

Automaticity of Force Application During Simulated Brain Tumor Resection: Testing the Fitts and Posner Model[☆]

Abdulgadir Bugdadi, MD, MSc,^{*,†} Robin Sawaya, BSc,^{*} Duaa Olwi, MSc,^{*} Gmaan Al-Zhrani, MD, MA,^{*,‡} Hamed Azarnoush, PhD,^{*,§} Abdulrahman Jafar Sabbagh, MBChB, FRCSC,^{*,||,¶} Ghussn Alsideiri, MD,^{*,#} Khalid Bajunaid, MD, MSc,^{*,**} Fahad E. Alotaibi, MD, MSc,^{*,‡} Alexander Winkler-Schwartz, MD,^{*} and Rolando Del Maestro, MD, PhD^{*}

^{*}Department of Neurosurgery and Neurology, Neurosurgical Simulation Research and Training Centre, Montreal Neurologic Institute and Hospital, McGill University, Montreal, Quebec, Canada; [†]Department of Surgery, Faculty of Medicine, Umm Al-Qura University, Makkah AlMukarramah, Saudi Arabia; [‡]Department of Neurosurgery, National Neuroscience Institute, King Fahad Medical City, Riyadh, Saudi Arabia; [§]Department of Biomedical Engineering, Amirkabir University of Technology, Tehran Polytechnic, Tehran, Iran; ^{||}Department of Surgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia; [¶]Clinical Skill and Simulation Center, King Abdulaziz University, Jeddah, Saudi Arabia; [#]Department of Surgery, College of Medicine, Sultan Qaboos University, Muscat, Oman; and ^{**}Division of Neurosurgery, University of Jeddah, Jeddah, Saudi Arabia

OBJECTIVE: The Fitts and Posner model of motor learning hypothesized that with deliberate practice, learners progress through stages to an autonomous phase of motor ability. To test this model, we assessed the automaticity of neurosurgeons, senior residents, and junior residents when operating on 2 identical tumors using the NeuroVR virtual reality simulation platform.

DESIGN: Participants resected 9 identical simulated tumors on 2 occasions (total = 18 resections). These resections were separated by the removal of a variable number of tumors with different visual and haptic complexities to mirror neurosurgical practice. Consistency of force application was used as a metric to assess automaticity and was defined as applying forces 1 standard deviation above or below a specific mean force application. Amount and specific location of force application during second identical tumor resection was compared to that used for the initial tumor.

SETTING: This study was conducted at the McGill Neurosurgical Simulation Research and Training Center, Montreal Neurologic Institute and Hospital, Montreal, Canada.

PARTICIPANTS: Nine neurosurgeons, 10 senior residents, and 8 junior residents.

RESULTS: Neurosurgeons display statistically significant increased consistency of force application when compared to resident groups when results from all tumor resections were assessed. Assessing individual tumor types demonstrates significant differences between the neurosurgeon and resident groups when resecting hard stiffness similar-to-background (white) tumors and medium-stiffness tumors. No statistical difference in consistency of force application was found when junior and senior residents were compared.

CONCLUSION: “Experts” display significantly more automaticity when operating on identical simulated tumors separated by a series of different tumors using the NeuroVR platform. These results support the Fitts and Posner model of motor learning and are consistent with the concept that automaticity improves after completing residency training. The potential educational application of our findings is outlined related to neurosurgical resident training. (J Surg Ed ■■■■-■■■. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

[☆]*Funding:* This work was supported by the Di Giovanni Foundation, the Montreal English School Board, the B-Strong Foundation, the Colannini Foundation, and the Montreal Neurological Institute and Hospital. Dr. H. Azarnoush held the Post-doctoral Neuro-Oncology Fellowship from the Montreal Neurological Institute and Hospital. Robin Sawaya holds the Christian Gaeda Scholarship from the Montreal Neurological Institute. Dr. R. Del Maestro is the William Feindel Emeritus Professor in Neuro-Oncology at McGill University.

Correspondence: Inquiries to Abdulgadir Bugdadi, MD, Department of Neurosurgery, Neurosurgical Simulation Research and Training Centre, Montreal Neurologic Institute and Hospital, McGill University, 3801 University Street, Room E2.89, Montreal, Quebec, Canada H3A 2B4; e-mail: Abdulgadir.Bugdadi@mail.mcgill.ca

KEY WORDS: Fitts and Posner Model, automaticity, consistency, skills script, brain tumor simulation in neurosurgery, NeuroVR/NeuroTouch

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

The complex term “expertise” has no exact definition relating to neurosurgical psychomotor performance; however, achieving expertise in surgical technical skills is an aspirational goal.¹⁻³ Understanding the multiple interacting factors resulting in the acquisition of expertise may be useful to enhance learning and maintenance of neurosurgical ability. Fitts and Posner proposed a motor skill learning model highlighting stages the learner navigates when acquiring new motor skills: cognitive, associative, and autonomous.^{2,4} In the cognitive phase, the learner builds component units of the skill and consciously performs the task slowly, committing numerous errors with marked inconsistency. The performance becomes faster, more accurate, and consistent in the associative phase. In the autonomous phase, the skill becomes habitual, executed unconsciously with fluency, accuracy, and consistency of performance.^{2,4-6} If this model pertains to the neurosurgical acquisition of operative skills, components of this model should be both testable and true. During training, residents should progress through the 3 phases outlined. Our group has developed and validated psychomotor metrics that objectively measure manual performance in medical students, residents, and neurosurgeons during resection of virtual reality tumors using the NeuroVR platform.^{7-17,25-27} Automaticity of surgical performance encompasses many components including increased fluency, accuracy, and consistency. Our results are consistent with the model involving fluency and accuracy of manual psychomotor performance.^{7,12,13} “Experts” in the autonomous stage of learning faced with similar operative pathologies should demonstrate significantly more consistency in their surgical approach. Surgical consistency could include consistency of force application, rate of tumor resection, and amount of normal tissue injury. In this study, we focused on consistency of force application as excessive force application is related to surgical error.¹⁸ Our previous studies using virtual reality tumor resection categorized maximum force applied and sum of force used as safety metrics.^{7,11} Consistency in performance is the feature that most distinguishes experts from novices.¹⁹ The effect of consistency in sports performance is well established.¹⁹⁻²⁴ Neurosurgeons are faced with a wide variety of tumor pathologies involving multiple surgical approaches. However, similar tumors do present on different occasions and require comparable neurosurgical procedures.

One testable question posed by the Fitts and Posner model is: Are “experts” more autonomous in their operative resection when faced with identical tumors on different occasions separated by various tumor surgeries? To mirror clinical reality, we studied the virtual reality resection of 9 identical simulated brain tumors separated by the removal of a variable number of other tumors with different visual and haptic complexity. To address automaticity of operator performance, we assessed the consistency of amount and location of force applied during resection of these identical tumors by neurosurgeon and resident groups.

METHODS

Subjects

Nine board-certified and practicing neurosurgeons from 3 institutions, 10 senior (9 postgraduate year [PGY] 4-6 and 1 fellow PGY-7), and 8 junior residents (PGY 1-3) from McGill University participated in the study. The fellow had just completed neurosurgical residency, and it was considered appropriate to place this individual in the resident group as adding or excluding this individual did not change statistical results. No participant had previous experience with NeuroVR. All participants signed a consent approved by McGill University Health Center Research Board. As we have previously documented significant differences in psychomotor performance based on the ergonomics of handedness, only dominant right-handed participants were assessed in this study.¹²

NeuroVR Simulator

The previously described NeuroVR (formerly NeuroTouch) platform with haptic feedback was used for this study.^{7-17,25-30} Tumor resection was performed using a simulated ultrasonic aspirator held in the right hand (Fig. 1A).

Simulation Scenarios

To address the study question, the scenario employed involved resection of 9 identical simulated brain tumors on 2 separate occasions (18 procedures) separated by removal of tumors with different complexities (Fig. 1B).⁹⁻¹² The simulated operative procedure used can be seen in electronic [supplemental material, video 1](#) in a previous publication.¹¹ To prevent the operator from predicting the appearance of the next identical tumor in the resection sequence, the 2 identical ellipsoidal tumors were separated by between 4 and 12 different tumors (Fig. 1B-D). To maximize tumor differences, each of the 6 scenarios had 3 tumors of varying complexities involving color (black, glioma-like, and white) and Young’s modulus stiffness (3 kPa, soft; 9 kPa, medium; and 15 kPa, hard). White background with soft (3 kPa) tumor stiffness represented the surrounding

Download English Version:

<https://daneshyari.com/en/article/8834776>

Download Persian Version:

<https://daneshyari.com/article/8834776>

[Daneshyari.com](https://daneshyari.com)