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## **Challenge and threat states in surgery: Implications for surgical performance and training**

### **Introduction**

The operating room can be a highly pressurised environment in which surgeons encounter a variety of stressors, including technical complications, equipment failure, time pressure, distractions, evaluative threat and performance anxiety (1). Procedures that are complex or longer in duration are proposed to trigger even greater stress levels because they are more physically and mentally demanding (2). However, studies examining the effects of acute stress on operating performance have revealed considerable variability; from no effect, to either facilitative or debilitating effects [3,4] (see Arora et al., 2010 [1] for a recent review). This variability is likely caused by the individualistic way in which surgeons respond to stress. Whilst some might respond positively and perform well, others respond negatively and perform poorly. One theoretical framework that offers exciting potential for explaining such individual differences in stress response, and which has not previously been investigated in surgery, is the biopsychosocial model (BPSM) of challenge and threat (5).

### **Challenge and threat states**

According to the BPSM, when surgeons are actively engaged in a surgical procedure, they first evaluate the demands of the situation and then evaluate whether they possess the necessary resources to cope effectively with these demands (5). When a surgeon perceives that he or she has sufficient resources to meet the demands of the situation, a *challenge* state occurs. In contrast, if a surgeon perceives that he or she does not possess the resources required to meet the demands of the situation, a *threat* state emerges (5). A challenge state will result in a surgeon experiencing more favourable cognitive, affective, physiological, and behavioural outcomes compared to a threat state (6,7,8). Importantly, empirical and predictive studies in psychology,

across a range of tasks and situations, have revealed that a challenge state facilitates performance whilst a threat state hinders performance (8-10). Thus, a surgeon who adopts a threat state under stressful conditions is likely to display significantly poorer surgical performance relative to a surgeon who adopts a challenge state. Furthermore, a training study (11) demonstrated that ‘challenged’ individuals outperformed ‘threatened’ individuals during training on a complex task and during various post-training tests. Therefore, surgical trainees who adopt a challenge state might attain higher levels of proficiency in surgical skills quicker and perform better under stressful conditions than trainees who adopt a threat state.

One critical component of the BPSM is that the experience of challenge or threat states can be indexed objectively via distinctive patterns of neuroendocrine and cardiovascular responses (5). A challenge state is indexed by elevated sympathetic-adreno-medullary activity, increased epinephrine release, and is marked by increases in cardiac activity and decreases in peripheral vascular resistance. In contrast, a threat state is indexed by elevated sympathetic-adreno-medullary and pituitary-adreno-cortical activity, increased cortisol release, and is marked by either no change or small increases in cardiac activity and peripheral vascular resistance (see [5] for a review). Whilst the stress response is clearly linked to the situation experienced, individuals show moderate to high consistency in their evaluations across situations and over time (12). This consistency implies that individuals may have a trait-like quality that predisposes them to habitually appraise situations as challenging or threatening.

The strong empirical support for a dichotomy of stress responses provides an excellent launch pad for extending the research testing the BPSM into the surgical environment. To date, only one study has investigated the psychophysiological measurement of challenge and threat states in the medical literature (13). Harvey and colleagues found that emergency medicine and

general surgery residents who evaluated a high stress trauma resuscitation simulation as a threat experienced increased cortisol levels and reported experiencing greater negative emotion (anxiety). There is therefore a need to perform more empirical studies in surgery to examine the influence of challenge and threat states on technical and decision making performance, and to determine if a trait-like stress response may predispose individuals to either thrive or struggle in the most demanding surgical situations.

### **Implications for surgery**

Although many skills and attributes are required to become a surgeon, the ability to make the most of these under pressure is clearly of critical importance. The research summarised in the current commentary suggests that a knowledge of individual differences in stress responses may have important implications for the selection and training of surgical trainees (14). For example, though provocative, there could be a rationale to exclude high threat responders from specializing in particularly stressful branches of surgery. However, perhaps of more benefit might be interventions aimed at ensuring that surgeons *do* learn to evaluate stressful events as a challenge rather than a threat. The BPSM would suggest that such a modification could be achieved by changing the perceived demands of the task, or by altering the actual or perceived resources of the surgeon. A range of factors could be targeted to alter demand and resource evaluations including, but not limited to, familiarity, uncertainty, difficulty, danger, attitudes, and the presence of others. We argue that social support plays a vital role in shaping these evaluations through clarifying the meaning and situational demands or providing individuals with appropriate resources. In this way, a supportive training environment might facilitate high performance by fostering a challenge state. Indeed, previous research suggests a simple

intervention such as manipulating the verbal instructions given to the surgeon might be effective in altering surgeons' resource and demand evaluations (7).

## **Conclusion**

We have presented a theoretical framework, which we suggest might help improve our understanding of individual differences in surgical performance under stressful conditions. We propose that poor surgical performance may arise when surgeons evaluate a stressful event as a threat. Interventions should thus aim to modify surgeons' evaluations of stressful events to ensure they are perceived as a challenge rather than a threat. As well as improving surgical performance and patient care, such interventions could also have important cardiovascular health implications for surgeons experiencing *chronic* threat states (15). Furthermore, such interventions may also be beneficial to other high-stress specialties. Finally, we propose that 'challenged' trainee surgeons are likely to become more proficient over time than 'threatened' trainees, as role responsibilities become ever more stressful. We believe that these concepts warrant further research attention

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