



# A Mental Workload Study on the 2d and 3de Viewing Conditions of the da Vinci Surgical Robot



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## Abstract

Fifteen medical students performed a standard training task using the da Vinci Surgical robot's 2d and 3d viewing conditions. Measures of mental workload associated with both viewing conditions were assessed using a secondary interval production task as well as the NASA Task Load Index (NASA-TLX) and the Multiple Resources Questionnaire (MRQ). The results of the NASA-TLX indicated that the 3d viewing condition results in lower scores of mental workload when compared to the 2d condition. The MRQ data provided diagnostic information regarding which information processing pools were stressed in both the 2d and 3d viewing conditions.

## Introduction

• Compared to conventional laparoscopic surgery, the da Vinci Surgical Robot (Intuitive Surgical) provides an improved user-interface by providing a broader range of movement and stereoscopic vision.

• The primary aim of this study is to determine if the 3d display results in lower mental workload compared to the 2d display. Mental workload refers to the ratio of mental resources used for the task and the total amount of resources available. Thus, if an interface results in lower demands on mental resources, more resources are available to perform other tasks concurrently, which in turn may result in improved patient safety.

• Mental workload measures include secondary tasks as well as subjective responses. **Secondary tasks** require the performance of a secondary task while concurrently performing the task of interest. **Subjective workload** measures require participants to complete questionnaires regarding their mental workload experience. The **NASA-Task-Load Index (NASA-TLX)** is the most widely used workload questionnaire. The NASA-TLX differentiates between 6 different dimensions. The **Multiple Resources Questionnaire (MRQ)** is a new mental workload measure that assesses 17 cognitive and perceptual pools of resources.

## Methods

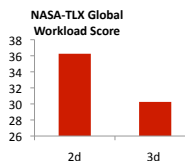
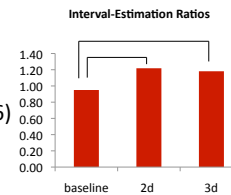
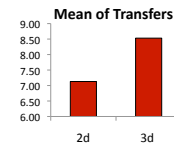
**Participants:** Fifteen first year medical students (11 male, 4 female) with a mean age of 24.6 years participated.

### Procedure:

1. Completed 90 sec baseline interval production task (requiring the estimation of 21 sec intervals)
2. Completed a 90 sec practice and experimental trial at both the 2d and 3d interfaces of the da Vinci surgical robot (which required participants to perform a peg-transfer task at each interface while simultaneously completing the interval production task)
3. Completed the NASA-TLX and the MRQ after completing the peg-transfer task at the 2d and 3d interfaces

## Results

- **Performance:** The number of transfers was greater in the 3d condition compared to the 2d condition ( $t(14) = 2.14, p = .050$ ).
- **Interval-Production Task:** The ratio of the estimated to the actual times was calculated. A repeated measures ANOVA was significant. Simple comparisons indicated that the baseline score was lower than the 2d and 3d scores ( $F(1.79, 25.06) = 9.89, p < .05$ )\*.
- **NASA-TLX:** The NASA-TLX was analyzed using a repeated measures 2 (interfaces)  $\times$  6 (NASA-TLX dimensions) ANOVA. A main effect for interface was observed ( $F(1, 11) = 5.46, p = .05$ )\*.



- **MRQ:** The MRQ was analyzed using a 2 (interfaces)  $\times$  17 (MRQ dimensions) repeated measures ANOVA. A main effect of MRQ scales was observed,  $F(4.79, 67.04) = 36.85, p < .05$ \*. Bonferroni corrected  $t$ -test were utilized to assess which scales differed significantly from 0.

MRQ Dimensions	Averaged across 2d & 3d
Auditory Emotional	
Auditory Linguistic	
Facial Figural	
Manual	x
STM	x
Spatial Attentive	x
Spatial Categorical	x
Spatial Concentrative	x
Spatial Emergent	x
Spatial Positional	x
Spatial Quantitative	x
Tactile Figural	x
Visual Lexical	
Visual Phonetic	
Visual Temporal	x
Vocal	

Note. x significantly different from 0

## Discussion

- **Performance:** The 3d display results in improved performance.
- **Mental Workload:**
  - **Interval Production Task:** This task failed to be sensitive to reflected changes in workload in the 2d and 3d conditions.
  - **NASA-TLX:** The TLX indicated that the 2d condition results in greater workload than the 3d condition. However, the TLX was not diagnostic; it did not indicate the different types of workload demands imposed in the 2d and 3d conditions.
  - **MRQ:** The MRQ failed to be sensitive to differences in workload in the 2d and 3d conditions. However, the MRQ was diagnostic of the different types of resources utilized in the robotic interface.

## References

1. Hart, S. G. (2006). NASA-Task-Load index (NASA-TLX): 20 Years later. *Proceedings of the Human factors and Ergonomics Society, 50*, 904-908.
2. Boles, D. B., Bursk, J. H. Phillips, J. B., & Perdelwitz, J. R. (2007). Predicting dual-task performance with the Multiple Resources Questionnaire. *Human Factors, 49*, 32-45.

\* corrected using Box's Epsilon

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