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An Overview on Studies of Stress State Affect

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Stress is a multidimensional concept and it always shapes our performances. An individual strive to overcome with this stress by the help of technology. But in one hand where the technology has provided the acuity and sharpness to human performance on the other hand it has also engendered ample amount of stress for users. The current review focuses on stress and how it affects the human performance. The human experience of stress and the outcome of their task performance often are tightly linked because tasks itself create stress without the addition of any external stressor. So, present review clarifies this strain effect in term of transitory states of stress. This review comprises of effects of mind's transitory states on discriminability and prolongs awareness in tasks. Many researches had been done to explain the effect of task stress and individual's strain which induced by task, but none was able to present a general model that could account for all of the various results and prevent the performance decrement. Therefore the current review is an attempt to appraise these works which describes stress as multidimensional states of stress which play crucial role during performances. For each string, founding scientific articles, researches and contemporary empirical developments are quoted that demonstrate the range of novelty and technical innovations that has taken place. Many contemporary concepts like techno-stress, task stress, and strain effects are rooted in this manuscript. This review provides a new dimension to think. The relation between stress and performance is well-known to us but this literature review identified the strain factors during task. The current review represents the facts and strain importance in which the human performance takes place most accurate and robust. At last this review shed on the issues of stress-states and vigilance as well as automation and provides new perspective to vigilance researches because the technological intensification can be seen in various types of applied tasks for example transportation, medical monitoring, sonar and radar operations as well as in manufacturing industries sector etc. Moreover, this review is also to attract human factors and ergonomics researchers to design a system that to be stress-free as possible for the users.

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Today, the rapid running world seems to be, as a dream runway in which the absence of technology proves to be a difficult task to survive. In one hand the technology has provided the acuity and sharpness to human performance, on the other hand it has also engendered ample amount of stress for users. These technological intensification can be seen in various types of tasks for example transportation (air traffics control, prolong driving), military watch standing, medical monitoring, sonar and radar operations as well as in manufacturing industries sector etc. where, attention play crucial role. Therefore, attention considered as a one of the fastest growing of all the fields within cognitive psychology and cognitive neurosciences (Posner & Rothbart, 2007). Of the many cognitive processes associated with human mind attention is considered most concrete because it hold the core property, in perceptual as well as in cognitive process. Therefore, Posner & Rothbart, (2007) refer attention as the basic set of mechanisms that underlie our awareness of the world and the voluntary regulation of our thoughts and feelings. In traditional view attention is the process in which we pick out the information for further processing while ignoring others. Like the other cognitive phenomena attention is a higher mental process that determines what element of informational stimulation reaches to our mind. Additionally, attention allows people to select the information that is most relevant to ongoing behavior. By focusing their mental resource observer rejects irrelevant information or stimuli while attending to relevant inputs (Parasuraman and Davies, 1984) through filtering (Broadbent 1958), delayed processing (Deutsch and Deutsch 1963), attenuating the stimulus potential (Triesman 1964), or allocation of mental resource to various stimuli (Kahneman 1973). After a focus is established, sustained attention involves the continuous maintenance over time of alertness and receptivity for a particular set of stimuli or stimulus changes (Parasuraman & Davies, 1984; Parasuraman, 1984). This is why experimental or cognitive psychologist often uses the term "vigilance" in place of sustained attention simultaneously. Vigilance is not only a state of behavioral alertness to predators (Lima & Dill 1990); rather, it is a general condition of enhanced ability to process information. For more than half century there has been unambiguous recognition that human cognitive performance involves a process of vigilance as well as attention.

Problem of Vigilance

Vigilance is central aspect of many cognitive functions which have play a vital role in today's techno scenario. In human vigil an individual staying his/her awareness or alertness on a specific stimulus (target) that is why vigilance is often used interchangeably with sustained attention. This type of sustaining of watchfulness is not so easy for individual therefore it tenseness in prolonged time can have severe consequence in all of these applied settings like several hazardous problem.

The failure of alert represent in baggage inspection at airport security checkpoints, military surveillance, ATC, nuclear power plant regulation etc. (Hartley, Arnold, Kobryn, & Macleod, 1989; Satchel, 1993; Warm, 1993; Wickens & Hollands, 2000; Hancock & Hart, 2002) where workers directly involved with task. This problem is a notion as vigilance decrement- progressive decline in performance during prolong period, has consistently since been documented in N. H. Mackworth's initial research, and continues to be the most ubiquitous finding in a variety of real world and lab settings (Davies & Parasuraman, 1982, See, Howe, Warm, & Dember, 1995, Singh, Tiwari, & Singh, 2007,Warm, & Jerison, 1984). Several studies have shown that most of the decrement occurs within 30min (Teichner, 1974), although for perceptually demanding visual targets it can appear within 5min (Nuechterl et al., 1983) and in younger observer's performance which have been better than their older cohorts (Bicknell, 1970; Canestrari, 1963; Deaton & Parasuraman, 1993).

Davies and Parasuraman (1982) suggested that the vigilance decrement results from a decrement in perceptual sensitivity and temporal change in response criteria. However, numerous studies suggested that vigilance task imposed a considerable degree of workload and stress on operators causing impairment in performance across time periods (Hancock & Warm, 1989; Szalma, Hancock, Dember, & Warm, 2006; Szalma, Warm, Matthews, Dember, Weiler, Meier, et al., 2004; Warm, Dember, & Hancock, 1996). Moreover, Hockey (1970) stated that in the condition of stress, operators display physical or cognitive attentional narrowing on the tasks, resulting in significantly more errors such as increasing the likelihood of error occurrences, commission error, disrupting concentration, and resulting in poor decision-making etc.

After verifying the vigilance decrement phenomenon, many theories such as inhibition theory, expectancy theory, activation or arousal theory, resource theory, habituation theory and signal detection theory had been

developed to explain and prevent this effect but none was able to present a general model that could account for all of the various results. In recent years researches has pointed that only automation can be considered as a dominant factor that helps to overcome the problem of vigilance decrement. Similarly this is the way which provided machines to take the role of human. People believed that modern computer-aided technology has reduced their mental workload and stress but in fact, it has increased their mental workload and it also weakened their social support (Sharma, 1999). Now the nature of work has become more and more as a matter of stress and transitory mental states of the task rather than physical workload and others.

Stress and Vigilance Performance

Demand of attention is great requirement of all kind of performance in technology prone world. Often this demand creates a potential burden and strain on the human. The studies provide powerful converging evidences showing that vigilance assignments impose substantial demands on the information-processing resources of observers and are highly stressful. Taking this notion the original work of Hancock and Warm (1989) a step further towards dynamic model of stress and performance that explicitly recognized that tasks themselves represent a major proximal source of stress for operators. Besides that, stress which associated with vigilance tasks may be related to the task demands themselves but also to the cognitive appraisal of boredom associated with these demands. On the basis of previous studies it has been well established that such type of attentional task particularly vigilance task, induced much stress. However, investigating the role of stress in vigilance, Hancock (1998) has argued that a considerable degree of the stress of vigilance may derive from this imposition of the task on the individual. Therefore over the last four decades the effect of stress on cognitive performance has become a major focus of research (Hockey, 1983).

In general, Yerkes and Dodson (1908) were the first who emphasize on the relationship between stress and performance and contribute “inverted U hypotheses”, which revealed that individual performance increased with stress and resulted arousal was an optimal point and then decreased as stress and stimulation increased beyond this optimum (curvilinear relationship) Scott (1966). Despite the empirical evidence of the inverted-U hypothesis is still the most intuitively

appealing and the most used explanation for how stress and performance are related (Muse, Harris, & Field, 2003). This traditional view is also applied on vigilance performance where, individual's level of vigilance depends on their arousal and the performance decrement results either from under arousal resulting or from the under stimulating environment of the vigilance task (Frankmann and Adams; 1962). Further, the stressful nature of vigilance tasks is revealed by observer's consistent reports that they feel less attentive and more bored, strained, irritated, and fatigued at the end of a vigil than prior to its start (Warm, 1993). Perhaps this type of task stress generate due to high information processing load which imposed a continuous strain, pressure and vacillate the person's state of mind. Therefore, Singh et al. (2007) reported that not only stress affect performance but also performance changes the various components of stress states for that reason only measure of stress fail to capture the multidimensional nature of the stress construct. The majority of authors found that stress is a multi-componential construct (Matthews et al., 1999) and whether it affects the efficiency and performance of vigilance or just one's mood and feeling states. By considering the present view it can be said that sometimes people feel good and sometimes bad and it depends on their transitory subjective state of stress. The transitory subjective states of stress are shaped by several subjective and situational variables as motivational, perceptual, personality, arousal, demand of resource, thinking during or behind task, task situation, and task load as well as work load. Researches of these days, therefore concentrated on the stress states (Matthews, Campbell, Falconer, Joyner, Huggins, & Gillilan, 2002). Now this is clear that vigil performance may improve under moderate levels of stress and sound state of mind during task but decline under high or constant stress or distorted transitory stress-state.

In effort to define 'stress' and its consequences physiologist and behaviorist both were fascinated towards stress, but states side of stress always yet in dark. Further Matthews Joyner, Gilliland, Campbell, Falconer and Huggins (1997) suggested that research on the subjective state of stress, until recently, has been limited in scope, focusing primarily on state anxiety and mood. Thus there is a crucial need to contemplate about comprehensively transitory states associated with stress.

Stress – State Measures and Vigilance Performances

Stress impinges on how we perform (behavioral), how we feel (self-report), and many of our bodily functions (neuro-physiological) during task. A key step in understanding stress during performance is to identify multiple dimensions of stress response that may be differentially related to objective performance indices. There is little question surrounding the "what" of performance that becomes affected by stress. For that reason, Hancock and Warm (1989) recommended that traditional views of stress should be revised to take into account the findings that tasks themselves can be significant sources of stress but what about stress's state, its untouched till now. Prior to considering this issue it is necessary to define the concept of stress -states.

Concept of Stress-States

Defining subjective states in a single sentence is really difficult. Matthews and their associates (Matthews, Campbell, Falconer, Joyner, Huggins, & Gillilan, 2002) re-conceptualize the concept of stress and suggested that, a subjective state may be defined as a relatively transient quality permeating conscious awareness whose representation is distributed across a variety of metal process or structures, and which has the potential to generalize across activities and context. The structure of subjective states is too complex, therefore it can't be describe by a single dimension such as arousal or anxiety (Matthews 1992). few researcher have proposed that stress process involves three distinct but related components viz. stressor, modifier and strain; a short term physiological, psychological or behavioral manifestation of stress. Although both physiological and behavior oriented theorists were fascinated toward defining 'stress' and its consequences, but they always excluded the fact that what is the manifestation of stress during task in different domains of stress states. The concept of multidimensional stress states based on the idea of trilogy of mind is postulated by Hillgard, 1980. Further, Mayer et. al. 1997, analysis the trilogy of mind suggest a '*separate system*s' approach that distinguish affect, motivation and cognition as reflecting separate, but interacting systems.

Fundamental Dimension of States

Most commonly stress states variables or components affect the overall level of performance, although it is clear that these effects are not always entirely consistent. Still in modern form it (trilogy of mind)

divides psychological functioning into three domains of affect, conation (motivation), and cognition. The range of studies have shown that the characteristics of the vigilance tasks itself are critical determinants of performance (Davies & Parasuraman, 1982; Warm & Dember, 1998) because vigilance task imposed a considerable degree of workload and stress on operators which causes impairment in performance across time periods (Hancock & Warm, 1989; Szalma, Hancock, Dember, & Warm, 2006; Szalma, Warm, Matthews, Dember, Weiler, Meier, et al., 2004; Warm, Dember, & Hancock, 1996). Moreover the stress of sustained attention has been assessed through physiological as well as self report measures. Such reports, however, are based on instruments that tap only uni-dimensional aspects of stress state (e.g., fatigue, boredom), and such an approach does not adequately describe how different environmental stressors can induce different patterns of cognitive and affective responses (Hockey 1984).

According to Thayer (1989) self-report measures may provide a clearer picture of the psychological processes underlying stress because they closely coupled with cognitive states than physiological measures of stress. However several self-report measures have been utilized to assess stress states associated with the performance of vigilance tasks such as the Stanford Sleepiness Scale (Hoddes, Zarcone, Smythe, Phillips, & Dement, 1973) , Yoshitake Symptoms Fatigue Scale (1978) , Thackray, Bailey, and Touchstone (1977), 9-point scale etc.

While the above studies have been successful in identifying vigilance tasks as stress-inducing but measure only uni-dimensional aspects of stress and states too, thus they fail to assess the multidimensional nature of stress. So Matthews, Joyner, Gilliland, Campbell, Falconer, and Huggins (1999) developed the Dundee Stress State Questionnaire (DSSQ) for assessing these transient stress states. The DSSQ was designed specifically to reflect the multidimensionality of stress. Dundee Stress-State Questionnaire (DSSQ) which provides the first comprehensive multi-dimensional assessment instrument for transitory states associated with stress, arousal, and fatigue. The DSSQ seeks to measure state dimensions within the 3 traditional psychological domains of affect (mood), conation (motivation), cognition and workload.

Affect. The dimension of affect represent diffuse frame of mind. According to Thayer (1989) mood dimensions are considered to be

fundamental affective qualities, which may relate to broad, integrated neural systems. The Mood measures include four dimensions namely energetic arousal, tense arousal, hedonic tone and anger frustration.

Conation. Conation mirrors the push or pulls aspect of state dimension. Similarly, a motivational state, such as an immediate urge to achieve, should be represented across a variety of goals and sub goals, which may vary with context. Further this component of states represents two major features of motivation in performance settings viz. *intrinsic motivation,* extent to which the person is motivated by interest and engagement in task content and *task interest* and strivings to achieve successful.

Cognition. It is another relevant and important dimension that represents generalized states, and not just specific propositions, beliefs, or attitudes. The state is defined by the overall level of intrusive thoughts, not by the specific content of the thoughts. Thinking style dimension assess self-focus of attention (a state of self-preoccupation and reflection), concentration (attention to the task being undertaken and resisting distraction), self-esteem (sets of beliefs about self-worth, especially as evaluated by others) and control and confidence; (beliefs about personal control and success in task performance). Thinking style consist of two basic dimensions as *thinking content dimension,* which assess self-referent beliefs and *styles of thought* which assess task-related and task-irrelevant interference.

Workload. According to Eggemeier and Wilson et al. 1991 Mental workload refers to the portion of operator information processing capacity or resources that is actually required to meet system demands. In states measure workload is also consider as significant and determining factor due to reflect the cost of mental operations in vigilance. Further workload can be characterized as a mental construct that reflects the mental strain resulting from performing a task under specific environmental and operational conditions, coupled with the capability of the operator to respond to those demands. It may be assessed through self-report. Although domain-specific affective, motivational, and cognitive states were distinguished psychometrically (Matthews et al., 1999), and the inter correlations of these state dimensions implied the existence of higher order state factors as task engagement, distress and worry.

Early Researches on DSSQ and Vigilance

In this section role of states, which may have sound impact on vigilance performance had been reviewed. Self-report measures of stress basically focus on the present investigation, and can provide a different perspective on task-induced stress in vigilance than that offered by physiological measures. According to Thayer, 1989 self-report measures are more closely coupled with cognitive states than physiological measures of stress that is why it may provide a clearer picture of the psychological processes underlying stress. In an initial investigation Matthews et al., 1999, discovered that participants feeling more distressed and less task-engaged after participating in a vigil than prior to its start, but did not report task-induced differences in worry. These findings have been replicated in additional experiments by Szalma (1999), Helton, Dember, Warm, and Matthews (2000), Alikonis, Warm, Matthews, Dember, and Kellaris (2002), and Grier et al. (in press). Additionally the findings also show that cognitive and sensory both tasks generate the same pattern of stress reactions and specifically, distress increased and task engagement decreased from pre- to post-vigil. Moreover, in an unpublished doctoral dissertation of Beam (2002) proves that the participants reported themselves to be less worried and engagement in task but more distressed after the vigil than prior to its start on combination of task type (cognitive-simple, cognitive complex, and sensory). However, Matthews et al., 2002 cited as one of the major finding that is there was greater loss in task engagement during task at simultaneous (SIM) than the successive (SUC) task. Moreover Galinsky et al., 1993 and Szalma et al., 2004 reported in a study that visual tasks induce greater levels of stress than auditory tasks. In this context the growing studies additionally suggests that sensory modality is as well important factor on DSSQ stress states responses in vigilance performance (Warm, Matthews, & Finomore, 2008 and Szalma et al. 2004, Hatfield & Loeb, 1968). So now it is clear that task type and specific task characteristics are crucial cause of task-induced stress in vigilance and several studies reveal that task engagement is a critical factor underlying the efficiency of vigilance performance (Reinerman, 2008; Reinerman et al., 2006). These finding adds task type to the list of psychophysical factors like signal salience (Temple et al., 2000), sensory modality (Szalma et al., 2004), and event rate (Warm, Matthews, & Finomore, 2008) that influence vigilance task-induced stress responses on the DSSQ. According to Warm et al. (in press) observers in both event rate conditions (high and low) found the vigilance task to be stressful as

reflected by self-reports in both conditions of significant post-test declines in some dimension as energetic arousal, hedonic tone, intrinsic motivation, and concentration, task irrelevant interference and increment in other typically self-esteem, tense arousal and task relevant interference. These findings also supported by Reinerman et al, (2006) and Warm et al. (in press), Singh, Tiwari, & Singh, 2007. Moreover, Warm, Matthews, & Finomore, 2008 stated that operators reported being more worried at the end of a vigil than prior to its start on slow event rate and less worried on opposite in a visual vigilance task. Further Helton et al. (2004) reported that participants who transitioned from the low-demand to the high-demand condition felt more task-engaged than controls who performed the high-demand version of the task throughout the vigil. By contrast, participants transitioned from the high-demand to the low-demand condition reported feeling less task-engaged than controls who performed the low-demand task continuously. These results were replicated in a later study by Helton, Shaw, Warm, Matthews, and Hancock (2008) using the same vigilance display and Reinerman, 2008, Matthews and Desmond (2002) on other vigilance task. Clearly it is emanate that the stress states profile associated with the fast event rate condition was more severe than that associated with the slow event rate. A substantial number of subsequent experiments (Matthews et al., 2000, Helton, Shaw, Warm, Matthews, Dember, & Hancock, 2004; Helton, Shaw, Warm, Matthews, & Hancock, 2008) related to transitions in task demand also confirmed the above mentioned fact. Stress effects are also more likely to emerge when critical signal salience is low than high, high levels of signal salience produce greater distress as compared to low (Temple et al., 2000). Results supported the contention of Matthews & Dorn (1995), who predicted the effects of stress-states on the present direction.

Some dimensions of the states poorly tied with task switching Ungar, (2005). Traditionally, research on states has focused basically on affect, conation and cognition but workload is an important factor which can't be ignore. Warm, Matthews, et al. (2008) and Hancock & Warm, (1989) argued that vigilance tasks produce a high level of perceived mental workload in participants, and increments in workload are associated with heightened stress levels. In addition, high distress appears to relate to high workload, as indexed by the NASA-TLX (Matthews & Campbell, 1998; Matthews et al., 1999; Matthews et al., 2002). Generally, worry is linked to negative thoughts about performance and personal issues where the extent to which an individual

worries varies across task types (Wells & Matthews, 1994) while a number of studies with the DSSQ have shown that participation in a vigilance task typically leads to a loss of task engagement accompanied by feelings of distress and that these changes increase with increments (Warm et al., 2008).

Finally, physiological and subjective reports confirm that high resource demanding vigilance tasks generated task disengagement, distress and worry whereas also showing the highest workload.

Conclusion

As noted in beginning of the paper, vigilant behavior plays a key role in the operational environment and states profile richly coupled with it. Researches on the subjective state of stress, until recently and has been inadequate in scope, focusing primarily on state anxiety and mood. While many researches on vigilance have been made to correlates with several aspect of stress but result move to fail to define the strain effect on vigilance performance. Strain aspect of vigilance performance basically, involve with state profile of stress-states. The multi component of stress particularly task disengagement, distress and worry effect vigilance performance impact fully. The performance of operators on several types of vigilance task may be good or worse depend not only on stress, arousal level, or environmental stressors other than lack of motivation, tendency to experience intrusive, distracting thoughts, concentration and task related relevant thinking play significant role to shape performance in different demanding condition.

Hence, it is clear that vigilance decrement phenomenon can be explained with both arousal and person's state of mind and component of stress states determine the performance. Finally, these findings further suggest that stress and performance related with each other subsequently and also cause of change in various components of stress states. Although several attempts have been made to evaluate the problem of vigilance but researchers failed to correlate it, with multidimensional stress-states of the participants. Moreover previous studies had investigated 'stress' and its consequences but the causal relationship are not conclusive due to a great variety of psychological and situational determinants. The focus of researchers on arousal has led to neglect of other components of the person's 'state of mind' which may influence performance. Researches on stress, fatigue and mood however suggests that there are multiple dimensions of state variables, which are

psychometrically distinct from arousal. But on other hand some query about state's role remain yet. that how the various components of multidimensional stress states like energetic arousal (mood), motivation, mental workload, self-esteem, self-focus attention, concentration, control and confidence, task related and unrelated interference would affect vigilance performance?

- What is role of particular component to reduce or improve the performance?
- What is role of states in different demanding condition (event rate) among personalities?
- What is contribution of states profile to determine the perceptual sensitivity and response criterion in different demanding condition?

However recourse demanding conditions pays great concern on vigilance performance but what is the variation in states profile during task is not exactly clear. Therefore, it is crucial to understand the factors that affect vigilance and how potential decrements in such performance may be ameliorated. Researches of these days, that is why concentrated on the stress states (Matthews, Campbell, Falconer, Joyner, Huggins, & Gillilan, 2002). Further, it is important to consider that there is great need to examine the effects of multidimensional stress-states with several variables such as personality, different task type, and distinct level of event rate.

Future Perspective on DSSQ Research

This review provides a new dimension to think. The relation between stress and performance is well-known to us but the objective of this literature review was to identify the strain factors during task. Broadly, this review offers to facilitate the performance of operators in future by designed the task which induced less stress. In a perfect notion of Parasuraman & Riley, 1997 concerns that poorly designed automation may itself be a source of stress; in fact it has increased mental workload and also weakened their social support (Sharma, 1999). So the another instance of this review is despite the need to consider the influence of individual difference factors such as mood, thinking , perception of demand and load during task etc. on behavior of alertness. The practical implications of the review are to avoid high task demands in display design and much conscious about personality variable which directly related to individual difference. The utility of such measures in vigilance has already been established cited by range of studies but now it is

necessary to cognizant about states in real-world where frequencies of accidents are common. The interdisciplinary science of human factors/ergonomics extends well beyond aviation, being concerned with people and their successful interaction with all forms of technology (Dempsey, Wogalter, & Hancock, 2000). Thus, at last this review shed on the issues of stress-states and vigilance as well as automation and provides new perspective to vigilance researches.

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