

From the Inverted-U to the Extended-U: The Evolution of a Law of Psychology

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The Yerkes-Dodson relationship is one of the oldest 'laws' in behavioral research. It is used repeatedly as an explanation for stress effects on performance and is a fixture of undergraduate psychological texts. However, as is the case of most classics, it is more cited than read. In actuality, Yerkes and Dodson's report dealt with animal learning under states of compulsion and is only tangentially related to human performance in stress filled conditions. Our re-evaluation is motivated by two primary circumstances. The first is the evident failure of the unitary arousal notion, which has commonly been invoked as the causal source to "explain" the Yerkes-Dodson, inverted-U relationship. The second relates to criticisms of the curvilinear description itself and its interpretations, which we present here. Together, these concerns demand not simply a re-evaluation, but a replacement of this over-simplistic and fundamentally flawed proposition. In repealing this 'law,' we offer a more sophisticated and hopefully more veridical representation, which is given primarily in the following reprinted article of Hancock and Warm (1989). This approach posits an 'extended-U' description founded upon attention and adaptability as central mechanisms of response.

Laws of Behavior

In the history of research on human behavior, very few relationships have been established to a sufficient degree so as to be called laws. The few phenomena that have achieved this status are consequently all the more valuable, since they nominally provide unique insights into general facets of human activity. Extant laws in psychology appear to share common threads in that they are founded frequently on logarithmic transformations of raw data that then provide linear descriptions between independent and dependent variables in Cartesian coordinate space. Such laws include the Hick-Hyman law of choice reaction time (RT) with increasing stimulus entropy (Hick, 1952; Hyman, 1953), and Fitts' law for the relationship between Movement Time (MT) and the speed and accuracy of voluntary movement (Fitts, 1954). More recently, Sternberg (1966) has demonstrated a linear relationship between the speed of memory scanning and the number of items to be retained in short-term memory. Also, the primed recognition of three-dimensional images dependent upon rotational angle has received acknowledgement for its lawful link between identification time and rotation angle (Shepard & Cooper, 1986). Thus, many current laws of behavior are tied to the entropic aspects of information-processing and so illustrate both descriptive simplicity and theoretical clarity in their exposition.

While the value of all such laws needs to be recognized explicitly, their origins and their potential shortcomings need to be scrutinized in detail since their effects have a critical impact beyond the realm of psychological research alone. For example, such laws can dictate design decisions and operational procedures in many complicated technological systems (see Hancock, 1997; Sanders & McCormick, 1993). Careful critiques are especially needed when both the fundamental description and the causal foundation of any law come under question. It is for these reasons that we feel it is essential to reconsider the foundation of one of the oldest laws in psychology, the so-called Yerkes-Dodson law. Originally, the Yerkes-Dodson relationship was constructed to describe the link between discrimination



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learning and aversive reinforcement. Only later was it used to relate stress to human performance capacity largely through the introduction of the mediating influence of arousal. Since arousal as a construct has also been the subject of much recent contention (e.g., Neiss, 1988) and further, since a number of descriptive alternatives relating stress to performance capacity have emerged (see Hancock & Desmond, 2001), a re-evaluation of the theoretical veracity and descriptive foundation of the Yerkes-Dodson law is clearly necessary.

The Yerkes-Dodson Experiment

The inverted-U curve describing the relationship between stress and performance is one of the most ubiquitous observations in all of psychology. Derived from Yerkes and Dodson's report, the inverted-U, supported by the unitary arousal construct, has had a pervasive influence now for several decades. We are very aware that such constructs in general are not supplanted or discarded solely on the basis of disconfirming data above. Indeed, as one author has noted "once accepted, a theory is not ousted by conflicting evidence, only by a better theory" (Poulton, 1977, p. 1078). As part of this ousting process, we should immediately note that we are not the first to frame a critique of the Yerkes-Dodson law. Indeed, there has been a sequence of critiques and criticisms over a prolonged period (see Baumler, 1994; Baumler & Lienert, 1993; Brown, 1965; Teigen, 1994). However, despite these objections the untrammelled and unquestioned publication of the Yerkes-Dodson inverted-U relationship is still repeated in a large number of introductory psychology texts (see Table 1). It was Winton (1987), who, having looked through 25 introductory psychology texts, found that at least nine incorrectly continued to cite the Yerkes-Dodson law as a relation between arousal and performance. Since that time little improvement is evident.

When citation accompanies such observations, it is most often to the original study of Yerkes and Dodson (1908). One of the most prevalent misconceptions about this oft cited but seldom read study, is that it used human participants. In reality, and following earlier work by Yerkes (1908), the experiments concerned the behavior of dancing mice¹. Also, despite confusion introduced by many commentators, the original focus was not on performance per se, but rather on differentiated rates of learning.

Since so many misinterpretations persist, it is worth looking again at the original work in more detail. The Yerkes-Dodson report is composed of three experiments designed to examine learning under different conditions

of black/white discriminability. In each experiment to reach a successful criterion, the mice were required to complete all of the 10 trials for a single day correctly and to repeat this on three consecutive days. Learning was then measured by how many days were required for the mouse to reach the criterion.

The experimental apparatus used by Yerkes and Dodson is shown in Figure 1. In the experimental procedure, each mouse was placed in each area B and was "encouraged" to return to the rest box A via the alleys (labeled E). To reach E, the mouse had to pass through either the black or white passage. The experimenter administered a shock if the mouse began down the black passage, but allowed the mouse to return unmolested to the rest box A on passing through the white passage. In order to ensure that discrimination was between the black and white boxes, they were interchanged so that individual mice did not habituate to a decision to take either the left or right passage.

In order to reduce random activity, the experimenter compressed area B to 'encourage' the mouse to make a choice. Entrance to the white passage was regarded as correct, and the mouse proceeded undisturbed. Entry into the black passage resulted in an electric shock followed by a "hasty retreat" to area B. During preliminary experimentation, mice were trained through the shock reinforcement. However, whether a correct response was recorded or whether there was a mistake, mice were allowed to return to the rest box on each trial prior to the start of another test, but only via the correct white box. Yerkes and Dodson (1908) did not report the time taken prior to a choice or whether previous mistakes had an effect upon subsequent time to initiate the next 'forced' choice. Using this specific methodology, Yerkes and Dodson ran three experiments, employing a between-mouse design, with four mice (2 males, 2 females) in each cell for each of the first two experiments, but only two mice per cell (1 male, 1 female) in the final, critical procedure.

The discriminability of each box, between which the mouse had to choose, was manipulated by changing the amount of illumination in box B. The authors were particularly careful to provide exact details of illumination level, in order to permit subsequent replication. These manipulations had the effect of the first experiment making [Set 1] the medium level in terms of discriminability (average level of lighting), whereas the second experiment, [Set 2] provided increased discriminability (higher levels of illumination) and so simplified the task. The third and final experiment in [Set 3] rendered the least discriminability (lowest illumination level) and so represented the most challenging task.

1. Dancing mice, known officially as jerker mice, are a mutation of *mus musculus* that are known to be hyperactive and, most notably, run around in tight circles. The reason for their behavior has recently been attributed to a point mutation that causes them to be deaf.

- Baron, R.A. (1998). *Psychology* (4th ed.). Boston: Allyn & Bacon.
- Fernald, L.D., & Fernald, P.S. (1985). *Introduction to Psychology* (5th ed.). Dubuque: Wm. C. Brown.
- Gergen, M.M., Suls, J.M., Rosnow, R.L., & Lana, R.E. (1989). *Psychology: A Beginning*. San Diego: Harcourt, Brace, & Jovanovich.
- Haber, A., & Runyon, R.P. (1983). *Fundamentals of Psychology*. Reading: Addison-Wesley.
- Houston, J.P., Bee, H., & Rimm, D.C. (1983). *Invitation to Psychology* (2nd ed.). New York: Academic Press.
- Lahey, B.B. (1983). *Psychology: An Introduction*. Dubuque: Wm. C. Brown.
- Lefton, L.A., & Valvatne, L. (1992). *Mastering Psychology* (4th ed.). Boston: Allyn & Bacon.
- Morris, C.G., & Maisto, A.A. (2002). *Psychology: An Introduction* (11th ed.). Englewood Cliffs: Prentice Hall.
- Roediger III, H.L., Rushton, J.P., Capaldi, E.D., & Paris, S.G. (1984). *Psychology*. Boston: Little, Brown, & Co.
- Seamon, J.G., & Kenrick, D.T. (1992). *Psychology*. Englewood Cliffs: Prentice Hall.
- Silverman, R.E. (1982). *Psychology* (4th ed.). Englewood Cliffs: Prentice Hall.

Table 1: List of introductory psychology texts that give reference to the stress-performance interaction as the Yerkes-Dodson Law.

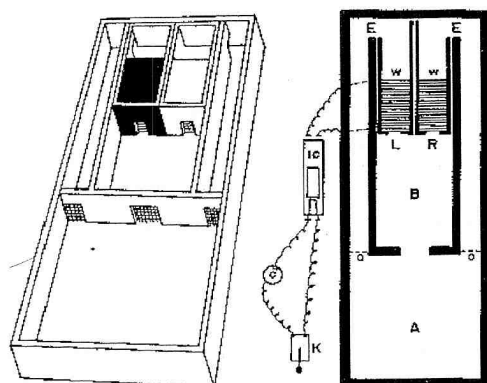


Figure 1. The original apparatus used by Yerkes and Dodson (1908).

One initial problem that faced the authors in the first experiment was the calibration of the shock level given to the mouse. Unfortunately, due to a problem with the equipment, shock level could not be accurately determined and due to this limitation the authors designated this first procedure as a preliminary test. Even though only approximate levels were reported, these levels themselves (See Table 2) have been considered inaccurate (see Baumler, 1994; Teigen, 1994). This did not deter Yerkes and Dodson from illustrating these results, but as we shall see, this inaccuracy is important especially with regard to later interpretations of these findings. In the second and third experiments, Yerkes and Dodson used a calibration curve derived for the electrical apparatus used, which allowed a much more precise quantification of the shock administered for an incorrect response.

The original results of Yerkes and Dodson are reproduced in Figure 2. This shows that in Experiment 1, three levels of electric shock were evaluated. The first was marginally above threshold, while the highest condition was noted as extremely disturbing. The middle value remained just that, an unspecified intermediary. In Experiments 2 and 3, five and four levels of calibrated shock were used, respectively. The overall study loses some of its elegance when we realize that the three data sets are based on different stimulus strength values (the strongest shocks used being different for each of the three tasks). This becomes a problem in interpretation since it is clear that the fifth stimulus level, present in Experiment 2, continues in an almost linear decrease in trials to criterion.

The published account suggests that it was the authors' intention was to conduct one single experiment. The preliminary data of Experiment 1 were provocative enough such that Yerkes and Dodson conducted the second and then the third experiment in an attempt to determine just what had occurred to produce their initial curvilinear function. Yerkes and Dodson felt that these preliminary results needed "a more exact and thoroughgoing examination of the relation of strength of stimulus to rapidity of learning" (1908, p. 472). As a result, they decided to proceed by first making the discrimination task easier (by allowing more light to enter the white box), and using five rather than three levels of shock.

As predicted, the learning speed was facilitated by this manipulation, but the U-shaped function was not reproduced in this second experiment (see Figure 2). Although the weakest stimulus still gave the slowest rate of learning, the strongest stimulus now led to the most rapid learning, yielding an approximately linear relationship, which confirmed the original hypothesis set forth by the authors. Clearly, these results contrasted with the findings for Experiment 1 and so, as a result of these contradictory trends, Yerkes and

| | Strength of Stimulus (in unknown units) |
|------------------------------------|--|
| Experiment 1 (Average Lighting) | Weak (125+/-0) Medium (300+/-25) Strong (500+/-50) |
| Experiment 2 (Bright Lighting) | 135 195 255 375 420 |
| Experiment 3 (Dim Lighting) | 135 195 255 375 |

Table 2: The experimental design used by Yerkes and Dodson (1908). The independent variable in each experiment was strength of stimulus. Illuminance of the experimental box was a between experiment variable.

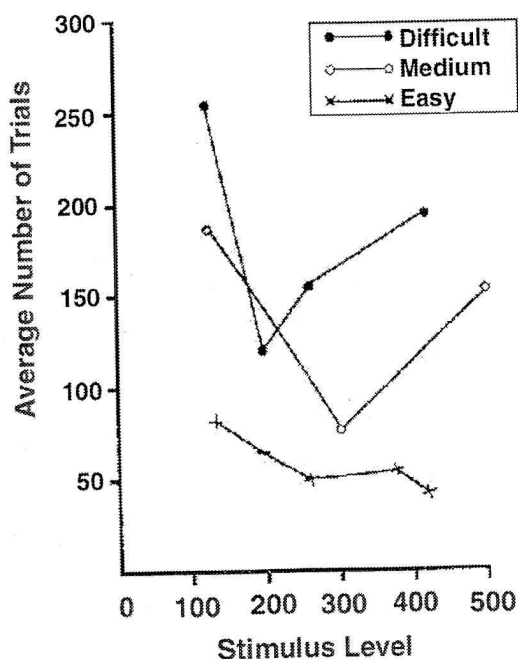


Figure 2. Original data from the study by Yerkes and Dodson (1908) showing the effects of three levels of discrimination difficulty and shock level administered on the average number of trials each mice group took to achieve the required criterion. The different objections to the findings of each of the three series of experiments are detailed in the text. The experimental design used by Yerkes and Dodson (1908). The independent variable in each experiment was strength of stimulus. Illuminance of the experimental box was a between experiment variable.

Dodson performed the third and final experimental sequence, to resolve this ambiguity. In this latter experiment, the authors again manipulated the discrimination difficulty level. Results from this final procedure proved similar to those from the first experiment, which led Yerkes and Dodson to conclude that "as the difficulty of discrimination is increased the strength of that stimulus which is most favorable to habit-formation approaches threshold" (1908, p. 481).

One of the main points for arguing against subsequent interpretations drawn from these findings lies in the fact that Yerkes and Dodson themselves connected none of these observations with stress and performance which came to be associated with the law bearing their names. In fact, Teigen's (1994) comment is most relevant here since he notes that "to the animal experimenter of 1908, speed of habit-formation is speed of habit-formation and nothing else. The tasks vary in 'difficultness of discrimination,' and strength of shock is simply 'strength of stimulus' with no attempt to speculate about its aversiveness, or its emotional or motivational significance" (p. 528-529). As we should understand, the original authors cannot be held accountable for subsequent ways in which others have misinterpreted their findings.

The extension of this program of experimental work examined comparable effects in other animal species. In the decade following this initial work, further experiments sought to elaborate on Yerkes and Dodson's findings (see Cole, 1911; Dodson, 1915). Even though Cole's was the closest to a complete replication of the original experiment, using chicks instead of mice, his data yielded a linear decrease in learning rate with increased shock, seen in Figure 3. These data are never cited by those who use Yerkes and

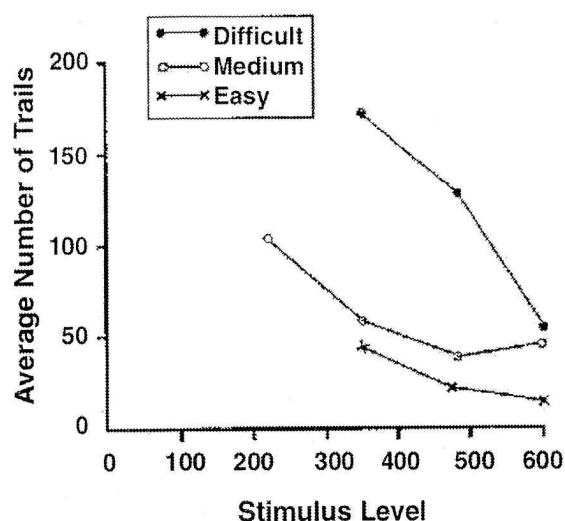


Figure 3. Results from a comparable experiment by Cole (1911) using chicks, instead of mice. Should the supposed optimality by stress by complexity pattern represent a ubiquitous learning phenomenon then these results should coincide with those given originally by Yerkes and Dodson (1908). As is evident, these results fail to support such a conclusion.

Dodson (1908) as the fundamental foundation of the inverted-U description.

The Inverted-U Description

Laws can be purely empirical, although few scientists are content to leave them as such. Since we examine the causal mechanisms associated with the inverted-U later, let us summarize here the *descriptive* characteristics of the inverted-U postulate. It is evident that the derivation of the inverted-U from the original Yerkes and Dodson (1908) work is fraught with problems. The alarmingly small number of mice per cell in the design and the arcane method of test success leave even the more reliable observations open to significant challenge. The criterion of success is a primary concern. In order to be considered successful, the mouse had to complete each of the 10 trials given on one day correctly and then had to repeat this success for three consecutive days. In this situation, a mouse could make a mistake on the first trial of one day, followed by nine correct trials. Then, with two perfect days the mouse would approach the success criterion. But supposing the mouse made a mistake on the last trial of that third day. This would mean 38 consecutive, correct trials without overall success being achieved. Figure 5 shows the original data, transformed by using a criterion of 10 successful trials only. As is clear, all of the

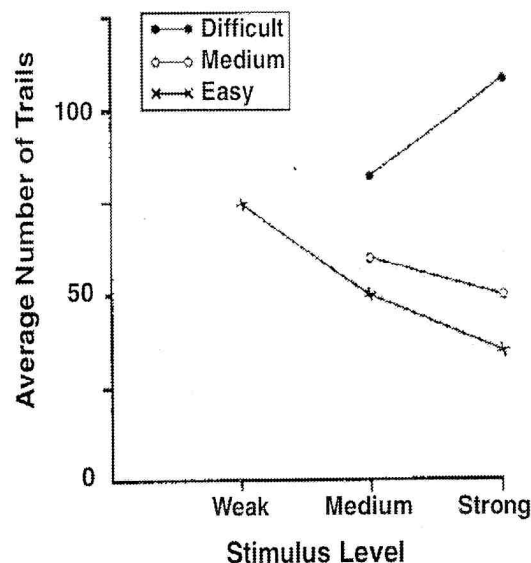


Figure 4. Dodson's (1915) attempt to replicate earlier findings, using kittens as experimental subjects. Again, of these data, do not support the inverted-U function.

trends are attenuated and changing this one criterion dampens the strong inverted-U shape functions. When we add this measurement concern to the technical problems with the equipment on the critical Set 1, findings that were included despite even the authors' designation as preliminary, we find the basis of the inverted-U description on very shaky ground indeed. It is doubtful that any mainstream journal today would accept such a study based solely on these methodological objections alone. Yet it is from these data that the curvilinear relation between stress and performance and the interaction with task difficulty is not merely developed but has been perpetuated over the years. Given this precarious foundation, why is this too descriptive relationship still dominant today?

We propose that one continuing reason for the perpetuation of this description is that it has a strong intuitive appeal and is one that accords with most lay persons' understanding, or, more vernacularly, "common sense." For, is it not true that at some level, all of us do not do well when sluggish and under-stimulated and conversely does not each of us possess a level of stress at which overload reduces our performance capacity? This being so, it is a small step to believing in one optimal level of stress, which might vary according to the task you are performing (Csikszentmihalyi, 1989). We argue this "common sense" appeal is a strong motive force in the persistence

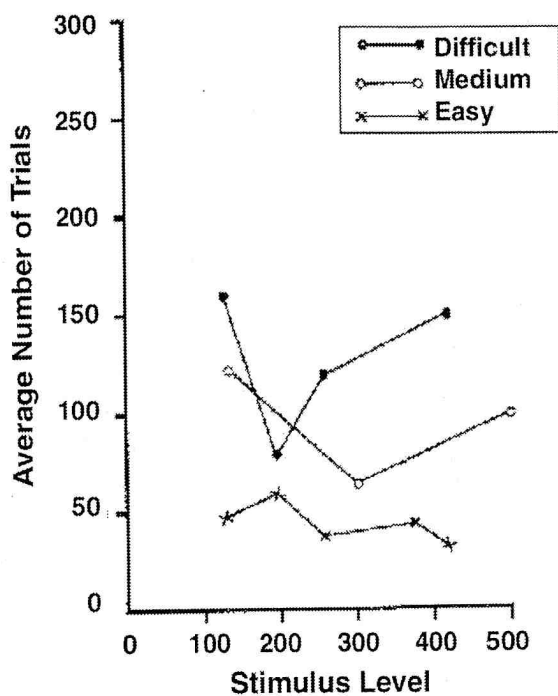


Figure 5. This is how the Yerkes-Dodson data would have appeared, had they set their criterion to 10 correct trials in a day.

of the description itself, regardless of any causal mechanism that is used to explain its effects. Indeed, eventually, when we consider evidence from both physiological response as well as performance capacity, we find that this intuition itself is not fundamentally misguided.

The Inverted-U: Quiescence and Resurrection

During the behaviorist ascendancy, energetic aspects of behavior such as stress and attention were the subject of relatively little interest in psychology, although remaining important in the medical sciences (see Selye, 1956). Yerkes and Dodson's (1908) results were relevant and useful to a behaviorist-oriented psychology, but there was little extension of these conceptions in animal learning into stressed human performance or the *energetic* aspects of performance in general (Freeman, 1940, 1948). Thus, there was little pursuit in the understanding of human stress effects in psychology until the early 1950's, when the paradigmatic shift into information-processing occurred. This change also resulted, in part, from the harsh lessons of the Second World War, which had exposed the insufficiency of behaviorism as a predictive

explanation of human response capacity, of especially great concern in relation to stress effects resulting from combat. The innovations of the nascent information-processing approach caused significant interest in a number of energetic aspects of response areas such as alteration and stress. In a particularly influential paper, which was the Presidential Address of the American Psychological Association, Donald Hebb (1955) drew attention to the dual role of sensory stimulation in providing specific information transmitted through major sensory pathways (the cue characteristic) and the more diffuse role in generally arousing the cortex (see Figure 6).

At this same time, Eysenck (1955) was investigating the role of personality in stress-influenced performance. He used Yerkes and Dodson's results as a foundation for his work and predicted that an "increase in autonomic drive level would lead to a decrement in performance on complex tasks in the more neurotic, while it would lead to an improvement in performance in the less neurotic" (Eysenck, 1955, p. 51). The pursuit of the issue of stress and performance by leading researchers such as Hebb and Eysenck caused a renewed general interest and gave much impetus to additional experimentation. One of these, an empirical evaluation, was reported by Broadhurst (1957) who used rats and varied the length of time without air to provide the 'motivation' factor prior to swimming through a maze. As is shown in Figure 7, Broadhurst found an interaction between task-difficulty and motivation such that peak performance occurred earlier as task complexity increased.

At this juncture, we encounter another major reason why the inverted-U has been successful as both a description and an explanation of stress effects. This concerns its descriptive ubiquity in being able to capture virtually all patterns of experimental findings post hoc, together with the subsequent capacity to use the catch-all arousal construct as an explanatory mechanism. No lost data set in search of interpretation was ever rejected by the ever-friendly inverted-U explanation. As shown in Figure 8, virtually all response outcomes can be embraced by windowing different locations on the curve and, as long as the author did not pre-specify arousal (whatever that was), an explanation for virtually any data set was forthcoming. Since stress, arousal, and complexity were almost always allowed to remain unspecified and free to vary, many authors found a ready-made explanation for otherwise unexplainable results. With an ever-present need to publish, this theory began to garner spurious support as challenged researchers sought "explanations" to satisfy irascible journal editors. As a consequence, much worthless "supporting" evidence was forthcoming. The underspecified descriptive and theoretical construct rescued many an orphan data

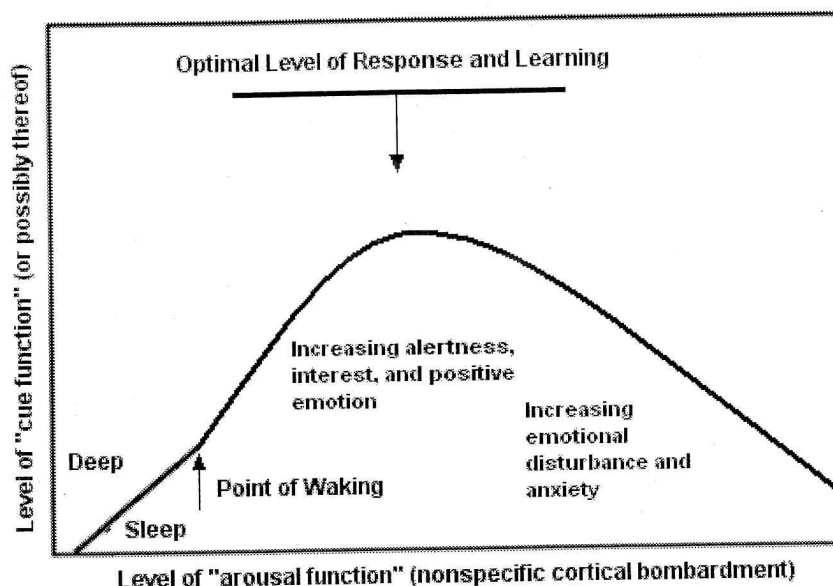


Figure 6. The curvilinear description relating arousal to cue function presented by Hebb (1955).

set in a highly symbiotic arrangement. With conceptual boosts from the likes of Hebb and Eysenck, it began a stellar ascendancy that still remains largely unquestioned today, except for a few arcane critics (see Hancock, 1987; Hockey, Galliard, & Coles, 1986; Teigen, 1994).

While the inverted-U relationship was intuitively appealing, what was necessary for a full explanation was a clear causal mechanism that produced the outcome observed. Following the neurophysiological advances accompanying the identification of the structure and function of the ascending reticular activating system (ARAS: see French, 1957), the idea of cortical arousal could be employed as the necessary mediating construct with respect to stress and performance. Moruzzi and Magoun (1949) found that EEG wave patterns changed when animals were aroused, the same patterns that were seen when the ARAS was directly stimulated. The reasoning for arousal as an account of the action of stress is that ascending signals from sensors in the peripheral nervous system are mediated through the ascending component of the ARAS while the response was also modulated by the general activation in the same structure. For a time, the unitary arousal concept held sway and there appeared to be both a necessary and sufficient account of the relationship between performance and stress. Indeed, this account was elaborated in Easterbrook's (1959) conception of cue utilization. His underlying principal assumption was:

...(a) that simultaneous use of task-relevant and task-irrelevant cues reduces the effectiveness

of response to some extent, and (b) that as the total number of cues in use is reduced, task-irrelevant cues are excluded before task-relevant cues. For any task, then, provided that initially a certain proportion of cues in use are irrelevant cues (that the task demands something less than the total capacity of the organism), the reduction in range will reduce the proportion of irrelevant cues employed and so improve performance. When all irrelevant cues have been excluded, however (so that now the task demands the total capacity of the subject), further reduction in the number of cues employed can only affect relevant cues, and proficiency will fall. If drive increments produce these changes in range of cue use, they will also produce this succession of facilitation and impairment (p. 193).

Hence, an inverted-U relationship between emotional arousal and performance exists. This, at one end, poor performance occurs when the user is overwhelmed by task-irrelevant cues as well as by lack of relevant cues at the other extreme (also see Wachtel, 1967).

Some of the first indications of incongruities in the unitary arousal notion appeared in the behavioral literature with Broadbent's (1963) observation on the apparent distinctive action of different forms of environmental stress (also see Duffy, 1962). While the physiological link induces little controversy, the arousal

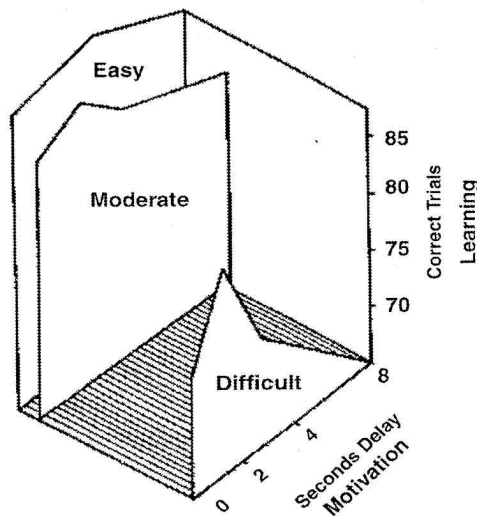


Figure 7. The relationship between motivation level and learning capacity of rats swimming an underwater maze after air deprivation of differing length (data from Broadhurst [1957]).

account of performance became the subject of growing criticism. However intuitively appealing a particular descriptive relationship is, it is the explanatory hypothesis behind it that is the great sustaining factor. For the inverted-U relationship, this theoretical sustenance was provided by *unitary arousal*, a concept that did not enter Yerkes and Dodson's expositional lexicon. Unfortunately for the inverted-U, the concept of unitary arousal first

fractured, and then slowly disintegrated (see Hancock, 1986; Hockey & Hamilton, 1983; Hockey, Galliard, & Coles, 1986; Pribram & McGuiness, 1975; Sanders, 1983), as increased evidence showed inconsistencies, and then obvious flaws, in its simplistic theoretical assumptions. However, despite this dissociation of its causal foundation, the inverted-U description continues to be advocated and taught to unsuspecting psychology students and employed by unwary behavioral scientists.

Criticism of the Yerkes-Dodson Law

We do not claim to be the first in criticizing the inverted-U. Indeed, there have, over the years, been a number of critical commentaries on the Yerkes-Dodson law with each critic seizing upon a different weakness as illustrating the fallacy of the relationship. For example, Brown (1965) focused on methodological issues and concluded that there was no reason to call the Yerkes-Dodson law ubiquitous and that it should be buried in silence. Baumler (1992, as described in Lienert & Baumler, 1994) looked at the performance criterion, which was the number of unsuccessful trials in each of six sets of 10 trials. He considered this number of unsuccessful attempts within a set the inverse of habit formation. His question was whether or not the error criterion and the series criterion, as set by Yerkes and Dodson, behaved the same way with respect to the electric shock that the mice received as punishment. His findings were that the two criteria showed different treatment effects on the intensity of the shock (see Baumler & Lienert, 1993). Baumler (1994) re-analyzed the 1908 data, adding a learning gradient as a criterion. He found, with the addition of this gradient, the data for the first and third

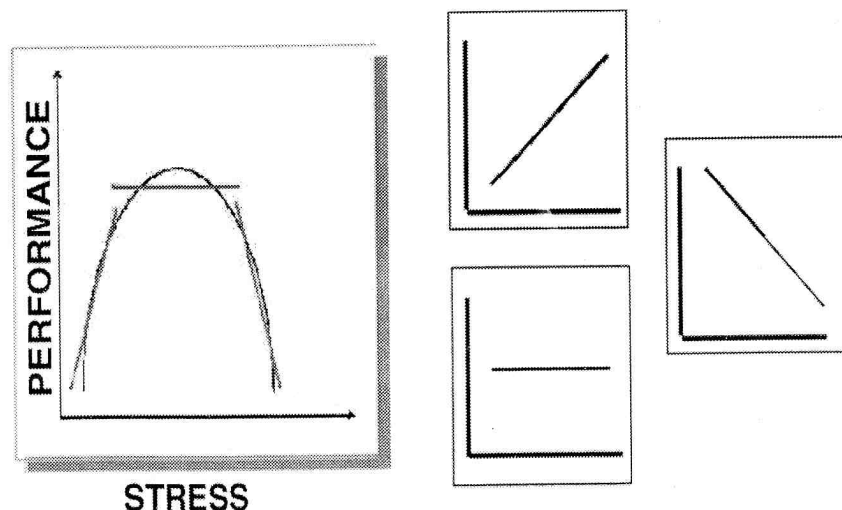


Figure 8. An illustration of the 'windowing' effect that is commonly seen in data that are explained by the Yerkes-Dodson law.

experiments produced linear results. In further statistical re-evaluation, Baumler and Lienert (1993) verified the statistical significance of the linear relationship using tests of trend, and Lienert and Baumler (1994) found the linear relation of rapidity of habit formation to stimulus intensity after performing a bivariate analysis of the Yerkes-Dodson data and the Baumler learning criteria. These are all statistical methods that were unavailable at the time when Yerkes and Dodson did their work, but, today are appropriate procedures to evaluate the data reported. They demonstrated that even the original data do not support on inverted-U interpretation.

Summary and Conclusion

In today's world, understanding the method by which stress affects the performance of an individual, acting either alone or in a social group, is a vital question. Our understanding in this realm has been stultified and continues to be hampered by an unfortunate adherence to an outmoded concept. It has been the misinterpretation of the original work, and the failure to quantify the respective stress and performance axes, which has allowed the inverted-U function to persist. That a spurious explanatory ubiquity, allied to a strong common sense belief in what ought to be, has resulted in long lasting law of psychology is salutatory indeed. Our strongest beliefs must always remain the subject of our strongest doubts. That many writers perpetuate and many students still learn the inverted-U mantra with little or no concern for its origins or its veracity attests to the developmental status of psychology in general and the sad state of human performance prediction, in particular. In contrast to popular belief, data rarely extinguish theory. In consequence, we do not expect the present critique to cause a mass change in popular undergraduate psychology texts. Rather, we offer the Hancock and Warm (1989) model as an alternative to the simple inverted-U. This latter "extended-U" concept retains the "common sense" grounding, but is much more congruent with known physiological and psychological effects and also emerging behavioral response data. The present work, therefore, acts as a precursor to an elaboration of the Hancock and Warm (1989) work, which we present here in this journal. If the latter conceptualization more clearly and more cogently represents how people perform under stress, it may be one way in which the inverted-U can be served with the valediction it so appropriately deserves.

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