A Mental Workload Study on the 2d and 3d 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.

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) × 6 (NASA-TLX dimensions) ANOVA. A main effect for interface was observed ($F(1, 11) = 5.46, p = .05$).

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


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