However, this does not mean that we cannot make useful and practical observations, as I hope the foregoing remarks are. What we have to assert is that the graceful failure, advocated in the inverted-U description, often derives from the averaged performance of individuals for whom giving up is a clear and sometimes preferred option. We do a great disservice when we apply this conceptualization to those who possess no such option.

Often, in works such as the present one, we talk extensively of "hot" combat conditions in which the bullets are flying and the enemy is actively engaged. It is the stuff of news media and of movies and it naturally attracts the attention of scientists in the same way that it attracts the attention of all people. However, much of military service is a relatively rote and boring repetition of circumstances in which nothing much happens. Although the U.S. military has outsourced many of its an-

cillary functions, there are still an overwhelming majority of tasks that are not involved with the use of arms and even those of a highly dangerous nature, such as patrolling in a HUMMWV, do not involve combat for the most part. Soldiers are subjected to the same chronic stresses and strains that we all face, except they do so under continuous, adverse conditions of potential threat. These sources of stress from home and from location may seem somewhat pallid and insipid compared to the action expressed in portrayals such as *Blackhawk Down*. Nobody pays to watch a 6-month-long movie of a soldier doing nothing much! Yet these apparently "minor" sources of irritation can themselves build up to push the soldier near to breaking point. Like the observation made earlier on chronic underload, they do not seem to be obvious sources of major momentary stress and so we underestimate their potential for long-term damage. However, even the highest mountain can eventually be destroyed by the slow but steady drip of erosion. Long-term chronic sources of stress can thus often hide themselves and "fly below the radar"; nevertheless, they can be equally as destructive in long-term effect as the bullets that soldiers fight so hard to avoid. If we view these as small nudges across the base of the Hancock and Warm (1989) model shown in Figure 1, it is easy to see that, eventually, the sum of these small accumulations will push the soldier over the edge as effectively as a sudden, excessive demand threatens to.

A CONCLUDING NOTE ON AFTER EFFECTS

It is perhaps the very essence of the human animal that it expresses the highest level of adaptability of all living organisms. It is quite remarkable what human beings are able to respond and adapt to. They can live and even prosper in geographical regions close to the very edge of physical tolerance. Humans thrive in both arctic and desert conditions, at altitudes close to the "death zone," and in urban jungles where violence can abound. Adaptations, both physiological and cultural, are amazing to behold (e.g., the Sherpa of the Himalayas). Yet these adaptations are not to be had without a cost. Living on the edge of physiological tolerance takes great skill and the untrained individual exposed to such conditions often simply dies. In conflict scenarios also, our soldiers have to adapt to a background of constant threat and constant cultural disconnection. These are chronic and invidious sources of stress. Yet our soldiers accomplish this and do so with facility in part because their training helps them to achieve this degree of adaptation and assimilation. But what is stable behavior for the streets of Fallujah or the highways of Hellmand Province does not play well on Rodeo Drive or even downtown Muncie, Indiana. The returning soldier is still attuned to the stresses of an environment that have now radically changed. Readaptation to one's old life takes a considerable period and the better one is attuned to the conflict environment, the longer and harder it is to reattune to the home environment. Yet we have relatively little training to as-

sist our soldiers in adapting to home conditions on the assumption that they can immediately reintegrate, even after months, if not years, of deployment. This also is a form of stress that we have to face and overcome. Response at the very edge implies restrictions of neither time, nor space, nor threat. If we are to ask individuals to constantly and consistently perform in such regions, we have to provide the very best of our science to support them.

ACKNOWLEDGEMENTS

This work was supported by grants from the Army Research Office under ARO-DAAD19-01-1-0621, Mitigating Stress, Workload, and Fatigue on the Electronic Battlefield, Elmar Schmeisser, Grant Monitor; and the Army Research Laboratory under ARL, Task Order 81 under Contract DAAD19-01-C-0065, Scalable Interfaces for Dismounted Soldier Applications, Mike Barnes, Grant Monitor. The views expressed here are those of the author and not necessarily those of any of the named agencies.

REFERENCES

Baumler, G. (1994). On the validity of the Yerkes-Dodson law. *Studia Psychologica, 36*, 250–259.

Brown, W. P. I. (1965). The Yerkes-Dodson law repealed. *Psychological Reports, 17*, 663–666.

Hancock, P. A. (1987). Arousal theory, stress and performance: Problems of incorporating energetic aspects of behavior into human–machine systems function. In L. S. Mark, J. S. Warm, & R. L. Huston (Eds.), *Ergonomics and human factors*: *Recent research.* (pp. 170–179). New York: Springer-Verlag.

Hancock, P. A., & Ganey, H. C. N. (2003). From the inverted-U to the extended-U: The evolution of a law of psychology. *Journal of Human Performance in Extreme Environments, 7*(1), 5–14.

Hancock, P. A., Masalonis, A. J., & Parasuraman, R. (2000). On the theory of fuzzy signal detection: Theoretical and practical considerations and extensions. *Theoretical Issues in Ergonomic Science, 1*, 207–230.

Hancock, P. A., & Warm, J. S. (1989). A dynamic model of stress and sustained attention. *Human Factors, 31*, 519–537.

Hockey, G. R. J. (2008). From theory to practice: Commentary on Bartlett. *Ergonomics, 51*, 21–29.

Hockey, G. R. J., & Hamilton, P. A. (1983). The cognitive patterning of stress states. In G. R. J Hockey (Ed.), *Stress and fatigue in human performance* (pp. 331–361). New York: Wiley.

Holland, F. G., & Hancock, P. A. (1991, June). *The inverted-U: A paradigm in chaos.* Paper presented at the Annual Meeting of NASPSPA, The North American Society for the Psychology of Sport and Physical Activity, Asilomar, CA.

Teigen, K. H. (1994). Yerkes-Dodson: A law for all seasons. *Theory and Psychology, 4*, 525–547.

Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit formation. *Journal of Comparative Neurological Psychology, 18*, 459–482.