

Motivation

How does the absence of haptic feedback in robotic surgery affect surgical skill acquisition? This study is a prospective single-blinded randomized controlled trial examining the effect of haptic feedback of instrument vibrations [1] during simulation-based training on resident workload and performance during simulated bariatric surgery and live operating room (OR) robotic-assisted sleeve gastrectomy (RASG).

Methods

Procedure: Twelve surgical residents (seven PGY-3, five PGY-7) were randomized to receive either haptic feedback or no haptic feedback during a proctored simulation session that took place before the first operative cases of a bariatric service rotation. None of the participants had experience as a console surgeon prior to the study. Participants each performed 5 simulated bariatric surgical procedures and between 3 and 14 live patient RASGs. Workload measures including pre- and post-procedure State-Trait Anxiety Inventory (STAI) [2] and NASA Task Load Index (TLX) [3] were recorded in both the simulated and OR settings.

Analysis: Multiple backward linear regression was performed to examine potential associations between workload measures and factors including haptic feedback, PGY level, number of cases already completed in the study, robotic operative time (in minutes), and sleep the previous night (in hours).

Results

The twelve subjects performed a total of 60 simulated and 79 live operating room RASGs. Sample video images from the simulated and live OR procedures are displayed in Figure 1.

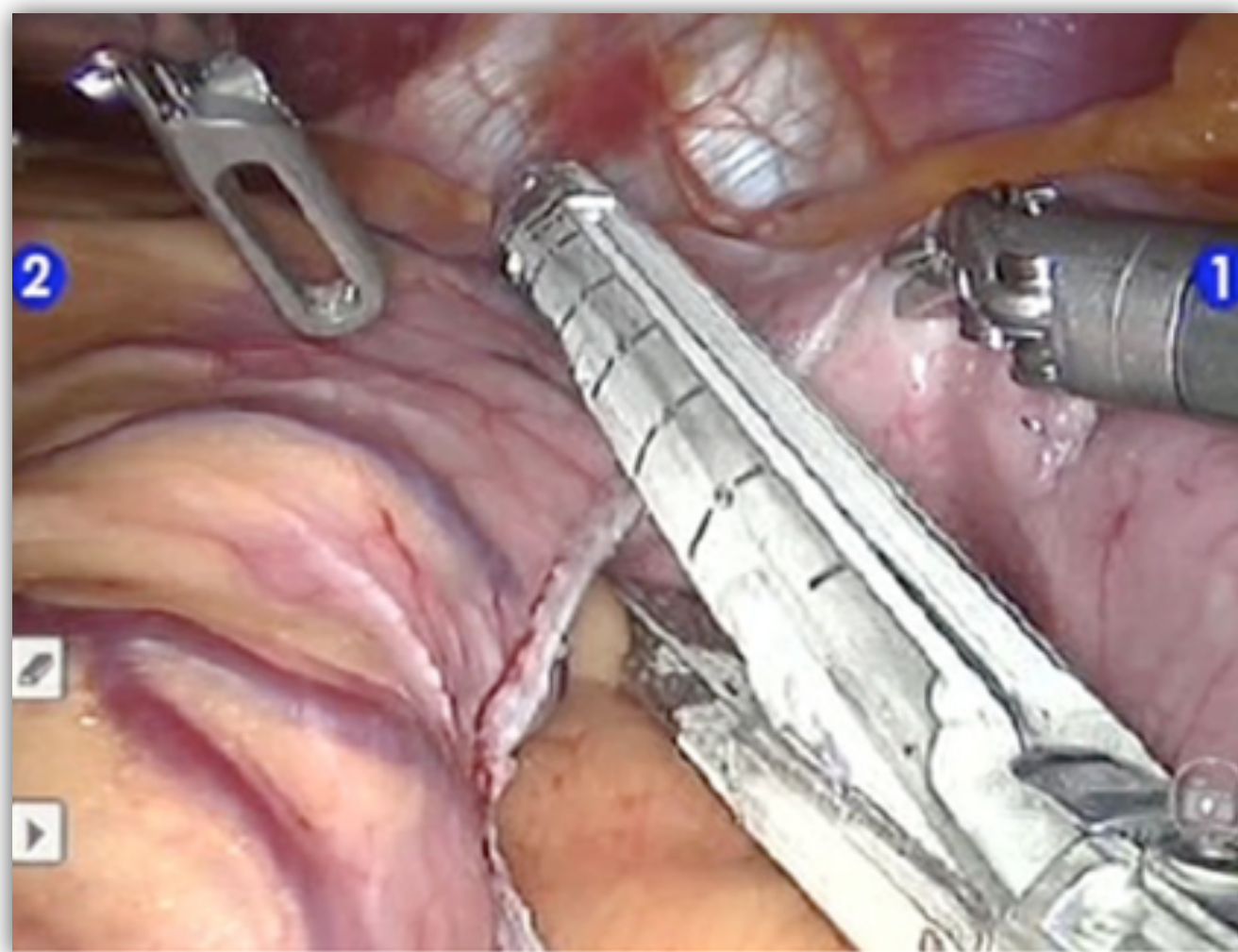
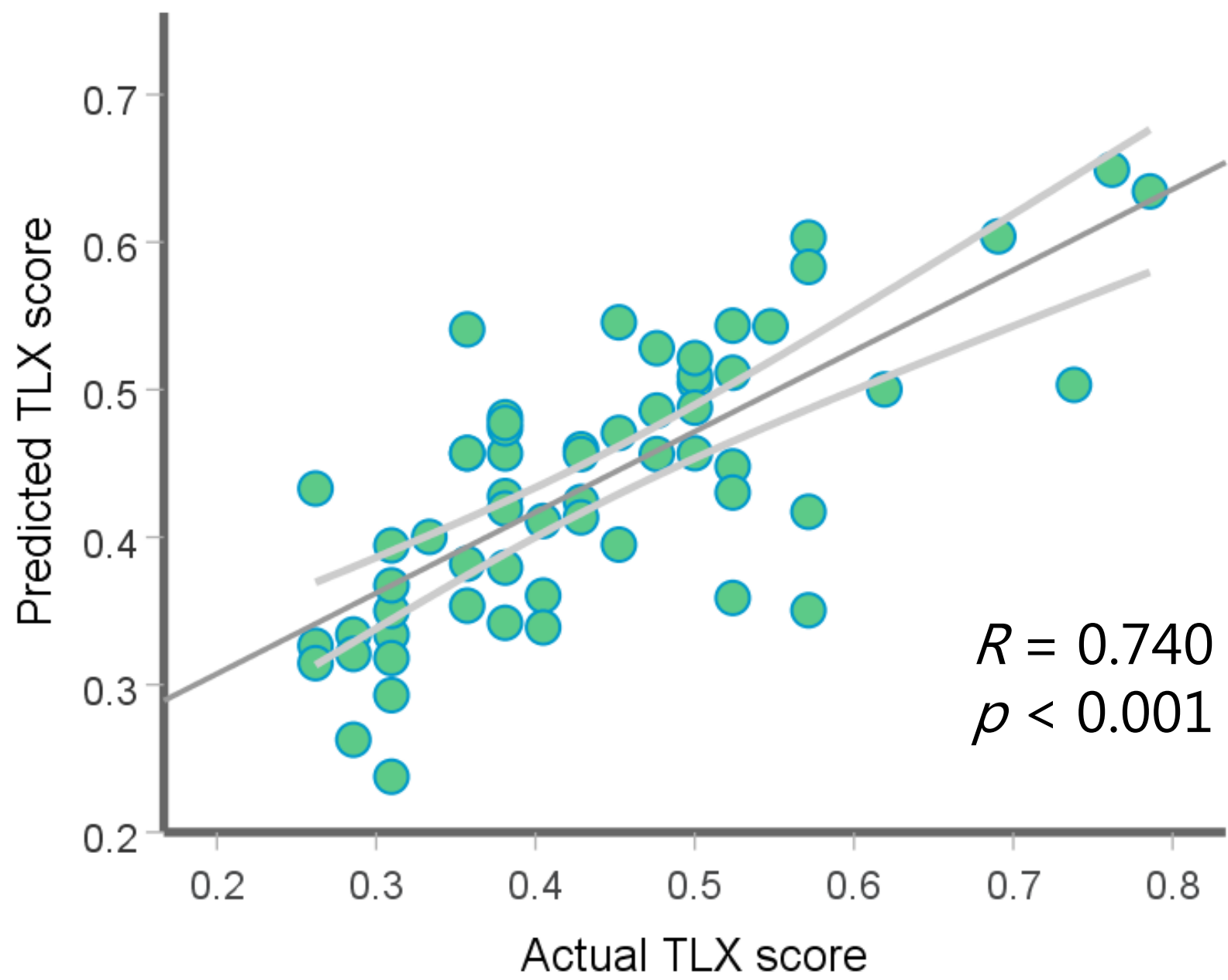


Figure 1: Video images from simulated (left) and live OR (right) robotic-assisted sleeve gastrectomies (RASG)

$$\begin{aligned} \text{TLX}_{\text{simulation}} &= 0.48 - 0.1 * \text{PGY Level} - 0.05 * \text{Sleep} \\ &+ 0.005 * \text{Time} + 0.02 * \text{STAI}_{\text{pre-procedure}} \end{aligned}$$



$$\begin{aligned} \text{TLX}_{\text{live OR}} &= 0.35 - 0.1 * \text{PGY Level} - 0.02 * \text{Case Total} \\ &+ 0.002 * \text{Time} + 0.02 * \text{STAI}_{\text{pre-procedure}} \end{aligned}$$

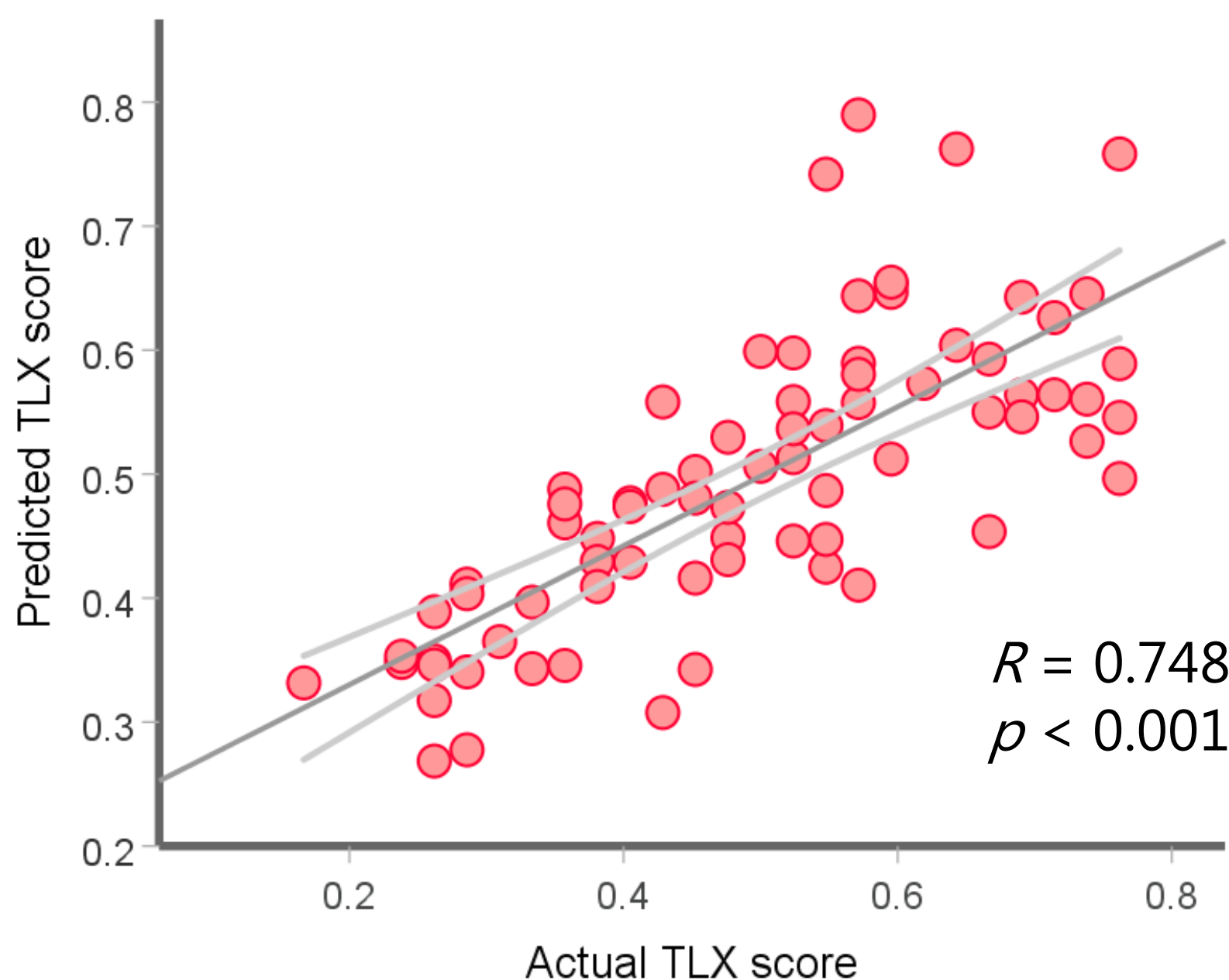


Figure 2: Correlation between predicted and actual TLX score from simulated (left) and live OR (right) bariatric surgical procedures

For both simulated and live RASGs, decreasing PGY-level, longer procedure time, and higher pre-procedure STAI were associated with higher reported workload as measured by TLX score. Increased hours of sleep were associated with lower TLX score for simulated RASGs, and increasing RASG case experienced was associated with lower TLX score for live OR RASGs. The plots of predicted and actual TLX score in Figure 2 show strong significant correlation ($R > 0.7$) for both the simulated and OR settings. Details of regression analysis are displayed in Table 1.

Table 1. Multiple backward regression for resident workload

Setting	Parameter	Unstandardized Coefficients		<i>p</i> -value
		B	SE	
Simulation (n=60)	(Intercept)	0.483	0.100	<0.001
	PGY Level	-0.104	0.024	<0.001
	Sleep (hours)	-0.052	0.016	0.002
	Time (minutes)	0.005	0.001	<0.001
	STAI pre-procedure	0.021	0.007	0.003
Live OR (n=76)	(Intercept)	0.345	0.063	<0.001
	PGY Level	-0.096	0.032	0.004
	Case Total	-0.019	0.004	<0.001
	Time (minutes)	0.002	0.001	0.003
	STAI pre-procedure	0.016	0.004	<0.001

SE: Standard error, OR: Operating room, PGY: Post-graduate year, Time: Operative time, STAI: State-Trait Anxiety Inventory

Discussion

Regression analysis did not identify haptic feedback during simulation training as a contributing factor to reported trainee workload during the simulated or live OR RASGs. However, decreasing PGY-level, longer procedure time, and higher pre-procedure stress as measured by the STAI were associated with higher TLX score, suggesting that these three factors demonstrate utility as consistent predictors of workload during the educational transition from the simulated to OR setting. The relevance of sleep and case experience to workload may warrant further investigation in the context of trainees as well as experienced surgeons. The TLX survey may be a more robust workload measure than the STAI survey in the context of robotic surgery.

References

- [1] Kuchenbecker K. J., Gewirtz J., McMahan W., Standish D., Martin P., Bohren J., Mendoza P. J., Lee D. I. VerroTouch: High-Frequency Acceleration Feedback for Telerobotic Surgery. In International Conference on Human Haptic Sensing and Touch Enabled Computer Applications. 2010:189-196. Springer, Berlin, Heidelberg.
- [2] Perpina-Galvan J., Richart-Martinez M., Cabanero-Martinez M. J., Martinez-Dura I. Content validity of the short version of the subscale of the State-Trait Anxiety Inventory (STAI). Rev Lat Am Enfermagem. 2011;19(4):882-7.
- [3] Hart S. G., Staveland L. E. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. Advances in Psychology. 1988;52:139-83.

If you are interested in learning more, please contact:

Ernest D. Gomez, M.D.
Beth Israel Deaconess Medical Center
330 Brookline Ave, Boston, MA 02215, USA
Email: egomez@bidmc.harvard.edu

Haliza Mat Husin, Ph.D.
Max Planck Institute for Intelligent Systems
Heisenbergstraße 3, 70569 Stuttgart, Germany
Email: hmh@is.mpg.de