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Effects of a novel mental skills curriculum on surgical novices' attention

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ABSTRACT

Background: Surgery is very cognitively demanding, particularly for novices. Novices are required to direct full attention on the procedure at hand, and additional demands can lead to cognitive overload. Through extensive practice, experts develop spare attentional capacity (SAC) for simultaneous tasks. However, little effort has been made to enhance novices' SAC. Mental skills may enhance attention management and increase SAC. The purpose of this study was to determine the efficacy of a novel mental skills curriculum (MSC) to enhance novices' attention management.

Methods: Sixty novice volunteers were randomly stratified to a control or MSC group based on baseline laparoscopic skill and mental skill use (assessed with the Test of Performance Strategies version 2 [TOPS-2]). All participants received laparoscopic training, whereas the MSC group received additional mental skills training. At all sessions, participants completed a secondary task during laparoscopy, which assessed SAC. Participants also completed the D2 Test of Attention and the TOPS-2 attention control subscale, which are valid attention measures.

Results: Fifty-five novices completed the study. Both groups displayed significantly improved laparoscopic suturing ability ($P < 0.001$) and D2 performance (control: $P < 0.005$, MSC: $P < 0.01$), but there were no between-group differences in D2 or TOPS attention control scores. However, only the MSC group displayed significantly improved hit rate on the secondary task ($P < 0.05$).

Conclusions: The novel MSC implemented in this study enhanced surgical novices' SAC compared to controls, and it is clear that this curriculum may be effective at enhancing learners' ability to attend multiple task-relevant stimuli concurrently. Additional study of the impact of this MSC on learners' attentional capacity is currently underway.

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Introduction

Surgeons are subject to several job demands such as sustaining focus on intricate technical details of an operation, communicating effectively with team members, managing distractions, and quickly making potentially life-altering decisions.[1-3] Shifting attention rapidly between tasks and maintaining attention on task-relevant stimuli, while an integral part of surgical practice, occupy a significant amount of cognitive resources and are often referred to as cognitive load.[4] Increased cognitive load maybe especially challenging for surgical novices, who are in the process of learning surgical skills and lack prior experiences at managing challenging situations.[1]

Cognitive load theory posits that learning a given task requires a high level of intrinsic cognitive resources to develop schemas that shift learned information from working memory (i.e., temporary storage of information) to long-term memory (i.e., crystalized learning of information).[4] For novices, intrinsic cognitive load is already very high when learning a task; therefore, additional cognitive load from task-irrelevant extrinsic sources can easily place excessive demands on working memory that lead to cognitive overload. Besides interfering with learning new skills cognitive overload may also negatively impact performance by leading to attentional narrowing (i.e., "tunnel vision"), decreased sensitivity for relevant peripheral information, and hyper vigilant decision-making, which is characterized by impulsive, disorganized thought processes.[5,6] Cognitive overload has been shown to negatively impact the performance of surgical trainees,[7] which could ultimately compromise patient safety. This issue may be exacerbated by laparoscopic surgical techniques that are more mentally demanding than traditional open surgery posing significantly increased cognitive load on working memory and attentional resources in part because of the disconnect between operating in 3D but using 2D displays and limited haptic feedback.[8] To prevent cognitive overload, developing the ability to selectively manage attention to focus on task-relevant sources of information and ignore task-irrelevant distractions is imperative, especially for novice surgeons. The literature suggests that while expert performance is characterized by automaticity (i.e., the ability to perform certain tasks automatically with enough spare attentional capacity [SAC] to engage in other concurrent activities),[9,10] surgical novices have limited to no SAC when they first engage in learning difficult novel tasks, such as laparoscopic surgical skills, but can acquire this ability through extensive practice.[11] Importantly, using a secondary task[12] can help detect learner automaticity and may augment skill acquisition on simulators and transfer to the clinical environment.[13] Although the need to enhance surgical novices' SAC and ability to manage attention is obvious and despite having the tools that allow us to measure these abilities, little work has been done in surgery on methods to help novices improve such skills.

Mental skills are considered to be the cognitive tools and competencies that support successful learning and performance[14] and can be taught to learners to reduce the variability in their performance to consistently execute in the upper range of their abilities.[15] Techniques such as attention management, refocusing strategies, mental imagery, goal-setting, self-talk, and relaxation skills can enable performers to maintain attention on task-relevant stimuli and block out distractions in spite of challenging performance situations.[15] Curricula consisting of these types of mental skills have been effective at enhancing the performance of elite athletes,[16] members of the armed forces,[17,18] and members of police special forces.[19] We and others have recently demonstrated that mental skills training can enhance surgical skill acquisition[20] and retention,[21] but it is unclear if these skills can also enhance surgical novices' ability to effectively manage attention. The objective of this study was to assess the efficacy of a novel, comprehensive mental skills curriculum (MSC) to enhance novices' attention-management ability. We hypothesized that this novel MSC would lead to improved attention focus and increase SAC as compared to a control group.

Methods

After institutional review board approval, voluntary participants ($n = 60$) with no previous exposure to surgical training were enrolled in this randomized controlled study. Participants answered a questionnaire detailing demographics and prior laparoscopic and simulator experience. In addition, they completed a baseline assessment of the Fundamentals of Laparoscopic Surgery (FLS) peg transfer and intracorporeal suturing.[22] Suturing performance was measured employing an objective suturing score calculated based on the following previously published formula = 600 − task time − 10 × (accuracy + knot security errors).[23-25] In order, 600 represents the maximum allowable time for completion in seconds, accuracy represents the distance in millimeters of the placed suture from predetermined suturing targets, and knot security represents the quality of the knot created. Mental skills use was assessed with the modified Test of Performance Strategies version 2 (TOPS-2), and ability to manage attention was assessed with the D2 Test of Attention. The TOPS has been previously shown to be a reliable and valid self-report assessment that measures a comprehensive range of psychological techniques employed in practice and performance settings.[26] Skills and strategies thought to underlie successful performance include goal setting, relaxation, activation, imagery, self-talk, attention control, emotional control, and automaticity. The TOPS-2 was modified with permission from the authors. The D2 Test of Attention is considered to be a valid and reliable timed test of selective attention that requires participants to scan 14 lines with the letters "p" and "d" that have between 1 and 4 dashes above and below the letter.[27] The participant is asked to cross out only the d's with two total dashes (i.e., two dashes above the letter, two dashes below it, or one dash above and one dash below) and disregard the other letters. Concentration performance, or the number of the correctly identified relevant items minus errors of commission, was used as a metric of participants' attention-management ability.