Video game experience affects multimodal parameters in laparoscopic surgery training

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Introduction: Video games can be a practical teaching tool to help train surgeons. Individuals who interact or play video games, tend to have a better visuospatial ability when compared to non-gamers. Numerous studies suggest that video game experience is associated with faster acquisition, greater sharpening, and longer retention of laparoscopic skills[1,2]. Given the neurocognitive complexity of surgery skill, multimodal approaches are required to understand how video game playing enhances laparoscopy skill. We investigated the impact of video game playing experience on the performance, subjective task load, and prefrontal (PFC) brain activity of novice trainees, and compared them with the corresponding variables in expert surgeons of varying levels of laparoscopy experience.

Methods: Data from 13 surgeons with varying levels of laparoscopy experience and no video game experience, and 27 students with no laparoscopy experience and varying levels of video game experience were used in this study. The students were subdivided into 12 non-gamer students (with no experience in video gaming) and 15 gamer students (with experience in video gaming). Participants performed standard training tasks including peg transfer and string pass using a laparoscopic trainer box. Data were recorded including time to completion, error rate, and overall work quality. After subjects completed each task, they completed the NASA task load index (NASA-TLX) questionnaire. At the beginning of the experiment, two 2-minutes-long videos that demonstrates the tasks were shown on a computer screen to the subject. After the video session the 15 min training was repeated by each subject for gamers and non-gamers. Further details of the procedure were provided in a recent study where we reported an analysis of the brain activity of surgeons and a subset of the student participants without regard to game playing experience[3]. All participants filled out a questionnaire detailing their video game experience including the frequency, duration and category. The gamers were divided into three groups based on their replies to the questionnaire: Only Shooter game group (that played first-person shooter and/or third person shooter and/or Role playing games), Only Strategy game group (real-time strategy, turn based strategy and multiplayer battle arena games), Shooter+Strategy game group (both strategy and shooter games).

Results: Figure 1A shows that the surgeons completed the task in a significantly shorter period of time when compared to gamers and non-gamers. A significant difference in completion time was noted between surgeons and non-gamers ($P < 0.01$) confirming the difference between the two groups. Although gamers appeared to be faster, the difference between gamers and non-gamers did not reach significance in Task 1. In Task 2 (not shown), there were similar trends although group differences were not statistically significant. Figure 1B shows that the surgeons had lower NASA-TLX workload scores when compared to gamers ($P<0.01$) and non-gamers ($P < 0.04$) during Task 1. There was a similar trend for Task 2. Significant difference in task load was seen between gamers and non-gamers ($P<0.02$). Figure 1C indicates that the left prefrontal cortical activation of surgeons in Task 1 was significantly lower than that of gamers ($P<0.004$) and non-gamers ($P<0.02$). As in the previous comparisons, Task 2 differences between groups were similar. Figure 1D,1E and 1F, indicates that the left prefrontal cortical activation in non-gamers was substantially higher than that in gamers which, in turn, was somewhat higher than that and surgeons. In Figure 1G and Figure 1H, through regression analysis we found a significant association between completion time and gaming experience. The extent of game experience was negatively correlated with completion time ($R2=0.22$, $P <0.01$). This figure only presents the results for Task 1. We observed a similarly significant association in Task 2 ($R2=0.18$, $P<0.02$). This figure also shows gaming categories which gamers play (the colour coded presentation used to show the gaming categories). No significant different was seen between only shooters player v only strategy players; only shooters player v strategy +shooters players; only strategy players v strategy+shooters player and Game experience. Figure 2B suggests that more experienced surgeons tended to be faster; however laparoscopy experience was not significantly correlated with completion time of task 1 ($R2=0.15$ $P=0.17$). Similar results were found in Task2.

Discussion: Our finding suggest that along the dimensions of performance, cognitive load, and brain activity, the effects of video gaming experience on novice laparoscopy trainees are similar to those of real-world laparoscopy experience on surgeons. We believe that the neural underpinnings of surgery skill and its links with gaming experience need to be investigated further using wearable functional brain imaging. In this work we have not investigated the longitudinal surgical skills learning over time. There is limited research relating to longitudinal studies for gamers and surgeons. This can be also considered in future studies.

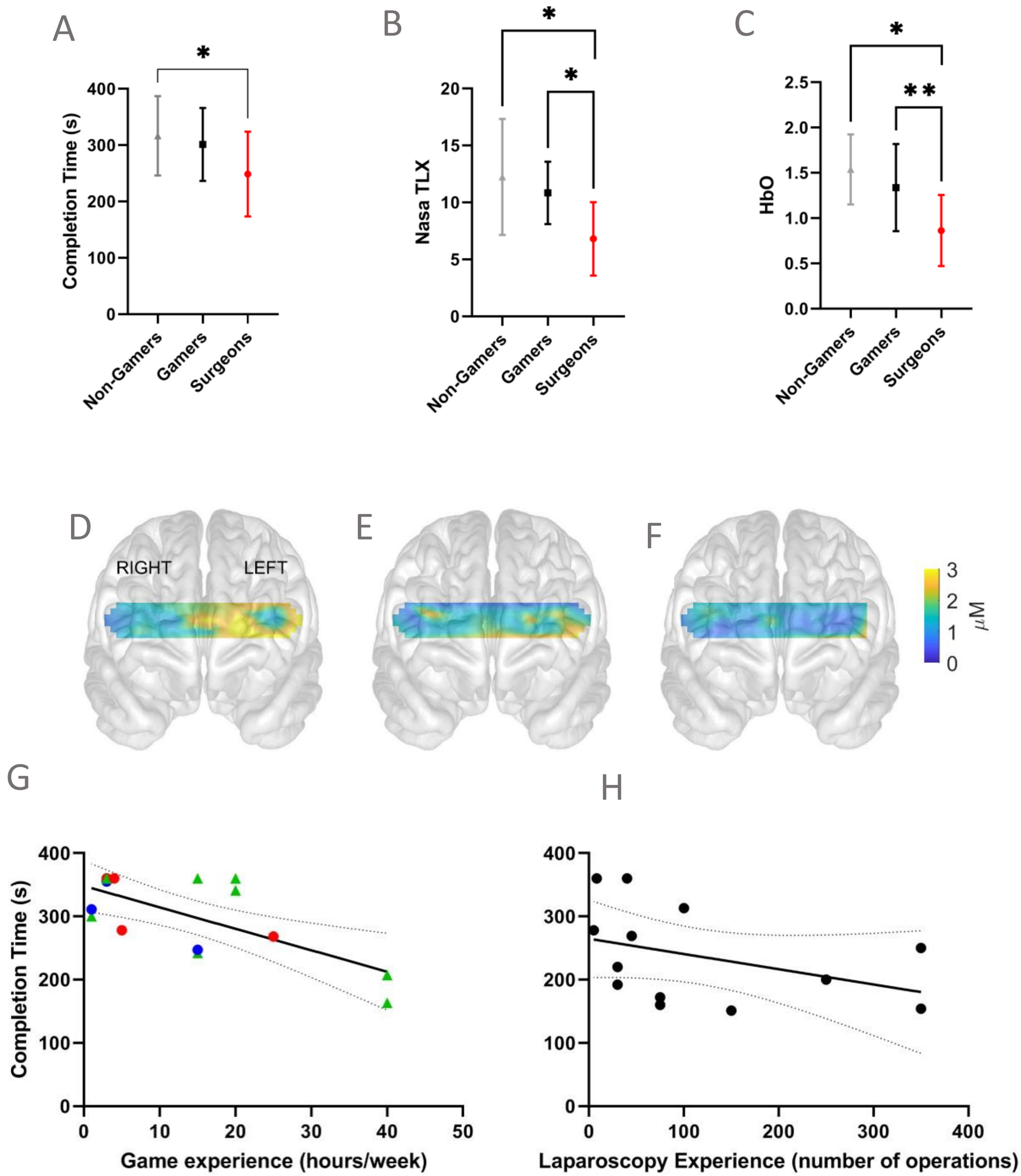

Figure 1. Performance, cognitive load, and prefrontal cortical activations of non-gamer students (gray triangle indicates the median). gamer students (black squares) and surgeons (red circles). The students have no laparoscopy experience and the surgeons have no gaming experience. Error bars indicate sample standard deviations (*p<0.05; **p< 0.01). **(A)** Task Completion Time. **(B)** Mean NASA-TLX Score. **(C)** Oxygenated hemoglobin oxyhemoglogin concentration changes in the left prefrontal cortex measured by fNIRS. Frontal view of the task-evoked cortical activations measured by fNIRS. The subject averaged topographic distribuftions of oxyhemoglobin over the prefrontal cortex are shown. **(D)** Non-gamer students**. (E)** Gamer students**. (F)** Surgeons. In Figure **(G) and (H)** Performance and its dependence on the gaming experience of students and on laparoscopy experience of surgeons. **(G)** Completion Time v gaming experience for students. Gamers are shown as only strategy game players (red circles), only shooter game players (green triangle) and both strategy and shooter game players (blue circles). Best fit line to the gamer data is shown (R2 = 0.22, P<0.01). **(H)** Completion Time v laparoscopy experience for surgeons. The solid black line indicate the linear best fit and the dotted lines indicate the 95% confidence interval (R2 = 0.15, P=0.17).

References:

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