

Transient Visualizations Hinder Learning When Controlling Moderating Variables: Critical Review and Experimental Example

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Outline

- Static versus Transient Visualizations (Animation and Video)
- Critical Review of Comparisons
 - Appeal bias
 - Variety bias
 - Size bias
 - Interaction bias
- Experimental Example
 - Methods
 - Results
- Discussion and Instructional Implications

Static versus Transient Visualizations

Format	Problem
Static	Mental Animation ⁽¹⁾
Transient	Transient Information ^(2,3)

- Transient Information Effect⁽³⁾
 - Process the current visible information
 - Remember the previous elements (no longer visible)
 - Integrate both streams of information in order to comprehend the material

(1) Hegarty, M. (1992). Mental animation: Inferring motion from static displays of mechanical systems. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 18(5), 1084-1102

(2) Lowe, R. K. (1999). Extracting information from an animation during complex visual learning. *European Journal of Psychology of Education*, 14(2), 225-244

(3) Ayres, P., & Paas, F. (2007). Making instructional animations more effective: A cognitive load approach. *Applied Cognitive Psychology*, 21(6), 695-700

Critical Review

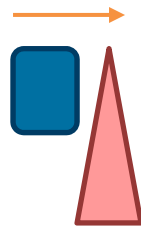
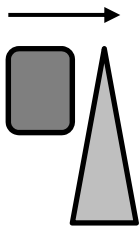
- Comparisons between Static vs Dynamic (Transient) Visualizations
 - Educational articles
 - STEM areas
- Improper Control of Confounding Variables⁽¹⁾
 - Appeal bias
 - Variety bias
 - Size bias
 - Interaction bias

(1) Tversky, B., Morrison, J. B., & Betrancourt, M. (2002). Animation: Can it facilitate? *International Journal of Human-Computer Studies*, 57(4), 247-262

Appeal Bias

- Different *Quality* of Visual Elements

Static	Dynamic	STEM topic
B&W	Colored	Electrochemical processes of a flashlight ⁽¹⁾

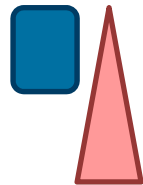
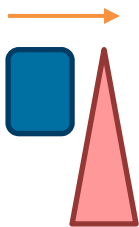


(1) Yang, E.-m., Andre, T., Greenbowe, T. J., & Tibell, L. (2003). Spatial ability and the impact of visualization/animation on learning electrochemistry. *International Journal of Science Education*, 25(3), 329-349

Variety Bias

- Different *Quantity* of Visual Elements

Static	Dynamic	STEM topic
Arrows included	Arrows not included	Optical phenomena ⁽¹⁾

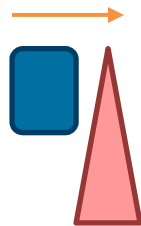


(1) Lewalter, D. (2003). Cognitive strategies for learning from static and dynamic visuals. *Learning and Instruction*, 13(2), 177-189

Size Bias

- Different size of the displays

Static	Dynamic	STEM topic
Small	Large	Electrical circuit ⁽¹⁾

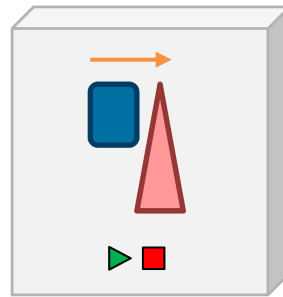
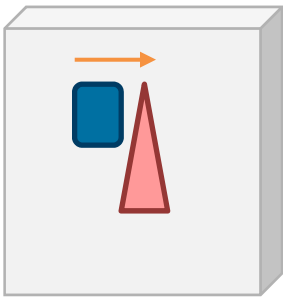


(1) Ng, H. K., Kalyuga, S., & Sweller, J. (2013). Reducing transience during animation: A cognitive load perspective. *Educational Psychology*, 33(7), 755-772

Interaction Bias

- Different features of interactivity provided

Static	Dynamic	STEM topic
Pace buttons not included	Pace buttons included	Assembling an engineering model device ⁽¹⁾

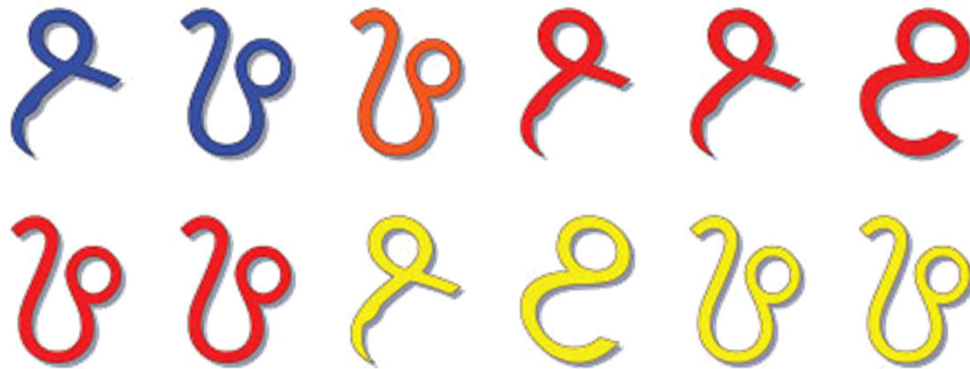


(1) Watson, G., Butterfield, J., Curran, R., & Craig, C. (2010). Do dynamic work instructions provide an advantage over static instructions in a small scale assembly task? *Learning and Instruction*, 20(1), 84-93

Experimental Example

- Methods

- Memorize the placement of 12 abstract colored symbols (by a static hand)



- 52 Australian university students (50% W, $M = 20.25$ years) learning both static and dynamic tasks (order counterbalanced)

Methods

- Static Task

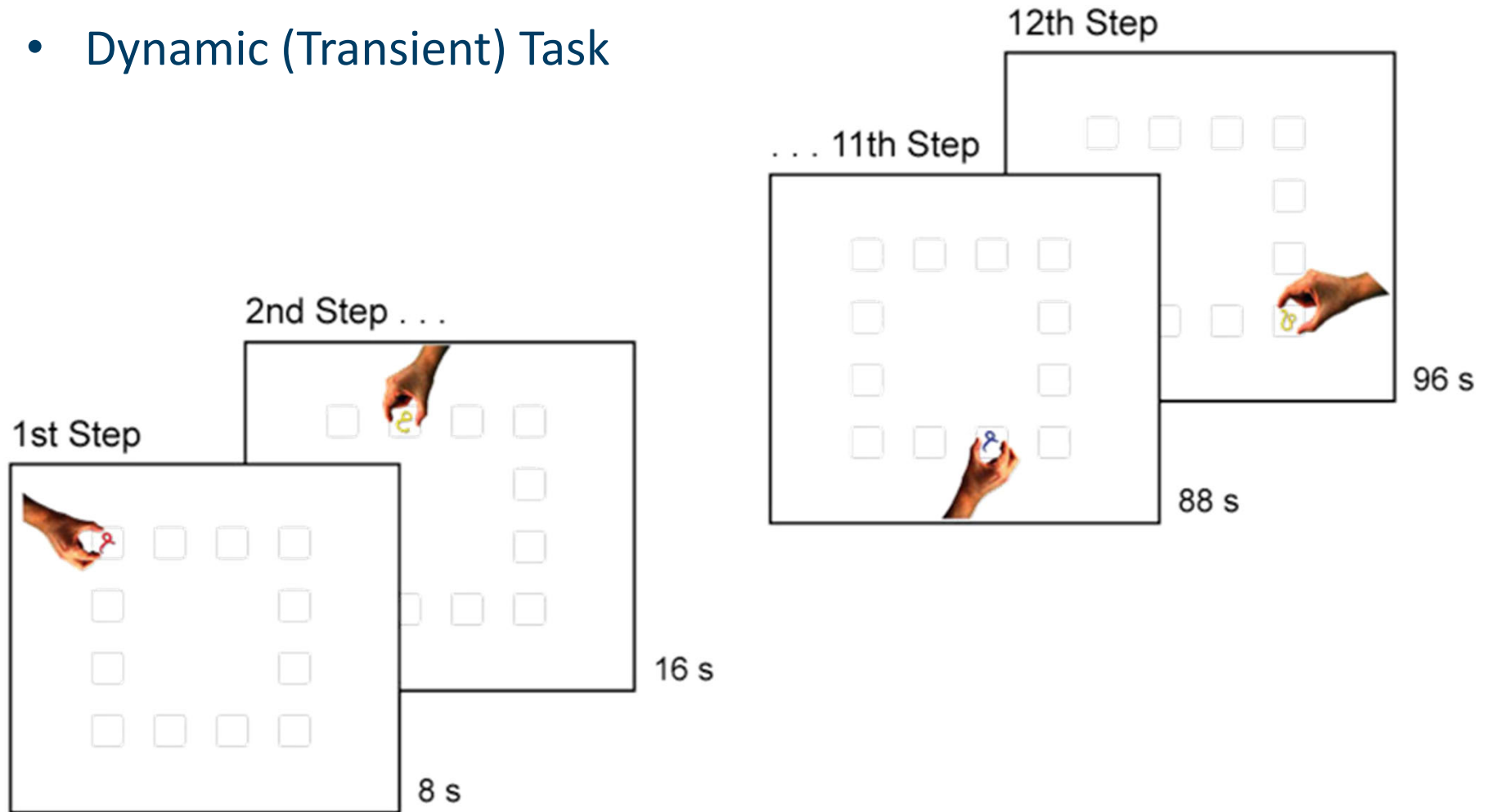
All steps



96 s

Methods

- Dynamic (Transient) Task

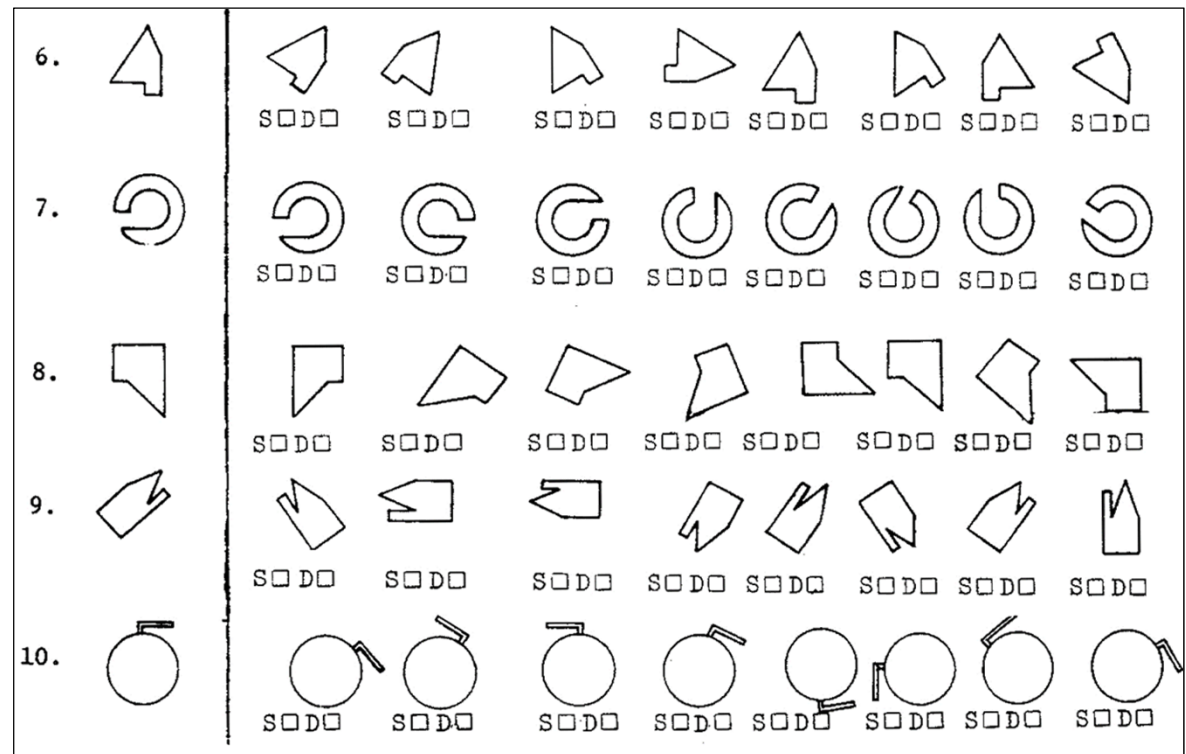


Methods

- Assessing individual characteristics
 - Spatial ability (mental rotation)
 - Spatial memory span
 - Gender

Methods

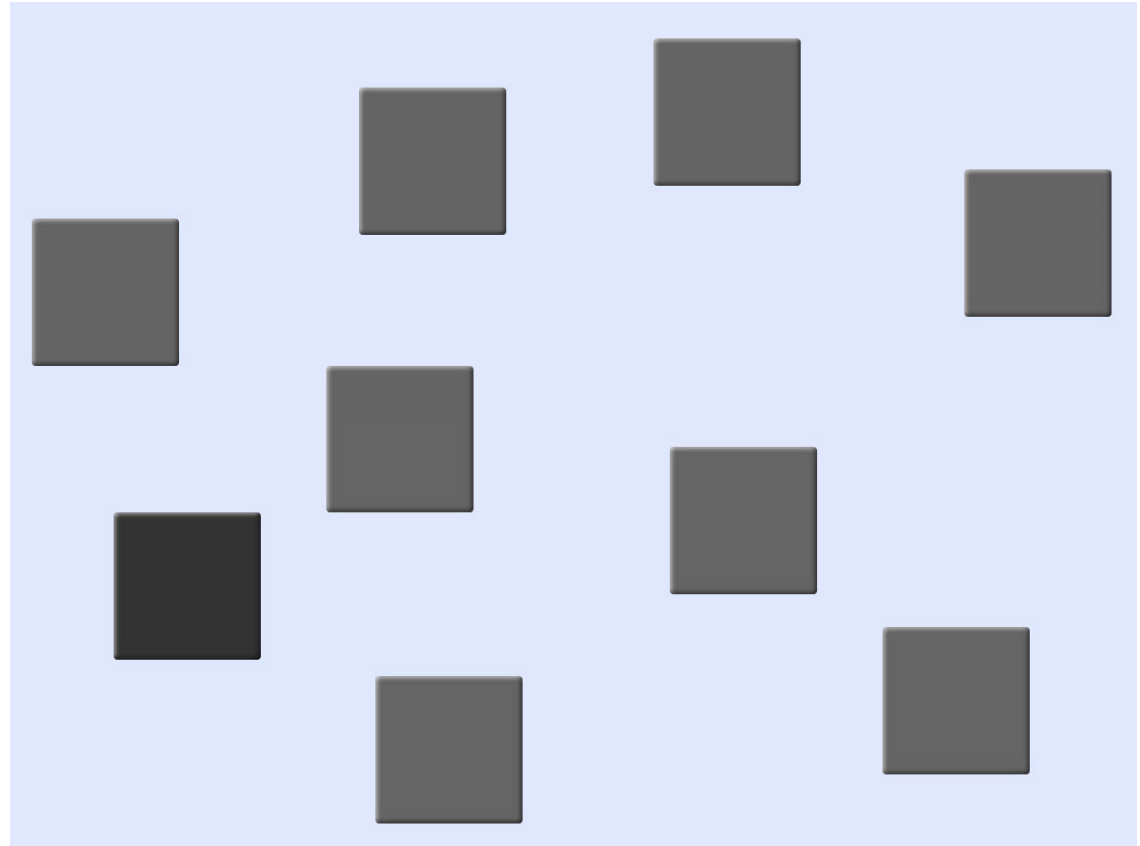
- Spatial Ability
 - Card rotations test⁽¹⁾



(1) Ekstrom, R. B., French, J. W., Harman, H. H., & Dermen, D. (1976). *Kit of factor-referenced cognitive tests*. Princeton, NJ: Educational Testing Service.

Methods

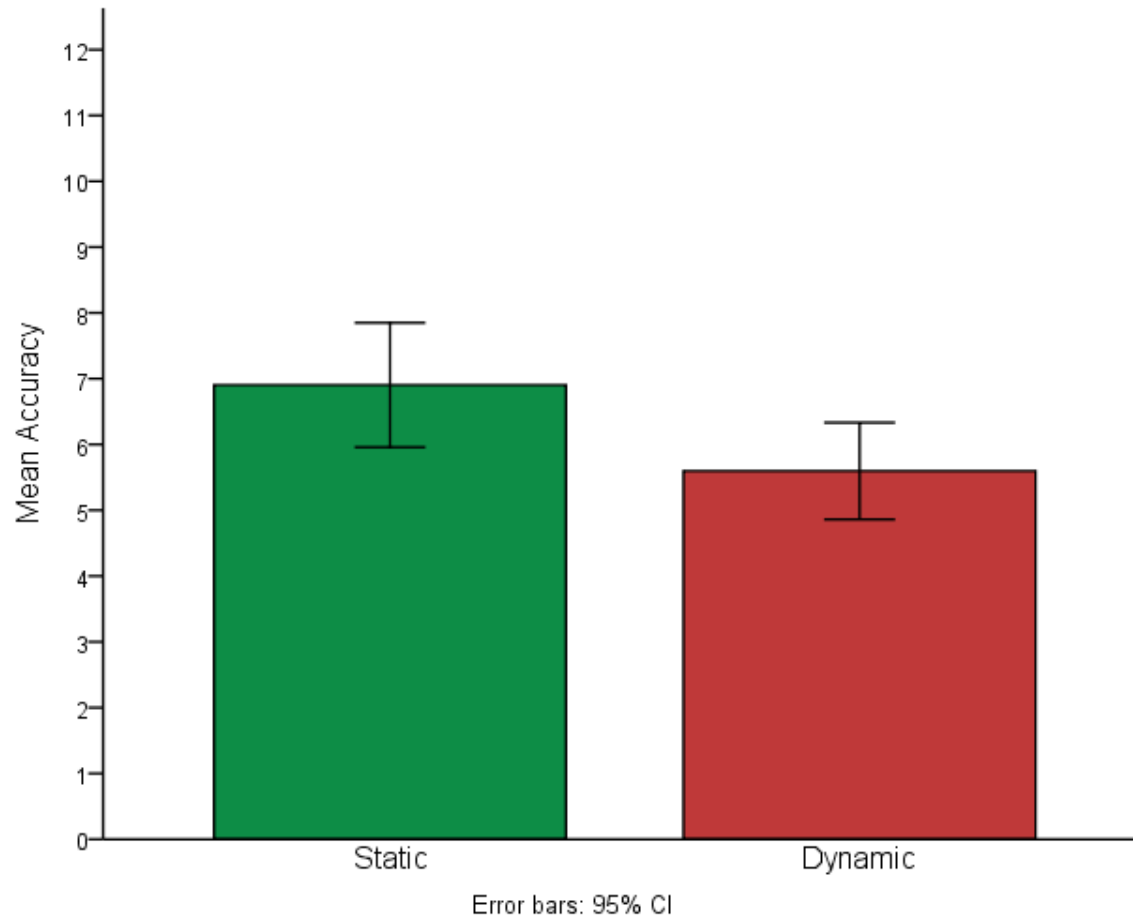
- Spatial Memory Span
 - Corsi block test⁽¹⁾



(1) Milner, B. (1971). Interhemispheric differences in the localization of psychological processes in man. *British Medical Bulletin*, 27(3), 272-277.

Results

- Learning (memory) accuracy
 - $F(1,51) = 7.91, MSE = 5.62, p = .007, \eta_p^2 = .13$



Results

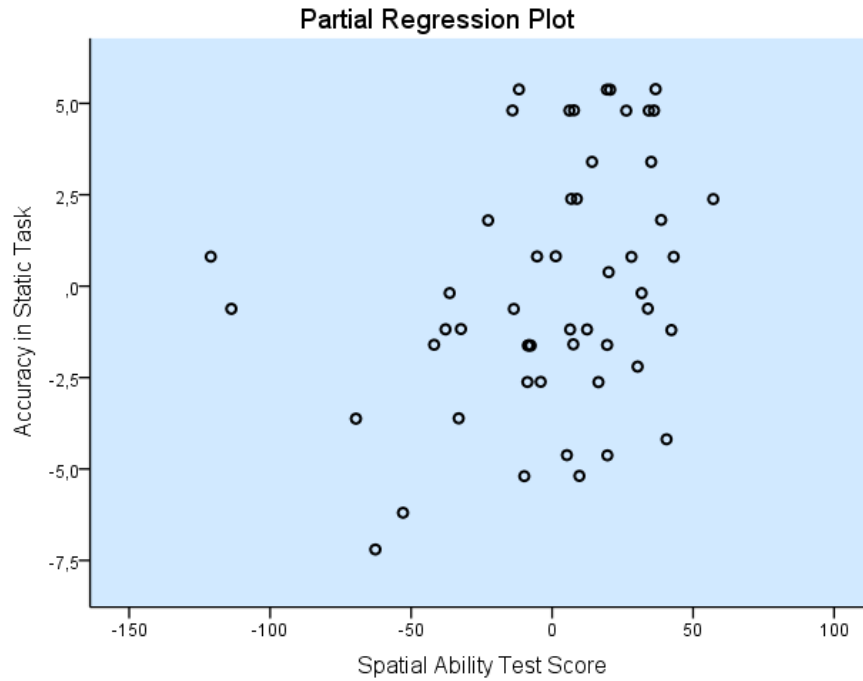
- Regression Analyses
 - Separate analyses for static and dynamic tasks
 - Forced entry with the predictors:
 1. Spatial ability
 2. Spatial memory span
 3. Gender

Predictor	Static			Dynamic		
	$R^2 = .11, F(3, 48) = 2.01, p = .126$			$R^2 = .23, F(3, 48) = 4.72, p = .006$		
1	$B = 0.03,$	$\beta = 0.34,$	$p = .022$	$B = 0.02,$	$\beta = 0.30,$	$p = .026$
2	$B = -0.06,$	$\beta = -0.09,$	$p = .555$	$B = 0.15,$	$\beta = 0.30,$	$p = .028$
3	$B = -0.54,$	$\beta = -0.08,$	$p = .569$	$B = 0.22,$	$\beta = 0.04,$	$p = .749$

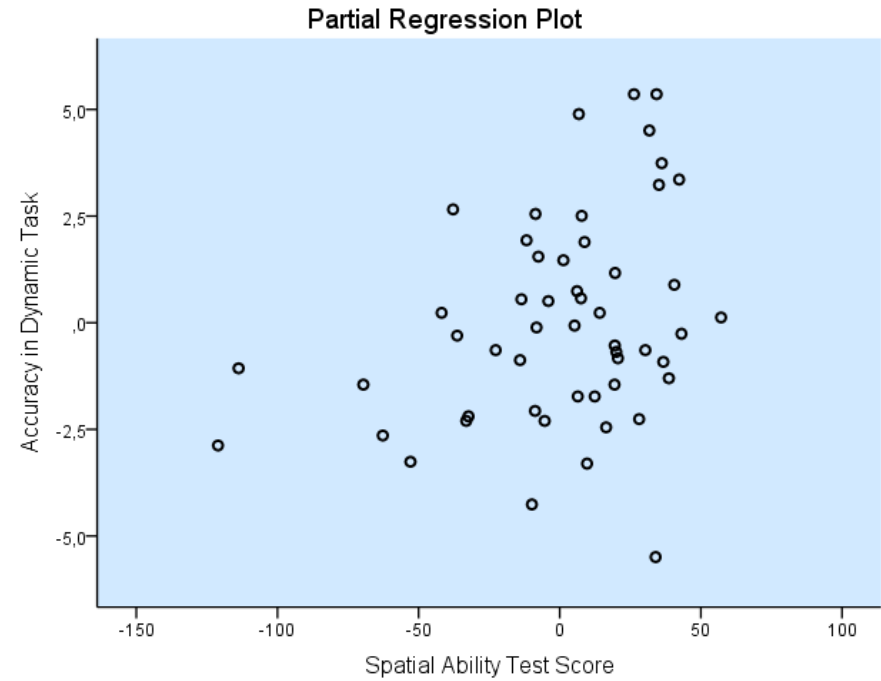
Results

- Regression Analyses: Spatial Ability

Static



Dynamic



Results

- Regression Analyses: Spatial Memory Span

Static



Dynamic



Discussion and Implications

- Critical Review
 - Instructional designers should try to avoid biases (e.g., appeal, variety, size, interaction, etc.) when comparing static and dynamic formats
- Experimental Example
 - Static pictures may be better than dynamic images for abstract tasks
 - Individual characteristics are important for abstract tasks
 - Spatial ability (both tasks) > spatial memory span (dynamic task) > gender (neither)
- New Directions: A Task from a Formal STEM Syllabus

Thank you!