Virtual ACS 2021 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Research

Bimanual Wrist-Squeezing Haptic Feedback Changes Speed-force Tradeoff in Robotic Surgery Training

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Introduction: Without haptic feedback, safely handling tissue with the robotic instruments can be challenging for novice trainees. While most surgical training paradigms focus on maximizing speed and minimizing tissue interaction forces, task completion time is often the primary performance metric. We hypothesize that providing novices with tactile feedback of the force magnitude they apply while training will significantly reduce their root-mean-square (RMS) force magnitudes while not increasing their completion time compared to trainees receiving no feedback.

Methods: Novice participants with little to no prior da Vinci or clinical experience (n = 20) performed a ring rollercoaster training task twelve times using a da Vinci S surgical robot. Participants were instructed to finish each trial as quickly as possible. Participants in the feedback group (n = 10) received haptic feedback for all twelve trials, delivered bimanually by wrist-squeezing tactile actuators. Participants in the control group (n = 10) completed all trials without haptic feedback.

Results: The feedback group produced significantly less RMS force than the control group ($p = 0.03$). Neither group significantly changed their RMS force throughout the experiment ($p > 0.05$). At the start of the experiment, the feedback group was significantly slower than the control group ($p = 0.01$). The no feedback group significantly reduced their task completion times throughout the experiment ($p < 0.01$), and the feedback group reduced their task completion times significantly faster than the control group did ($p = 0.03$).

Conclusions: Providing novice da Vinci users with tactile feedback of the forces they exerted had no significant effect on final task completion time and significantly reduced the applied forces. This could potentially reduce tissue damage and suture breakage in clinical settings later on.

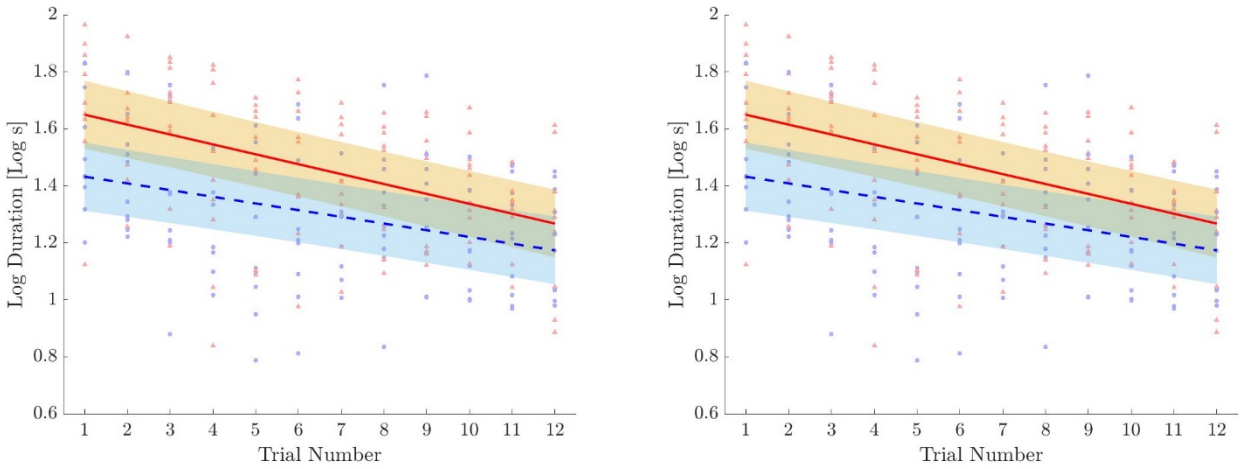

Figure 1: Log-transformed task completion time (left) and log-transformed RMS force (right), by feedback condition. Red markers and fitted line represent the feedback group. Blue markers and fitted line represent the no feedback group.