How do basic surgical techniques using the DaVinci machine vary with robotic surgical experience and technical skills scores?

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Context

The DaVinci surgical system is a robotic surgical system that

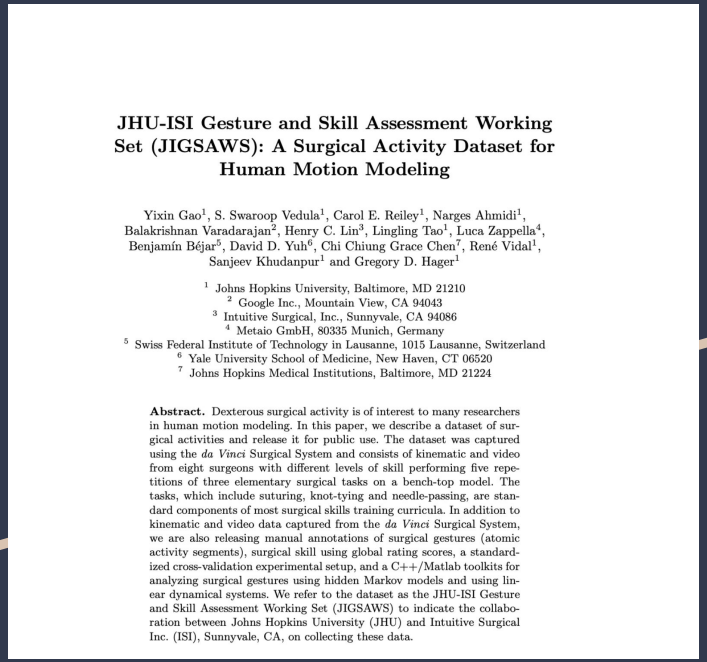
- uses minimally invasive techniques
- gives surgeons magnified, 3D high-definition views
- Allows for much greater range of motion than the human hand
- Commonly used for many procedures including prostate, kidney, and gynecological operations

Risk Factors

If surgeons do not learn to adapt techniques or learn new techniques, the DaVinci machine is futile.

If there are issues or complications, the surgeons will have to revert to open surgery with larger incisions.

What data did we look at?



JHU-ISI Gesture and Skill Assessment Working Set (JIGSAWS): A Surgical Activity Dataset for Human Motion Modeling

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Abstract. Dexterous surgical activity is of interest to many researchers in human motion modeling. In this paper, we describe a dataset of surgical activities and release it for public use. The dataset was captured using the *da Vinci* Surgical System and consists of kinematic and video from eight surgeons with different levels of skill performing five repetitions of three elementary surgical tasks on a bench-top model. The tasks, which include suturing, knot-tying and needle-passing, are standard components of most surgical skills training curricula. In addition to kinematic and video data captured from the *da Vinci* Surgical System, we are also releasing manual annotations of surgical gestures (atomic activity segments), surgical skill using global rating scores, a standardized cross-validation experimental setup, and a C++/Matlab toolkits for analyzing surgical gestures using hidden Markov models and using linear dynamical systems. We refer to the dataset as the JHU-ISI Gesture and Skill Assessment Working Set (JIGSAWS) to indicate the collaboration between Johns Hopkins University (JHU) and Intuitive Surgical Inc. (ISI), Sunnyvale, CA, on collecting these data.

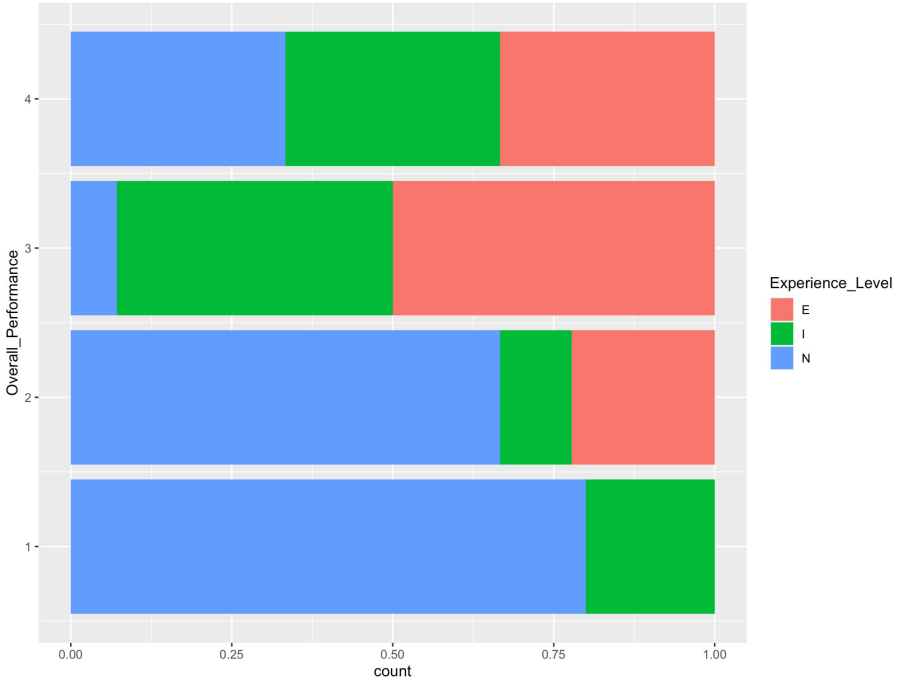
We analyzed the relationship between **surgeons' experience level** with robotic surgery (Novice = < 10 hrs, Intermediate = 10-100 hrs , Expert = 100+ hrs) and their corresponding **OSATs** (Objective Structured Assessment of Technical Skills) scores (from lowest (1) to highest (5)) for the following skills:

- Knot Tying
- Needle-Passing
- Suturing

Challenges we Faced

- Difficulty obtaining datasets
  - Many of the sets we wanted to use that looked at current trends and hospitals adopting robotic surgery were conducted after getting IRB approval
- Difficulty accessing large quantities of data
- Difficulty cleaning/sorting data

Knot-Tying

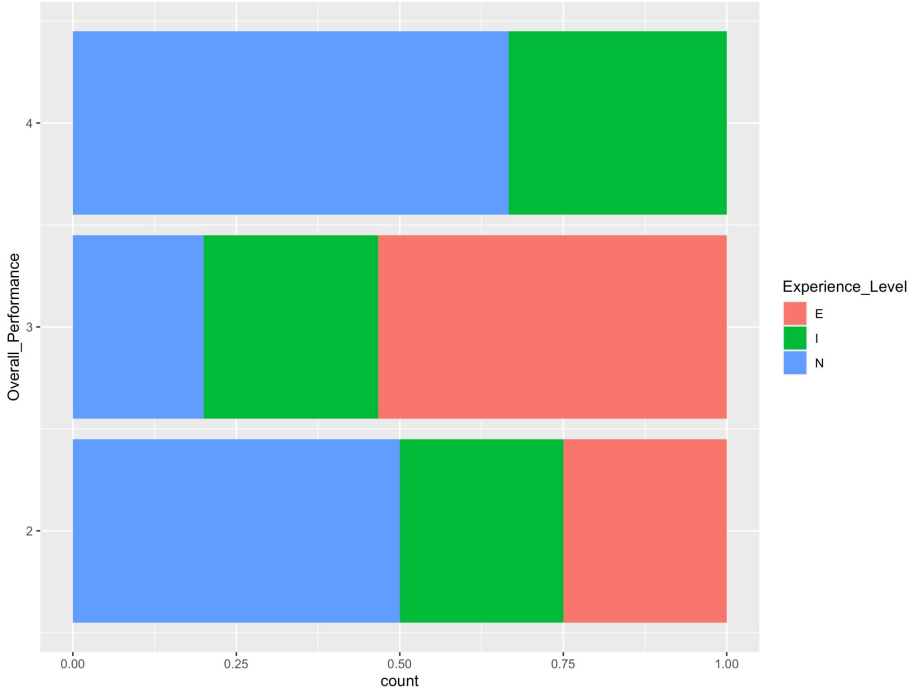


Gestalt Principles:

- Continuity: there are no breaks in the coloring
- Similarity: grouping same colors together

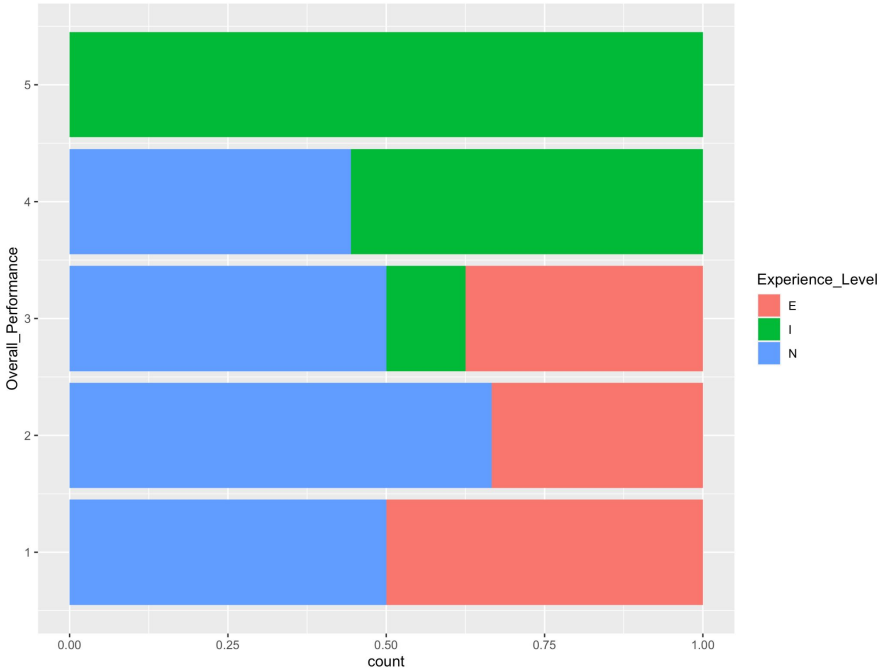
There is no strong correlation between overall performance and experience level - however those with novice experience levels tended to have lower performance scores and those with expert experience levels tended to have higher performance scores.

Needle-Passing



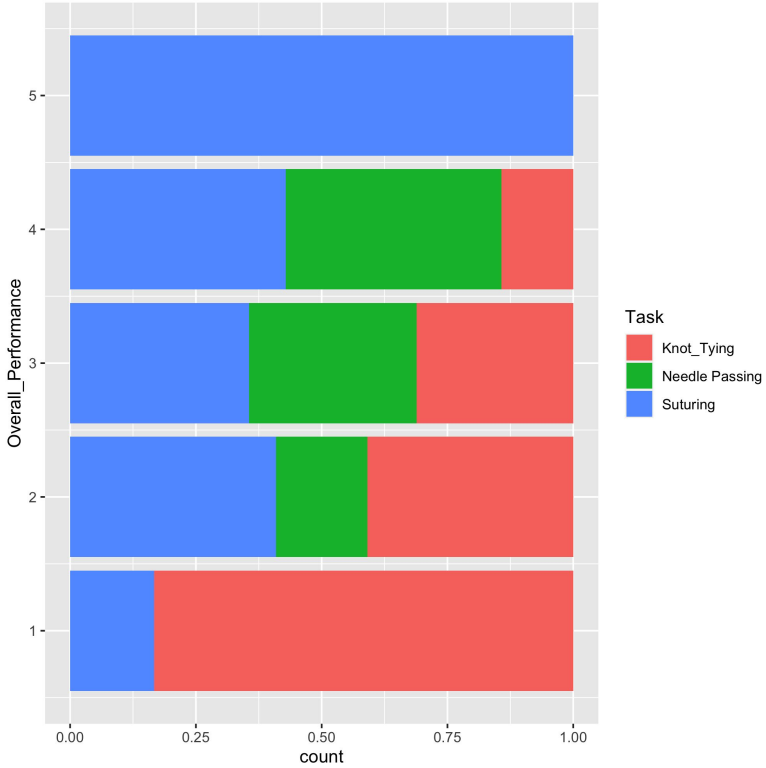
The plot shows that there is no strong correlation between overall performance and experience level in regard to needle-passing.
Additionally, a larger proportion of novices received high score of 4 compared to experts and intermediates.
No expert experiences level surgeons received a 4 and no surgeons received the highest score of 5.

Suturing



- Interestingly, only those with intermediate experience levels scored a 5 in suturing, and none scored below a 3
- Experienced surgeons scored the lowest overall among all levels
- A possible explanation could be that suturing is the easiest of the 3 technical tasks to do with the robot → does not need a lot of robotic experience to accomplish it well

Comparing Overall Performance across Tasks



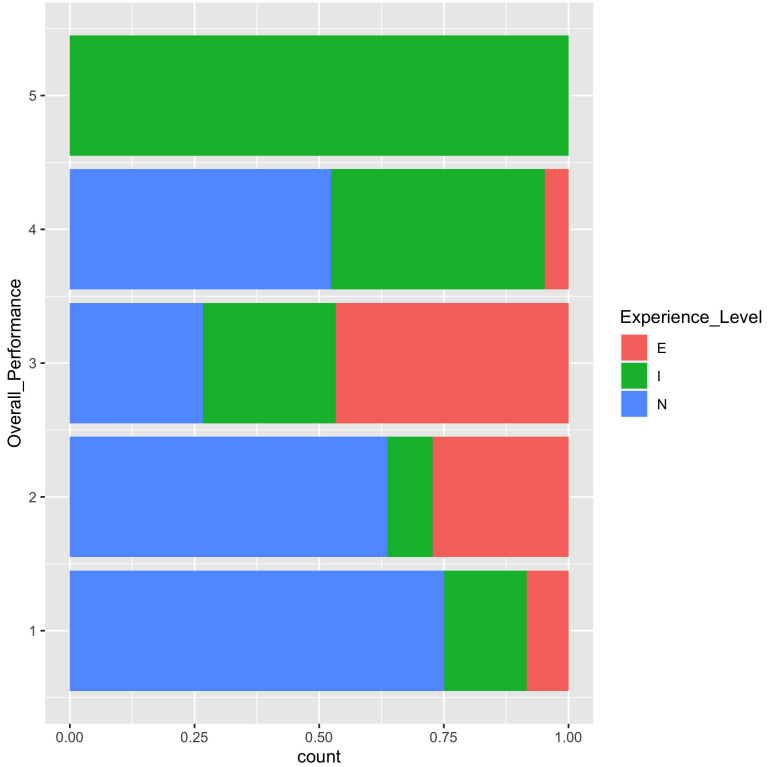
Observations:

- Knot Tying across all experience levels generally received the lowest scoring
- Suturing received generally higher scores
- Can be attributed to task difficulty

Gestalt Principles:

- Similarity: group similar colors together
- Continuity: there are no breaks in the colors or empty spaces

Comparing Overall Performance against Experience Levels



Observations

- Interestingly, only surgeons that were at intermediate experience levels received the highest score of 5
- A small percentage of surgeons with expert experience levels received the lowest score of 1