The influence of expertise in the processing of 2D and 3D images for action: the case of minimal invasive surgery

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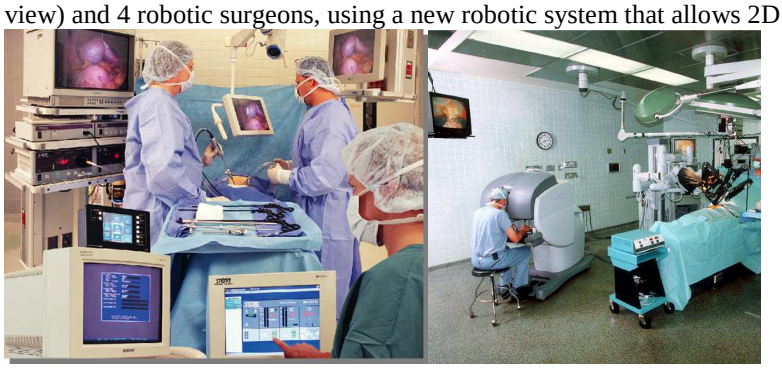
Introduction

Although 3D images lead to better performances than 2D ones in reaching and grasping tasks performances (Bingham and Pagano 1998; Jackson et al 1997), some factors affect this difference (for example, the complexity of tasks, Blavier et al., 2007). In this study, we evaluated the impact of subjects' expertise on this difference in a natural and meaningful setting with real experts.

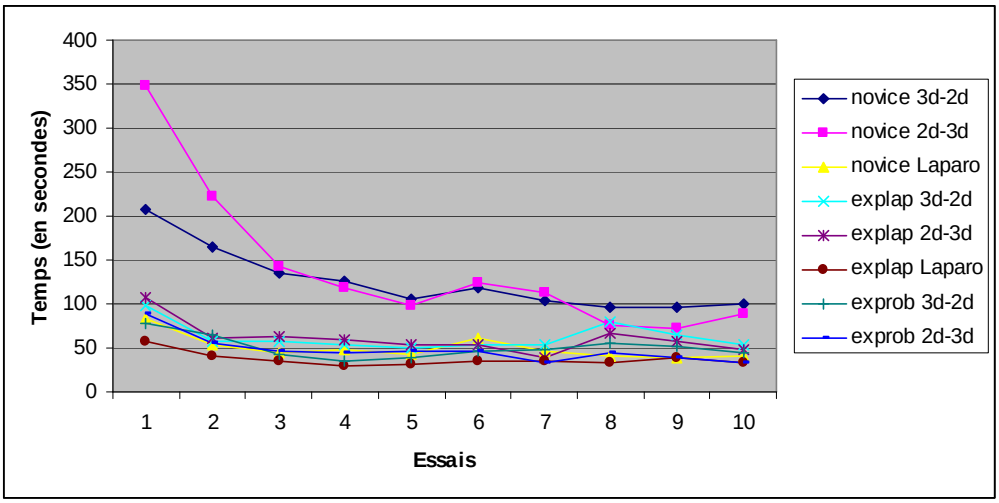
Method

Subjects: 12 novices (medical students) with the performance of 12 laparoscopic surgeons (using a 2D view) and 4 robotic surgeons, using a new robotic system that allows 2D and 3D view.



After a familiarisation phase, all subjects performed 4 tasks of increasing complexity in 3 conditions (classical laparoscopy (2D), robotic system in 2D and in 3D).

Results and discussion

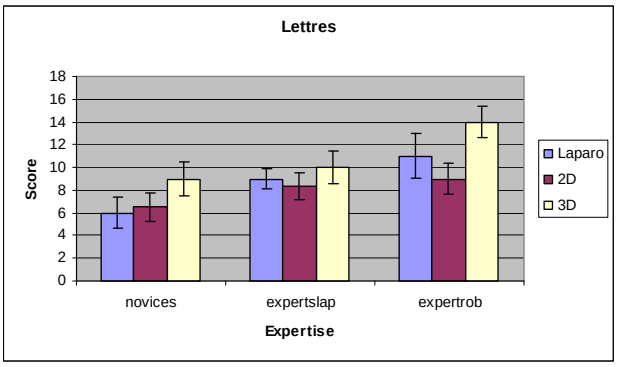


Learning curves according to the expertise and to the experimental condition in the Familiarisation phase

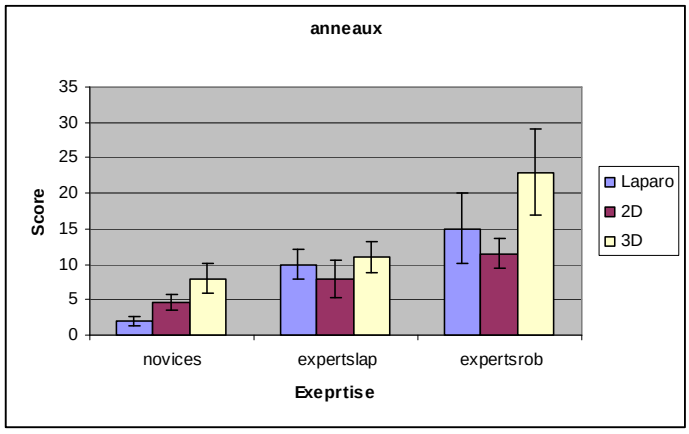
We observed a floor effect in the realisation of this easy task, particularly for the surgeons, regardless of the type of expertise (classical or robotic) and the condition. Medical students obtained a performance similar to surgeons in the classical laparoscopy condition. Moreover, novice subjects rapidly and accurately compensated for the lack of binocular depth perception with the 2D robotic system, relying on monocular cues to perform as fast as subjects in the 3D robotic system condition.

3.2 *Tasks of increasing complexity*

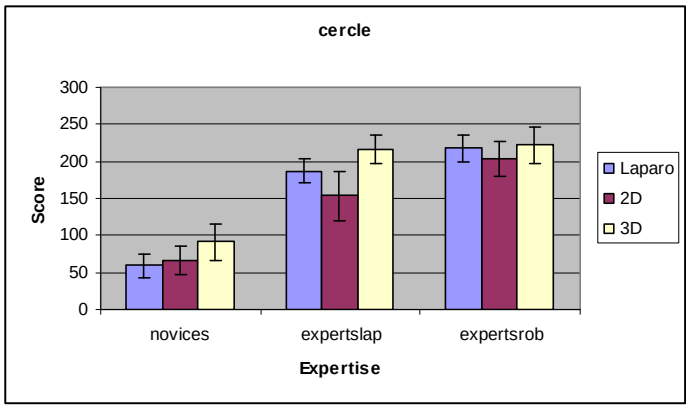
In task 1 (checkerboard), our results showed significant effect of expertise ($F=16.64$, $p<0.001$), experimental condition ($F=7.85$, $p<0.05$) and interaction ($F=15.44$, $p<0.005$).



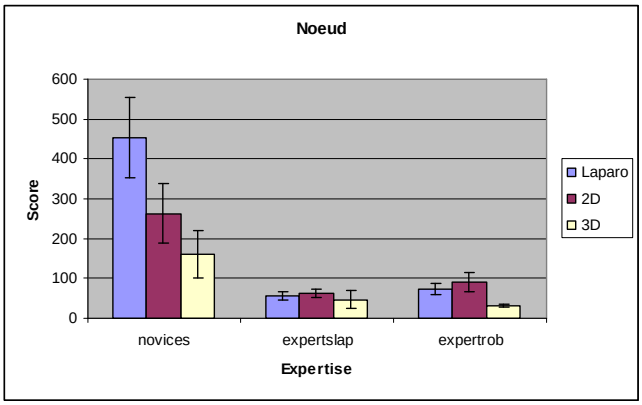
In the second task (rings route), we obtained a principal effect of expertise ($F=35.74$, $p<0.0000$), of the experimental condition ($F=28.84$, $p<0.0001$) and an interaction effect ($F=17.64$, $p<0.001$).



In the third task (circular pattern cutting), we obtained a significant effect of expertise ($F=43.75$, $p<0.000$).



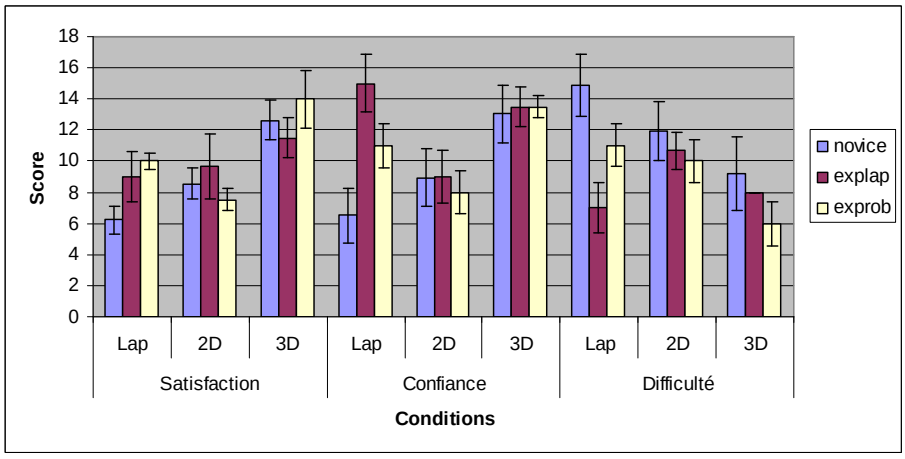
In the fourth task (suture and knot), the results we obtained also showed a significant effect of expertise ($F=37.45$, $p<0.0001$) and of the experimental conditions ($F=5.86$, $p<0.05$).



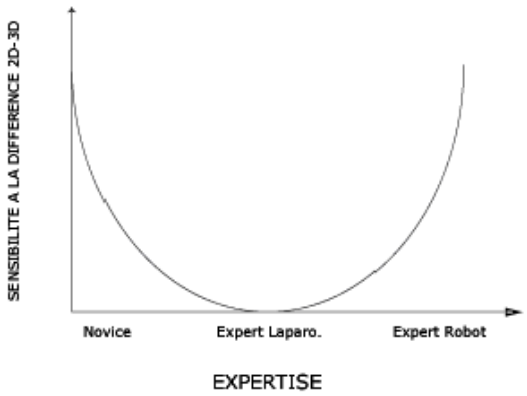
Time to perform the fourth task according to the expertise level and experimental condition

3.1 Answers to the questionnaire

We obtained a main effect of the experimental condition on the satisfaction ($F=6.36$, $p<0.05$) and on the self-confidence in all tasks ($F=13.46$, $p<0.005$, no significant effect on difficulty evaluation).



Conclusion: our results showed a trivial effect of expertise (surgeons generally performed better than novices). Furthermore, we showed the effect of 2D and 3D views was influenced by the expertise level: the novices' performance was strongly influenced by the 2D-3D difference (they performed significantly better in 3D than in 2D), whereas laparoscopic surgeons accurately compensated for the loss of depth perception in 2D view and performed similarly using 2D and 3D images. Robotic surgeons, who are used to manipulating robotic system in 3D, were also influenced by 2D-3D difference (they obtained same performance as laparoscopic surgeons in 2D view and a significantly better performance in 3D). These findings, illustrated by a U-curve, suggest that the sensitivity to the 2D-3D difference evolves according to the expertise and might disappear when subjects use only 2D view.



Acknowledgments

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