The American Journal of Surgery xxx (2017) 1–7

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

# The correlation between fundamental characteristics and first-time performance in laparoscopic tasks

Cuan M. Harrington [a, *], Richard Bresler [b], Donncha Ryan [a], Patrick Dicker [c], Oscar Traynor [a], Dara O. Kavanagh [a]

[a] Department of Surgical Affairs, Royal College of Surgeons in Ireland, Ireland
[b] School of Medicine, Royal College of Surgeons in Ireland, Ireland
[c] Department of Epidemiology and Public Health Medicine, Royal College of Surgeons in Ireland, Ireland

ARTICLE INFO

*Article history:*
Received 18 January 2017
Received in revised form
3 April 2017
Accepted 29 April 2017

This study was presented at the 2017 Association of Surgical Education Annual Meeting, San Diego, California.

*Keywords:*
Laparoscopic simulation
Aptitude
Resident competency

ABSTRACT

*Background:* The ability of characteristics to predict first time performance in laparoscopic tasks is not well described. Videogame experience predicts positive performance in laparoscopic experiences but its mechanism and confounding-association with aptitude remains to be elucidated. This study sought to evaluate for innate predictors of laparoscopic performance in surgically naive individuals with minimal videogame exposure.

*Methods:* Participants with no prior laparoscopic exposure and minimal videogaming experience were recruited consecutively from preclinical years at a medical university. Participants completed four visuospatial, one psychomotor aptitude test and an electronic survey, followed by four laparoscopic tasks on a validated Virtual Reality simulator (LAP Mentor™).

*Results:* Twenty eligible individuals participated with a mean age of 20.8 (±3.8) years. Significant intra-aptitude performance correlations were present amongst 75% of the visuospatial tests. These visuospatial aptitudes correlated significantly with multiple laparoscopic task metrics: number of movements of a dominant instrument ($r_s \geq -0.46$), accuracy rate of clip placement ($r_s \geq 0.50$) and time taken ($r_s \geq -0.47$) ($p < 0.05$). Musical Instrument experience predicted higher average speed of instruments ($r_s \geq 0.47$) ($p < 0.05$). Participant's revised competitive index level predicted lower proficiency in laparoscopic metrics including: pathlength, economy and number of movements of dominant instrument ($r_s \geq 0.46$) ($p < 0.05$).

*Conclusion:* Multiple visuospatial aptitudes and innate competitive level influenced baseline laparoscopic performances across several tasks in surgically naïve individuals.



## 1. Background

The global reduction in available training opportunities may be subsequent to shortening of surgical training programs and the introduction of reduced working hours. The impact of working time restrictions has been described as 'a catalyst to reconfigure or redesign service and training.'[1] The common goal in surgical training programs worldwide is the desire to produce highly competent individuals with an inherent ability to rapidly acquire technical and non-technical skills. With increasingly limited workplace time to achieve such technical competencies, innate predictors of technical skills may become of considerable interest in selection to surgical training programs.

Landmark papers such as 'To Err is Human' have provoked revolutions in surgical training with simulation now critical to its foundations.[2] Operative exposure amongst surgical residents is now failing to meet a minimum case mix volume in a number of nations including the United Kingdom, Ireland and North America.[3–5] Even with adequate operative exposure, some residents fail to demonstrate technical competency in assessments.[6] The significant financial restrictions amongst healthcare providers may limit the increased time and monetary investment needed for live operative teaching,[7] and cannot be sustainable as the sole solution.

The acquisition of laparoscopic technical skills can be

* Corresponding author. Dept of Surgical Affairs, Royal College of Surgeons in Ireland, 121 St Stephens Green, Dublin 2, Ireland.
*E-mail address:* cuanharrington@rcsi.ie (C.M. Harrington).

http://dx.doi.org/10.1016/j.amjsurg.2017.04.015
0002-9610/

challenging and even unsurmountable for some residents due to the demand for complex, non-intuitive skill development.[8,9] These include non-dominant hand skills such as inverted movements, the fulcrum effect and depth perception.[10] Research pertaining to innate predictors of technical performance is conflicting on the influence of a number of factors including: visuospatial and psychomotor aptitude, gender, age and musical instrument experience.[11,12]

Experience with videogaming has positive correlations with first time and future laparoscopic performances in Virtual Reality (VR) Simulators[13,14] and task trainers.[15] This may be due to the associations between videogames and improved complex hand-eye co-ordination[16] and elements of visual attention.[17] Extensive videogaming is thought to alter cortical network plasticity and effect other dissociated tasks.[16] Reconstructing two dimensional images into three dimensional environments or structures is integral to both videogames and laparoscopic surgery. This ability or 'pictorial perception' varies amongst surgeons and may be influenced by a number of factors.[18]

The present study aimed to evaluate for correlations between fundamental innate individual factors and first time laparoscopic performance amongst all levels without the significant influence of videogames experience on technical or aptitude performances.

## 2. Methods

This single centre study was conducted between April and May 2016 in RCSI, Ireland. Individuals were recruited from pre-clinical undergraduate years of the international medical university. Participants were consecutively enrolled and assessed for eligibility and each participant gave voluntary and informed consent.

Participants completed an electronic questionnaire to assess eligibility, which incorporated demographics, handedness, a revised competitive index (Houston et al., 2002)[19] and Likert-scale questions relating to prior background participation in sports, videogames and musical instrument experience. Information relating to personal experience with laparoscopy (live or virtual reality simulator) and frequency of personal video gaming in hours/week was obtained.

### 2.1. Exclusion criteria

Exclusion criteria comprised of: minors (<18 years old), experience with laparoscopy (live or simulated), a background of video gaming ≥3 h/week generally or ≥15 h over the preceding four weeks, or a history of surgical aptitude assessment completion.

### 2.2. Aptitude testing

Eligible participants proceeded to complete a single attempt at four aptitude tests for visuospatial awareness and depth perception involving PicSOR (Pictorial Surface Orientation, Cowie R),[21] card rotations (Ekstrom RB, 1976), cube comparisons (Ekstrom RB, 1976) and Map Planning (Ekstrom RB, 1976) on an electronic platform.[22] All aptitude testing was performed prior to virtual reality laparoscopic performances and scores were calculated electronically.

Psychomotor dexterity testing was performed using a single attempt at the modified grooved Pegboard (Model 32025, LaFayette Instrument Company, [PEG]). Following completion, individuals completed baseline laparoscopic testing using four tasks on the Virtual Reality (VR) simulator, LAP Mentor™ (3D systems, formerly Simbionix, Colorado, USA).

### 2.3. VR laparoscopic simulator testing

Virtual reality laparoscopic testing was performed using the LAP Mentor™ (version II). A standardised demonstration video of the four tasks was observed by each participant followed by a brief orientation to the simulator and instrument handling. Standardised objectives were provided at the beginning of each task by the

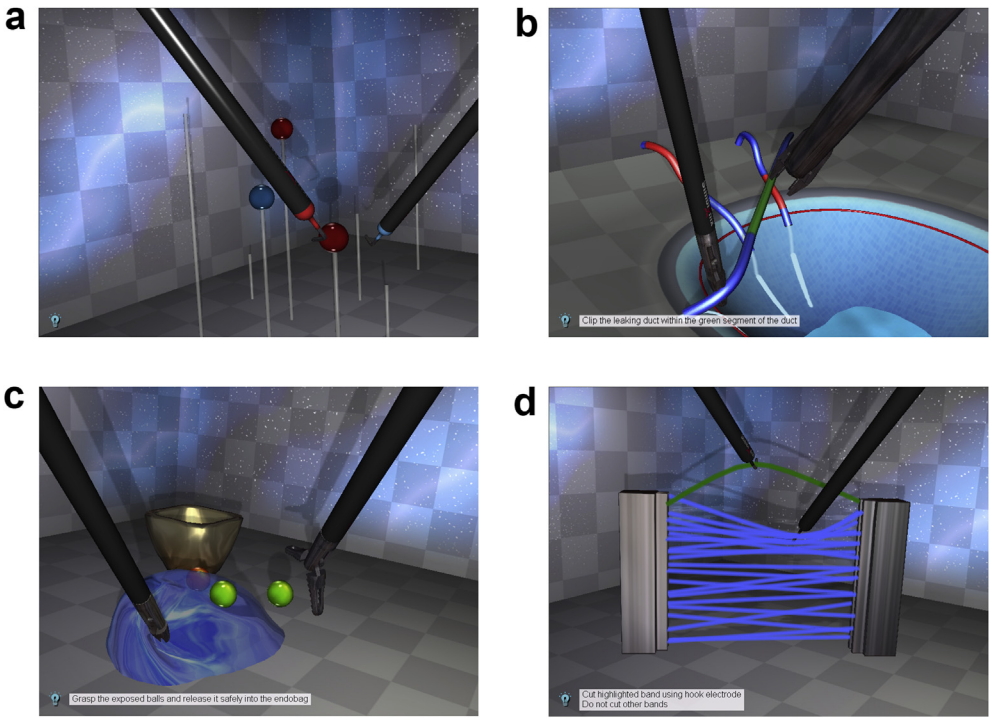


**Fig. 1.** Laparoscopic VR tasks: (a) Eye hand Co-ordination (b) Grasping and clipping (c) Two-handed manouvres (d) Fulguration.

Please cite this article in press as: Harrington CM, et al., The correlation between fundamental characteristics and first-time performance in laparoscopic tasks, The American Journal of Surgery (2017), http://dx.doi.org/10.1016/j.amjsurg.2017.04.015