Cognitive Precision: Attentional Focus in Surgical Expertise

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BACKGROUND AND CONTEXT

Surgeons must learn intricate motor control skills, often in pressurised environments, where consequences of sub-standard performance are considerable. Despite the importance of effective surgical training for successful patient outcomes, opportunities to apply insights from alternative fields (e.g., sport and exercise sciences and human performance) are underexplored. Millimetre errors in foot placement by climbers or millisecond misjudgements in rotation by gymnasts can lead to devastating consequences. In surgery, the costs can be similarly catastrophic, resulting in avoidable harm to patients. As in sports, surgical skills are honed as a function of deliberate practice guided by experts.

Psychomotor behavior literature indicates that the language used during instruction can steer attentional focus and determine movement quality (e.g., accuracy and efficiency of execution). Focus of attention can be classified as being internal (i.e., body-centred), such as the pressure and velocity exerted by the surgeon's hand during incision, or external (i.e., environment-centred), such as the intended scalpel trajectory. Surgical expertise is honed through extensive, deliberate practice guided by expert instruction, yet the potential benefits of this have yet to be realized. The present article aims to translate training science from sports to the operating room, bridging disciplines to facilitate a) more efficient training (and associated costs); b) development of data-driven performance metrics; c) identification of skills that are most robust under pressure, and d) continual improvement in patient outcomes.

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THEORETICAL UNDERPINNINGS OF THE FOCUS OF ATTENTION EFFECT

There exists a wealth of literature in high-performance sport, evidencing the benefits of an external focus of attention during practice and pressurised environments.[1] The 'constrained action hypothesis' suggests that adopting an external focus promotes automatic response programming and enhances performance accuracy and efficiency.[2,3] In contrast, the 'Ecological Dynamics Account of Attentional Focus'[4] suggests that an internal focus can offer similar benefits, provided the task goal is highly proprioceptive. Therefore, aligning focus of attention with the most relevant task information appears to be key for performance enhancement; an external focus should be used for target directed tasks (e.g., laparoscopic suturing, endovascular catheter navigation) and an internal focus for proprioceptively directed tasks (e.g., tactile feel of febrile tissue, tension of suture while hand-tying, resistance and vibration during orthopaedic drilling).

SURGICAL APPLICATION

There are substantial intersections between the application of skill learning phenomena to enhance both sporting and surgical performance. Promising findings outside of medicine, suggest that employing focus of attention interventions into training paradigms has potential to enhance several surgical-related outcomes (e.g., movement accuracy, economy, and form). Table 1 presents further context as to what this might look like in practice, given the surgical training environment and different contexts. Moreover, there are implications for enhanced educational practices and inhibiting debilitative effects of performance under pressure. Whilst most literature advocates an external focus of attention (e.g., directing a scalpel towards a

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TABLE 1. Illustrative Attentional Focus Instructions by Surgical Speciality and Motor Skill

Surgical Speciality	Motor Skill	Example Training Instruction: External *Likely optimal when: (a) visual information is available and important; (b) aiming for specific locations; (c) performing under extreme anxiety*	Example Training Instruction: Internal *Likely optimal when: (a) only tactile or proprioceptive information is available and important; (b) movement technique is a priority; (c) needing to exert precise pressures*
Open Surgery	Cutting	Follow the natural separation plane between the two tissue layers	Focus on making hand motions small and even
	Suturing	Guide the needle tip cleanly through the tissue at the marked point	Pay attention to how your wrist angles while turning the needle driver
Laparoscopic Surgery	Camera navigation and control	Focus on the path the camera takes to maintain optimal view	Use the feel and feedback you get through your hands to position the camera
	Tissue manipulation	Grip the tissue so it remains intact and stable	Focus on controlling the grip through your fingers
Robotic Assisted Surgery	Foot pedal coordination	Pay attention to exerting an even pressure through the pedal	Pay attention to applying an even pressure through your foot
	Micromotor adjustments	Adjust the instrument so the needle tip traces a smooth curved path	Focus on making small, controlled wrist rotations
	Spatial reorientation	Keep the instrument oriented so its jaws face the tissue surface correctly	Think about rotating your hands the opposite way to match the camera angle

precise incision location), in instances where visual information is limited and can only be perceived proprioceptively (e.g., during a deeper incision or robotic surgery), an internal focus of attention may be best.

Despite the obvious appeal of attentional focus within surgery, research has yet to systematically explore this paradigm. The closest we could find was the work of Tarasova and colleagues,[5] where an attentional focus intervention was trialled for venous cannulation. Health Science students ($n = 70$) focused either on the needle tip (external focus) or their hands (internal focus) during cannulation. After just four practice trials, those adopting an external focus performed the cannulation 2.37 times faster than those adopting an internal focus at retention. Whilst the research to date demonstrates benefits of applying attentional focus in health care, more empirically robust and ecologically valid research is required (e.g., integrating a more sustained period of practice trials, inclusion of a control group, assessing skill transfer under pressure, and using practicing surgeons). Moreover, with the increasing application of surgical sabermetrics (e.g., multimodal objective real time data) to enhance surgical performance[6] and the precise data that is available from robotic platforms, we recommend that these data streams be integrated within the surgical attentional focus paradigm.

FUTURE DIRECTIONS

Further research to investigate attentional focus in surgical settings is needed to determine: a) the efficacy of internal vs external focus of attention cues in surgery; b) the influence of expertise and task type (e.g., salience of proprioceptive vs target-directed information for task success); c) contextual differences (e.g., practice environments vs pressurised performance or laparoscopic techniques vs robotic surgery); and d) mechanistic accounts of the focus of attention phenomenon in surgery (e.g., movement planning vs control). Sophisticated techniques to analyse human movement, such as motion analysis, eye-tracking, electromyography or electroencephalography could prove informative. Machine learning has been successful in distinguishing between high- and low-performance in elite sport.[7] This has direct applications in surgery, for example, by identifying critical attentional signals through cognitive, physiological, or behavioral biomarkers that are associated with surgical events and patient outcomes.

It is also essential that attentional focus research evolves to meet the demands of contemporary surgical practice and emerging technologies. Robotic Assisted Surgery (RAS) offers a particularly compelling platform for empirical human factors research because of the inherent disconnect between perception and action compared with open and laparoscopic approaches. In this new technological world, surgeons operate at a distance, relying almost entirely on visual input from the console while receiving little proprioceptive feedback. Identifying which sensory channel most effectively supports skill development, and how attentional focus should be directed to optimize performance is critical.

CONCLUSION

The integration of evidence-based attentional focus strategies into the operating room offers meaningful scope to advance surgical performance and patient outcomes. Moreover, investigating focus of attention in surgical domains may forge a path for new theoretical models incorporating technological advances with direct relevance to other high-demand human performance contexts (e.g., space exploration, defence, finance, sports, transportation, and geopolitics). In this respect, surgery is uniquely positioned to lead and influence the science of human performance well beyond its own boundaries.

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