Training Perceptual Expertise in Radiologists

Jeanine K. Stefanucci, Alex N. Detrich & K. Hudson Guttman
Department of Psychology

Megan Mills, William Auffermann & Nathan Barber
Department of Radiology and Imaging Sciences

Katrina Visintainer & Jason Orlosky
Augusta University
Department of Computer Science

1U4U Innovation Funding

Funded Project Amount: $30,000

Abstract

Radiologists develop incredible perceptual expertise for searching for anomalies in 2D images of 3D anatomic structures. The implementation of new technologies also allows for searching for abnormalities in 3D; however, little perceptual training is provided to develop search processes for 3D imagery. This funded proposal implemented a new training procedure in 2D, 3D, and virtual reality. In the first experiment, 44 medical students were tested on their abilities to localize and classify acetabular pelvic fractures. To simplify the diagnosis of complex acetabular injuries, different fracture patterns are assigned classifications. 3D imagery may provide benefits in accurate fracture classification over 2D imaging alone. Using a previously validated 2D training program, participants' abilities in fracture detection, efficiency, accuracy of classification, and confidence in those judgments was assessed. In both time to detection and confidence two-way mixed ANOVAs showed that with more training, accuracy of detection and confidence in judgments increased. This was true for both 2D and 3D image types. In a second experiment, we specifically assessed whether individual differences in the ability to mentally transform non-medical 2D objects affects searching 2D or 3D medical imagery. Overall, the current work addressed the important question of whether training protocols for either 2D radiography or volumetric imagery can improve search.

Introduction

- Accurate identification of abnormalities in radiology is imperative for healthcare.
  - Radiologists develop perceptual expertise and pre-attentive processing to detect said anomalies through years of training.
  - Most of this training is on 2D CT scans (see *Figure 1*).
- New medical imaging techniques (Multitom Rax) allow for complete 3D renderings of radiographic images.
  - Radiologists do not have standard training techniques for these new 3D scans.
  - Using 2D images requires radiologists to mentally construct 3D representations of the fractures, which takes more cognitive effort than viewing a 3D image.
- **Research Questions:**
  - Does accuracy of identification of acetabular pelvic fractures differ among 2D and 3D representations in medical students?
    - Does this differ by fracture type?
  - Do those trained with 3D representations exhibit lower response times and higher confidence in their localization of the fractures compared to those trained on 2D representations?

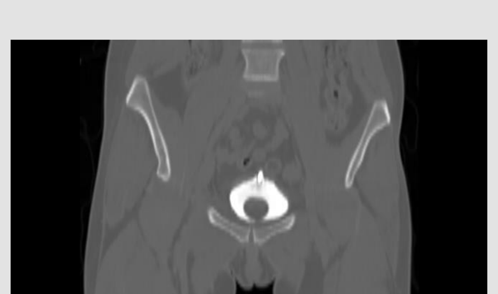


Figure 1. Example CT image of pelvis

Materials

- Desktop PCs and monitors
- Previously validated 2D training program for radiographic images, RadSimPE (see *Figure 2*)
- 2D CT scans and 3D models of musculoskeletal acetabular pelvic fractures (see *Figures 1 & 2*)

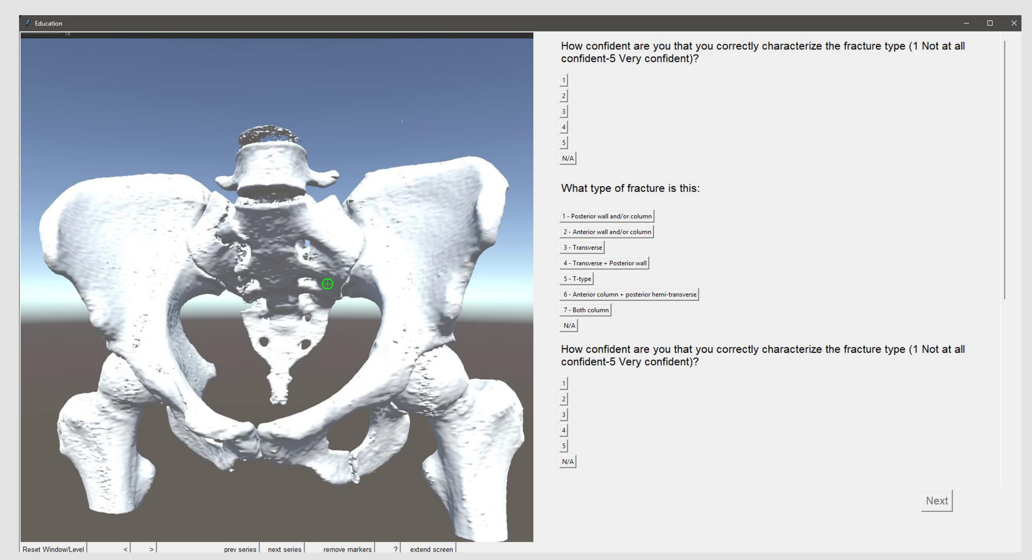


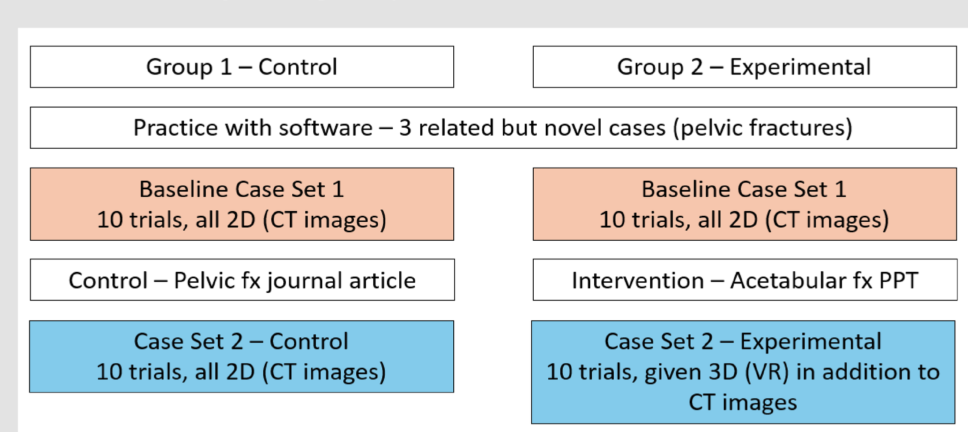
Figure 2. RadSimPE trial example with a VR image.

Methodology

- *N* = 44 medical students consented to participate in a training study with an expert radiologist.

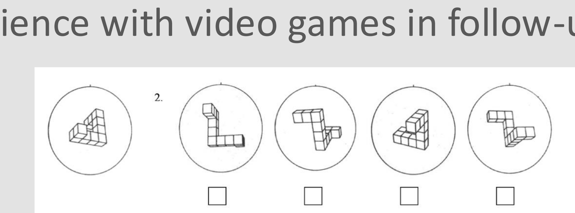
Experimental Design:

- *Between-subjects groups*



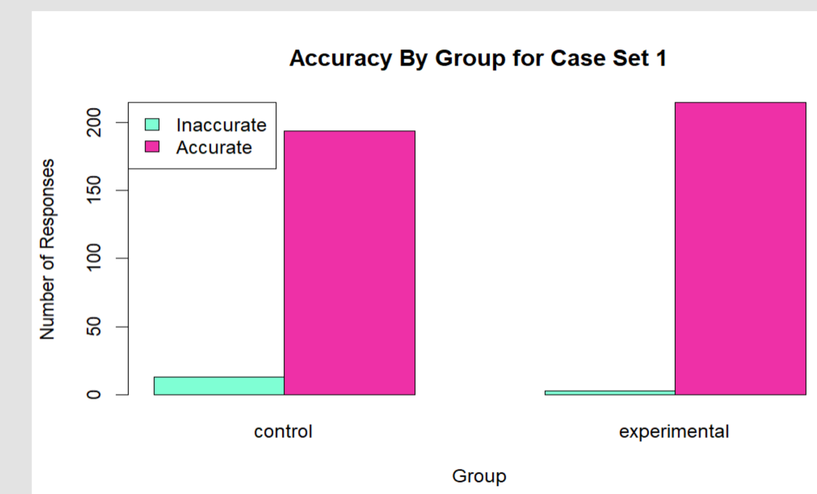
Task:

- Participants practiced identifying and viewing the types of images with 3 related, but novel cases.
- Participants then completed the baseline set (10 trials) in 2D.
- Following the baseline, participants were randomly assigned to one group:
  - ***CONTROL GROUP:*** Read a journal article on searching for anomalies and then completed another set of 10 cases in 2D.
  - ***EXPERIMENTAL GROUP:*** Got perceptual training on evaluating 3D images and then completed another set of 10 cases in 3D.
- All participants were debriefed with both types of images and some instruction.
- Additional questions about spatial skills (3D mental imagery) and experience with video games in follow-up study

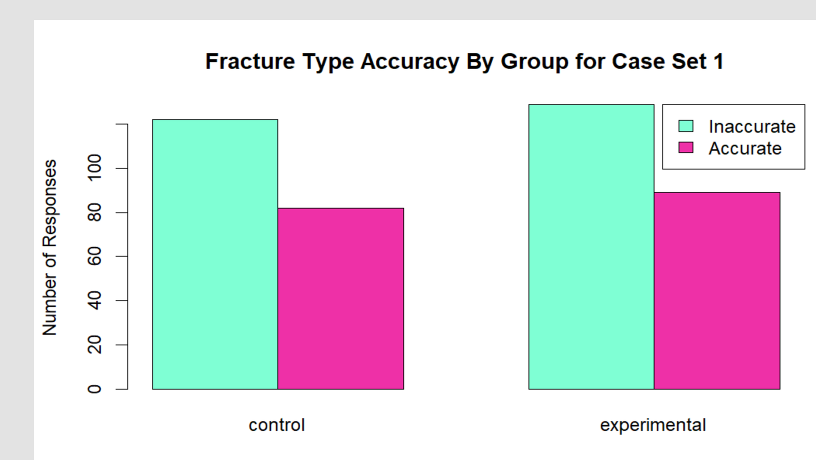


Results

- **Identification Accuracy**
  - No difference between experimental and control groups in accuracy for the baseline case set, χ^2 (1, *N* = 44) = 0.39, *p* = .53.
  - Significant difference in accuracy between groups after the intervention, χ^2 (1, *N* = 44) = 5.76, *p* = .010, as predicted.

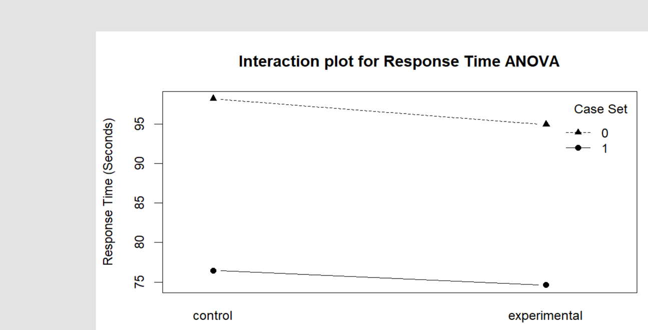


- **Fracture Type Accuracy and Confidence**
  - Groups did not differ in accuracy for specific fracture types, χ^2 (1, *N* = 44) = .00, *p* = .974.
  - Participants were quite inaccurate at selecting fracture types despite knowing a fracture was present.

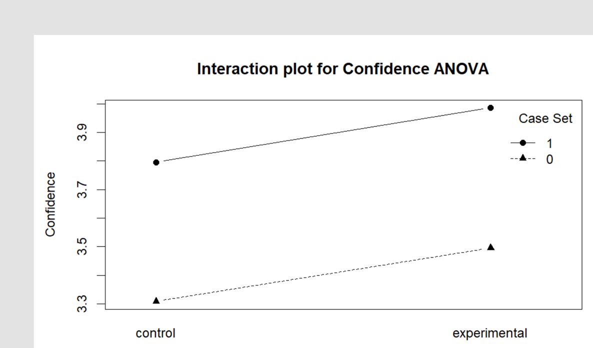


  - Participants were more confident in their estimates after the training interventions (Baseline: *M* = 2.52, *SD* = 0.60, Post-intervention: *M* = 2.71, *SD* = .70, *F*(1, 42) = 6.06, *p* = .018).

- **Reaction Time and Confidence**
  - Trials in the post-intervention case set took less time (Baseline: *M* = 96.59, *SD* = 25.43, Post-intervention: *M* = 75.53, *SD* = 22.07, *F*(1, 42) = 27.81, *p* < .001)



  - Participants were more confident in their estimates after either intervention. (Baseline: *M* = 3.40, *SD* = 0.75, Post-intervention: *M* = 3.90, *SD* = .95, *F*(1, 42) = 41.22, *p* < .001.



  - There was no main effect of group or an interaction between group and case set.

Conclusions

- Training with 3D images can increase accuracy in identifying pelvic fractures.
- However, correct categorization of fracture type takes further training.
- Any experience with 2D or 3D images of pelvic fractures improves reaction time for identification and confidence in accuracy.
- Ongoing data analyses and further training studies will provide more information about which skill sets (e.g., 3D mental imagery) may improve and aid training.

Recommendations

- A fundamental problem with understanding 3D scans may be that they are only able to be viewed in 2D currently.
- A planned future experiment will test training of search in a 3D virtual environment and compare it to search of 2D scans. Data collection is set to start in February.

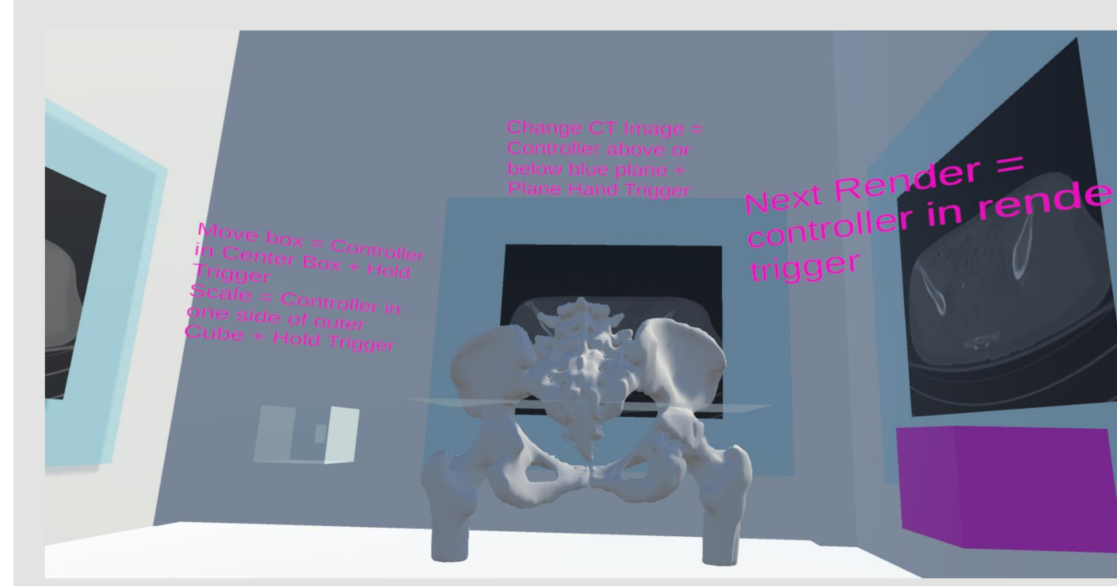


Figure 3: Prototype of the virtual environment for testing search in 3D.

Acknowledgements

The use of RadSimPE was integral to this training study. We acknowledge the first report of this system here:

Banerjee, S., & Auffermann, W. F. (2021). RadSimPE—a Radiology Workstation Simulator for Perceptual Education. *Journal of Digital Imaging*, *34*, 1059-1066.