Does gesturing improve the learning of human motor skills for children, when learning from instructional animation and statics?

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Introduction

- We are interested in whether adding gestures to existing static and animated instructions may facilitate learning of hand motor tasks, such as writing.

Animations versus Statics

- Animations are often no more effective than equivalent static graphics (Hegarty, Kriz & Cate, 2003; Tversky, Morrison, & Betrancourt, 2003)
- Mayer, Hegarty, Mayer & Campbell (2005) found that statics were better for learning about mechanical systems

Transitory effect

- Transitory reason proposed why animations can be ineffective (Ayres & Paas, 2007a, 2007b)
- Leahy and Sweller (2011) found a reverse modality effect for lengthy spoken text.
- Singh, Ayres, and Marcus (2012) found a similar transient effect showing that written text led to higher learning than spoken text.

Instructional animations

- However, recent research has shown that animated instructions can lead to superior learning for a human movement task when compared to equivalent static graphics
  - Ayres et al, 2009; Wong et al, 2009; Marcus, Cleary, Wong, & Ayres 2013; Lee & Shin, 2012.
- This may be due to our innate ability for observational learning, possibly from the use of mirror neurons (Van Gog et al. 2009).

Instructional animations

- It may also relate to the fact that human movement is *biologically primary knowledge* (Geary, 2007, 2012) and we have evolved to effortlessly observe and copy many body movements.

Adding human movement

- We thus suggest that whether or not an instructional format has movement inherent in it will impact on the learning of a motor task
- To date, we have found animations to be superior to statics for the learning of motor tasks, unless the animations become very long and complex, in which case they need to be segmented to reduce transience (see Wong, Leahy, Marcus & Sweller, 2012)

Embodied cognition

- Huge body of literature that shows benefits of including the body in learning of cognitive tasks
  - Involvement of the more basic motor system in the form of gesturing, reduces working memory load during instruction

    (eg. Goldin-Meadow, Nusbaum, Kelly, & Wagner, 2001; Ping & Goldin-Meadow, 2010; de Koning & Tabbers, 2011)
- Learning by observing or performing gestures; viewing hands; object manipulation; body movements for children

Gesturing

- Paas and Sweller (2012) argued that gesturing is a sensorimotor experience that may be a very old, very well-developed skill (i.e., biologically primary knowledge) that is acquired easily and can be used with a minimal working memory load. One of its functions may be to reduce working memory load when dealing with biologically secondary knowledge.

Can gestures improve learning by introducing human movement?

- In this study we were interested whether the inclusions of gestures can improve learning for the static graphic format, more than for the animation format.
  - the animated format already includes movement, while adding gestures to the static format introduces a form of movement

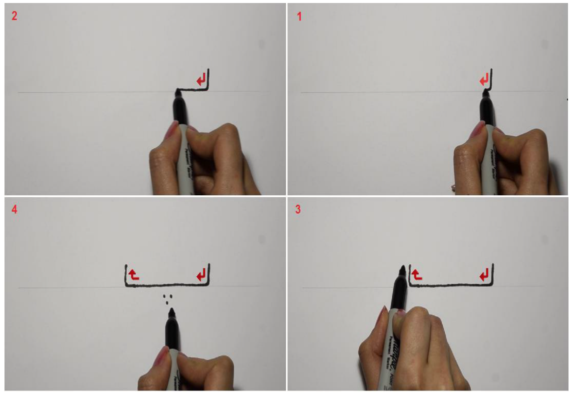
Hypotheses

- We hypothesize that including human movement into an instructional format will benefit learning as it taps into our movement processor (Van Gog et al. 2009).
- 1st hypothesis: animations will lead to better performance than statics.
- 2nd hypothesis: including gesture will lead to better learning than no gesture.
- 3rd hypothesis: (we predict an interaction effect) Gesture will facilitate learning more for statics than animation.
  - Gesturing may become redundant for more difficult animations when cognitive load is higher.

Method

- Four groups of 11 grade 1 and 2 students given 9 Persian characters to learn to write, ranging from easy to medium to difficult.
- 2 groups received animated instructional materials, with 1 group asked to gesture while learning. The other 2 groups received equivalent static graphics, with 1 group gesturing.
- All groups had equal learning times.
- Students were tested on their ability to reproduce the characters.

Static example of writing a Persian character

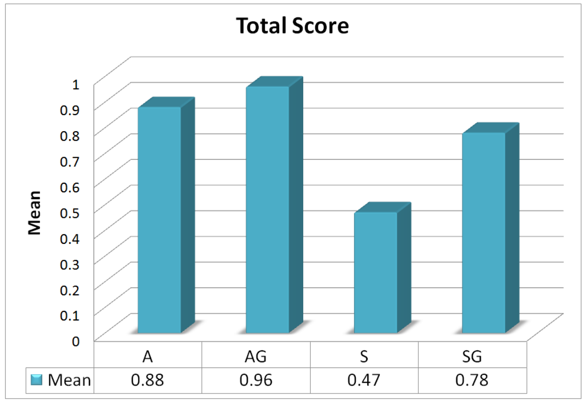


Animated example of writing the character

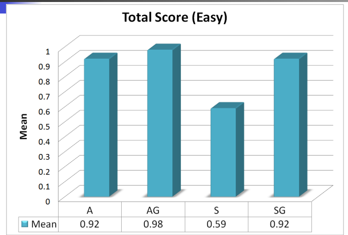
Test Method

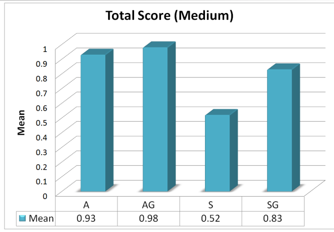
- The students were then tested on ability to reproduce the characters including:
  - correct strokes and dots,
  - drawing order, and
  - positioning relative to a guide line.

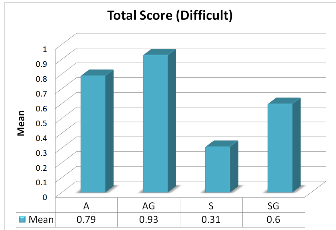
Summary of overall means



Summary bar graphs of means



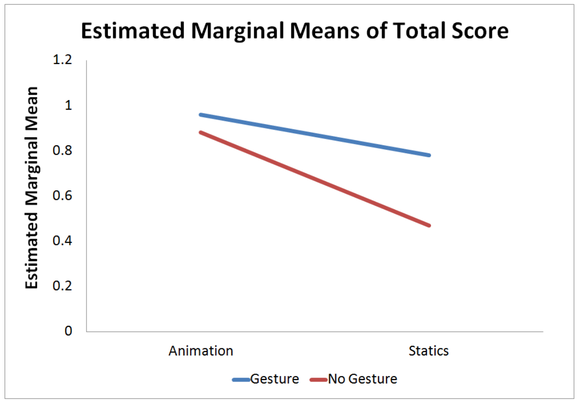




Results

- A MANOVA was conducted: IVs - presentation format + gesturing, DVs- three levels of the task
- Significant main effect for presentation format, F (3, 38) = 28.0, p < .001, animations > statics
- Significant main effect for gestures, F (3, 38) = 16.5, p < .001, gesturing > non-gesturing
- Significant interaction, F (3, 38) = 7.42, p < .001

Interaction effect



Results

- Univariate tests indicated a significant interaction (p <.001) for both easy and medium tasks, but not the difficult task.
- Simple effects tests showed:
  - for the static presentation, all 3 tasks found gesturing superior to non-gesturing,
  - for the animated presentation, only the easy task produced a gesturing advantage.

Results summary

- All 3 hypotheses were broadly supported:
- H1: Animations led to better performance than statics.
- H2: Gesture led to better learning than no gesture.
- H3: An Interaction effect found for easy and medium tasks, where gesture facilitated learning more for statics than animation.
  - Moreover, gesturing may have been redundant for the more difficult animations.

Conclusion

- Our results provide support for the existence of a human movement processor that when invoked can support learning, particularly for human movement tasks.
- Gesturing supported learning for young children, particularly for easier tasks (when less cognitively loaded) and when learning from statics (movement is not inherent to this instructional format).
- As expected, animations led to better learning than statics (even with a task where animations include a trace).
- Gesturing was redundant for the more difficult animated tasks when children were cognitively challenged, and movement was inherent.

Related Publications

- Ayres, P., Marcus, N., Chan, C., & Qian, N. (2009). Learning hand manipulative tasks: When instructional animations are superior to equivalent static representations. *Computers in Human Behavior, Vol 25(2), p 348-353.*
- Wong, A., Marcus, N., Ayres P., Smith, L., Cooper, G., Paas, F., & Sweller, J. (2009). Instructional animations can be superior to statics when learning human motor skills. *Computers in Human Behavior, Vol 25(2), p 339-347.*
- Van Gog, T., Paas, F., Marcus, N., Ayres, P., & Sweller, J. (2009). Instructional design consequences of the mirror-neuron system for observational learning. *Educational Psychology Review, 21(1), 21-30*.
- Wong, A., Leahy, W., Marcus, N., & Sweller, J. (2012) Cognitive load theory, the transient information effect and e-learning. *Learning and Instruction, 22(6),* 449-457.
- Marcus, Cleary, Wong & Ayres (2013). Should Hand Actions be Observed when Learning Hand Motor Skills from Instructional Animations? *Computers in Human Behavior, 29 (6),* 2172-2178.