Changes in Communication Patterns through Telestration

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Abstract

While medical imaging technology may improve the visualization of anatomy during surgery, verbal communication is often insufficient to clarify images on the screen. Surgeons must maintain a sterile field, and cannot use standard equipment like a computer mouse to point out structures. In our study, we analyze changes in communication patterns, performance, and cognitive load between instructor and student in a simulated surgical training setting with the option of gestural communication. The Microsoft Kinect captures body movement, and is used to overlay hand and arm gestures on live video feed. From a self-evaluation, the trainers experienced significantly less cognitive load during the telestration compared to the verbal-only instruction phase, with a p-value of 0.002. Gesture-based telestration systems may potentially improve communication efficiency, and thus surgical outcomes.

Background

Surgical training continues for a minimum of 5 years after medical school, and the resident works under the guidance a senior surgeon, the “attending” [American College of Surgeons]. However, advances in surgical techniques have increased the complexity of surgical teaching.

Minimally invasive surgery, which provides benefits to the patient with as faster recovery time and less scarring, places additional challenges on surgical teaching teachings. In minimally invasive surgery, several ports are made in the body to insert a camera and other surgical tools. The body is displayed on digital screens, which requires the resident to re-learn how to “see” the body, as the anatomy is often in the rotated view of the camera [Mentis, 2014]. The attending will also clarify the anatomy seen on the screen, pointing out important structures and orientations to the resident.

Within traditional educational environments one can use a laser pointer, or a mouse cursor to clarify videos and presentations. Improvement of technology in educational environments has enhanced learning outcomes through timely feedback [Hu, 1999]. But, a clinical environment has more constraints than traditional chalkboard learning environment, increasing the difficulty of efficiently providing feedback and instruction. In the operating room, there is a strict boundary between the sterile and non-sterile places restrictions on the surgeon’s movements. Thus, a surgeon would be breaking the sterile field if they touch a non-sterile input device like a computer mouse or the screen, requiring extra time to re-sterilize the material and “re-scrub”. While they sometimes direct team members to use input devices for them, doing so is inefficient

[O'Hara, 2014]. In one instances, a surgeon resorted to using a catheter wire as a makeshift pointer to communicate [O'Hara, 2013].

A potential solution to the communication difficulties inherent in minimally invasive surgical training is telestration. Telestration is a technique that enables drawing and annotation over an image or video, most often by sportscasters or weather forecasters on a television screen. The ability to annotate the live video stream was reported potentially reduce the needed teaching time by 33% [Budriunas 2016]. In the operating room telestration may allow for more seamless communication, resulting in improved operating outcomes and reduced operating times.

Training methods with telestration may be more effective than traditional master-apprentice approaches used in surgery. In the operating room, the attending and the resident are both maintain the view of the video screen displaying the body. Telestration would allow the trainee's eyes to remain in the direction of the screen and their hands, rather than needing to turn to face and view the instructor's gestures. In addition, annotating the images directly would allow them to more clearly demarcate barriers and the areas of interest.

Education environments had not only increased efficiency, but influenced communication patterns due to technological advances [Dwyer 1991]. Through telestration, the patterns of communication between the trainer and the trainee may change. Potentially the telestration will allow attendings and residents to communicate more effectively, reduce the number of commands, especially with regards to the number of clarifying commands.

The Microsoft Kinect® captures gestures through depth and infrared sensors within a range of 0.5 - 3.5m. Due to a pre-provided development kit and relatively low costs, there have been a range of possibilities and increased interest in its development for use in the medical field. In a recent instance, the Kinect was used to navigate through MRI and CT scanned images at Sunnybrook hospital in Toronto [O'Hara, 2014].

We investigate the effects of telestration on communication and instruction within a simulated setting of laparoscopic surgery, using the Microsoft Kinect to transform hand gestures into on-screen telestration. Through comparing traditional, verbal-based instruction instruction sessions to those with an telestration, we study its impact on communication patterns. In addition, measurement of the cognitive load of both the proctor and the trainee will illuminate whether the additional option of communication through telestration is significant enough to impede instruction and learning.

Methods

The study investigated the effects of telestration on communication between trainers and learners in a simulated laparoscopic surgery training environment. 7 total participant pairs were recruited for the study, with 5 general surgery residents, and two general surgical fellows as trainees. All participants has prior experience with performing a laparoscopic cholecystectomy. The trainers consistently of 1 independently practicing general surgeon, and a board certified general surgical fellow, who also acted as a participant for the study.

A low-cost, valid model created from readily available materials was used in the simulated environment for the laparoscopic cholecystectomy.

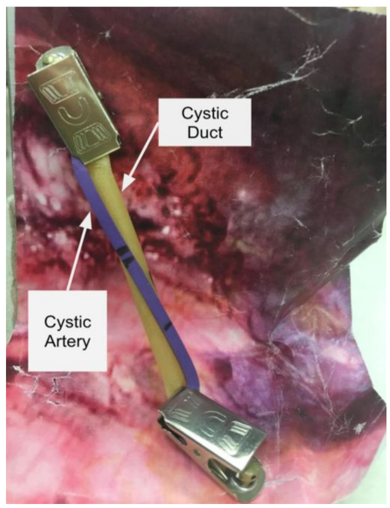

Figure 1: Contextual model of the cystic duct, cystic artery for training on laparoscopic cholecystectomies.

A rubber band represented the cystic artery, and the cystic duct was represented by penny rose tubing material. Borax mixed with elmer's glue (colloquially known as "Gak") formed the peritoneum covering (Figure 2).

Figure 2: Model with "peritoneum covering," for Task 4.

Each learner and trainer pair completed four context-relevant laparoscopic cholecystectomy tasks. The order of these tasks was counterbalanced among the participants.

Table 1: Overview of the task labels for simulated laparoscopic cholecystectomy tasks.

Task Number	Description
1	Free cystic duct and cystic artery from peritoneum
2	Clip cystic duct
3	Clip cystic artery
4	Cut cystic artery and cystic duct

This was a within-subjects study, and each pair performed half the tasks under standard, vocal-based instruction, with telestration added in the remainder. The order of the control-arm and the telestration arm were interweaved.

The trainee completed questionnaires on self-assessment of their skills, cognitive load, and evaluation of instruction quality for each trial. The trainer also completed surveys assessing the cognitive load, and assessed the trainee's general skills for the task.

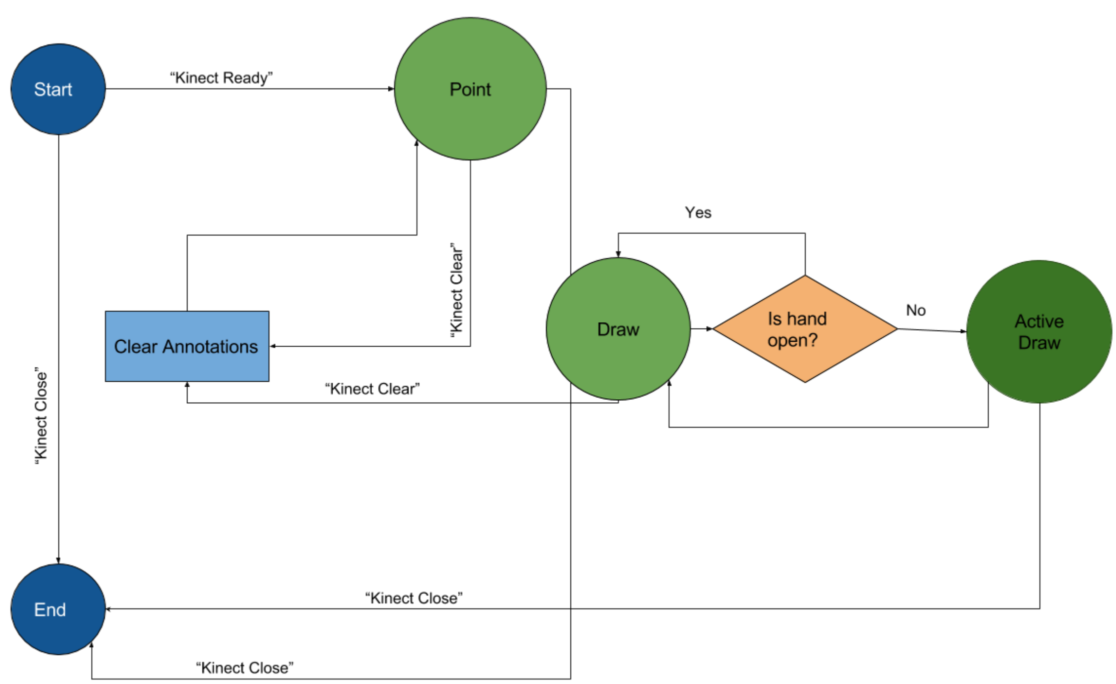

Figure 3: Telestration program flow diagram for drawing, pointing with the Microsoft Kinect.

Analysis:

The impact of telestration on the cognitive load for the trainer and trainee were assessed. For each trial, the cognitive load was normalized for each subject by subtracting the average cognitive load for the 4 trials for that particular trial. The Student t-test was performed to assess for statistical significance with a p-value of 0.05 for statistical significance between the conditions.

Results

Cognitive Load

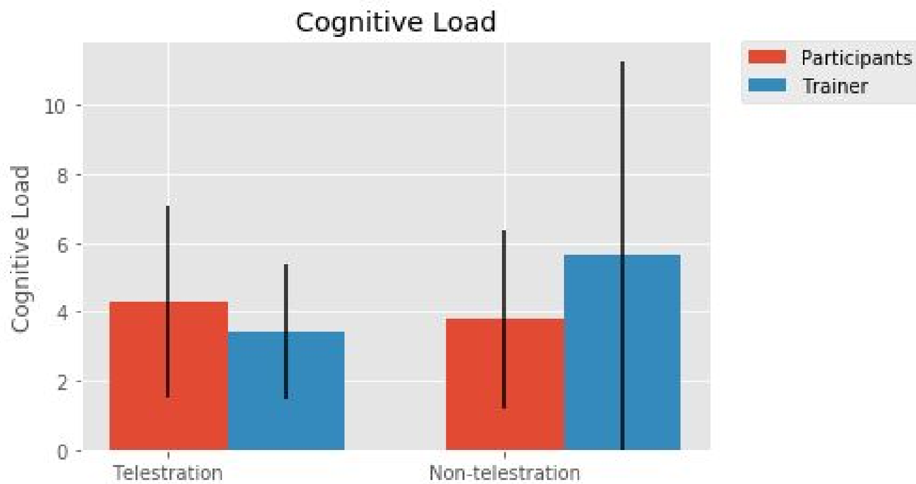

Figure 4: Raw mean of cognitive load reported by participants and trainers. Error bars represent one standard deviation.

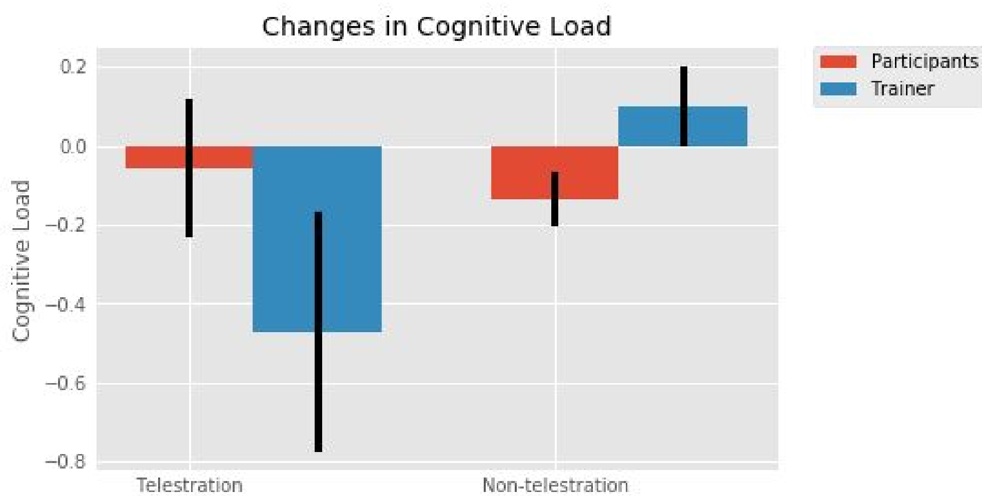

Figure 5: Normalized cognitive load (based on within subject mean) in each condition. Error bars represent one standard deviation.

While for participants, there was no significant difference in the cognitive load change with a p-value of 0.57 between the telestration and non-telestration conditions, the trainers had significantly lower reported cognitive load with a p-value of 0.002.

Discussion

We investigated the potential effects of telestration on communication in a simulated surgical training setting. Telestration appeared to have little effects on the cognitive load experienced by the participant, but lowered the cognitive load for trainers. Thus, telestration may make teaching easier for trainers. Further analysis of communication pattern data and skill assessments, which was not completed at the time of this writing, will help elucidate the effect of telestration on communication patterns and efficiency.

Future Design of Telestration System

The experimenters observed that the gestures were occasionally held in awkward positions, as the surgical trainer would move their hand far away from their body in order to place the telestration cursor on a correct area. Since an optimal sterile field is localized to the torso area, surgeons are limited in movements of their sterile, gloved hands. Thus, gestures detected through smaller movements would likely benefit the teaching system, and be more applicable to the operating room. Using the Kinect, it is possible to detect the number of fingers held up on a hand with over 90% accuracy from 4-5 feet away [Kulshreshth, 2013], and therefore detection of smaller movements could replace the current system for more ease of movement.

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