Solving the Gender Difference in Instructional Animation Research

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Never Stand Still

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The 9th Cognitive Load Theory Conference
Bochum, Germany
22nd -24th June, 2016

Animations: Good or Bad?

Good

Statistics (Wender & Muehlboeck, 2003)

Physics (Bétrancourt, Dillenbourg, & Clavien, 2008; Rebetez, Bétrancourt, Sangin, & Dillenbourg, 2009; Rieber, 1990a, b, 1991a, b)

Zoology (Pfeiffer, Scheiter, Kühl, & Gemballa, 2011)

Geometry (Korakakis, Pavlatou, Palyvos, & Spyrellis, 2009; Thompson & Riding, 1990)

Various motor tasks (Akinlofa, Holt, & Elyan, 2013; Arguel & Jamet, 2009; Ayres, Marcus, Chan, Qian, 2009; Castro-Alonso, Ayres, & Paas, 2015; Garland & Sánchez, 2013; Michas and Berry, 2000; Wong et al. 2009)

No different

Physics (in adults, see Rieber, 1996; Rieber, Boyce, & Assad, 1990; Bétrancourt, Dillenbourg, & Clavien, 2008)

Social movements (Morrison & Tversky, 2001)

Various motor tasks (Watson, Butterfield, Curran, & Craig, 2010)

Bad

Statistics (Scheiter, Gerjets, & Catrambone, 2006)

Physics (in adults, see Rieber, 1996; Rieber, Boyce, & Assad, 1990)

Social movements (Morrison & Tversky, 2001)

Machinery & Geoscience (Mayer, Hegarty, Mayer, & Campbell, 2005)

Physiology (Jones & Scaife ,2000; Koroghlanian & Klein, 2004)

Abstract symbols (Castro-Alonso, Ayres & Paas, 2014b)

Animations: Good or Bad?

Good

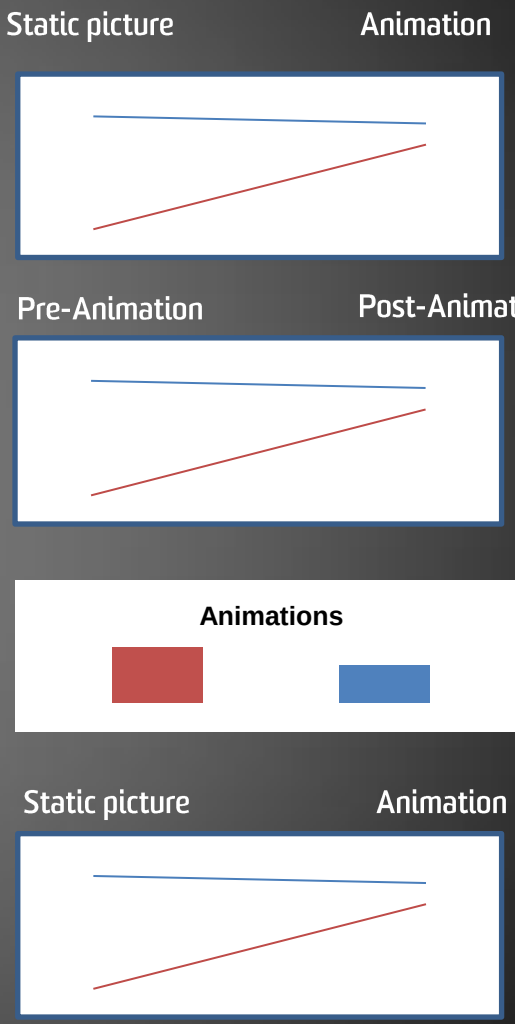
- General principles (e.g. more realistic, user-control, segmentation, modality effect)
- Human movement effect
  - Activate mirror neurons
  - Observational learning
  - Biologically primary skill (Evaluations)

Bad

- The transient information effect

Animation and gender

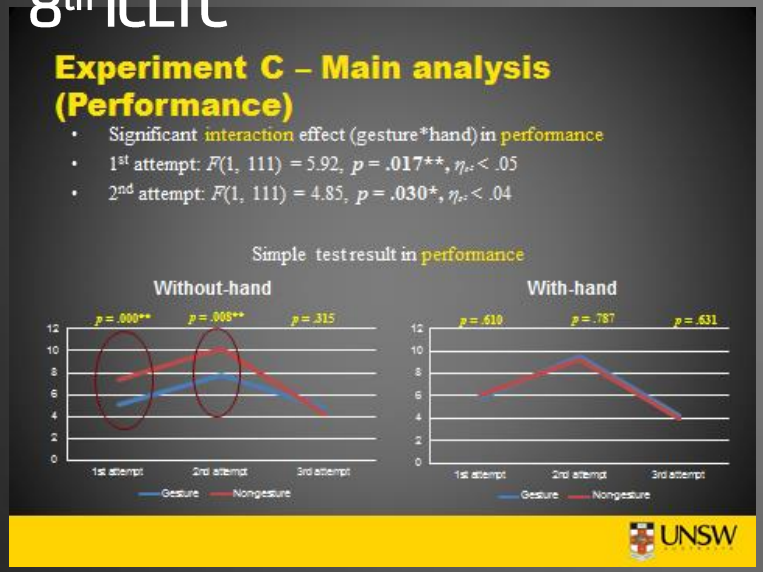
- Jacek (1997): Females learn better with animation than static picture; but males learn the same with both animation and static picture
- Yezierski & Birk (2006): males outperformed females in a pre-test, but not after the animation intervention
- Falvo and Suits (2009): female outperformed male in animation group
- Sanchez & Wiley (2010): male significantly outperform female with static picture when learning chemistry but no difference with animation



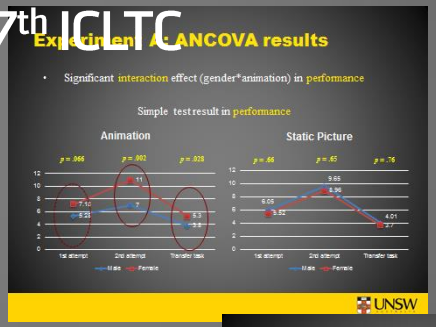
Animation and gender – Previous experiments

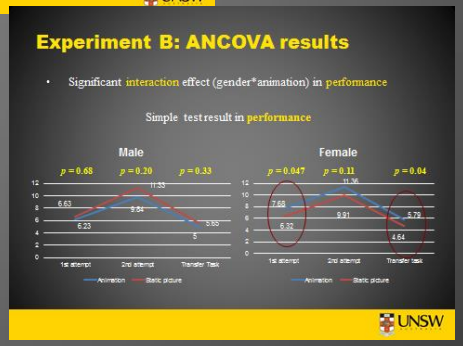
- Results consistently indicate that there is a gender difference in learning with animations and static pictures.

8th ICLTC

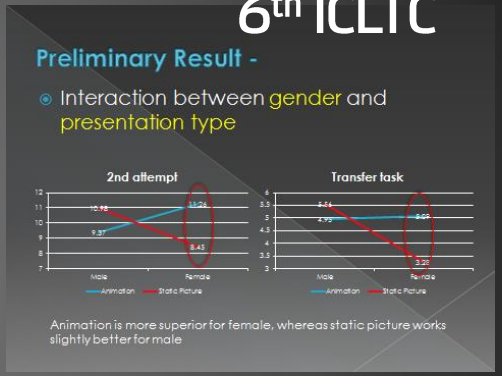


7th ICLTC





6th ICLTC



Females benefit more from animations!

Reason: (possibly) **Spatial ability**

Gender difference in spatial ability

- Males: ↑ *mental rotation ability*, *spatial perception* and *spatial orientation*
  - Performed better at an *object transformation task*
- Females ↑ *recalling landmarks*, *street names*, and *reporting route strategies*
  - Performed better at an *object location memory task*

(e.g. Choi & L'Hirondelle, 2005; Eals & Silverman, 1994; McBurney, Gaulin, Devineni, & Adams, 1997; Silverman, Choi, & Peters, 2007; Silverman & Eals, 1992)

- Neuroscience evidence also indicate that males and females (who performed at a similar standard in spatial test) have different cortical activation pattern (Jordan, Wüstenberg, Heinze, Peters, & Jäncke, 2002; Weiss et al. 2003)

Evolutionary perspective

- Evolutionary Theory (Darwin,1871): variation, natural selection & sexual selection
  - Sexual selection: intrasexual competition + intersexual selection

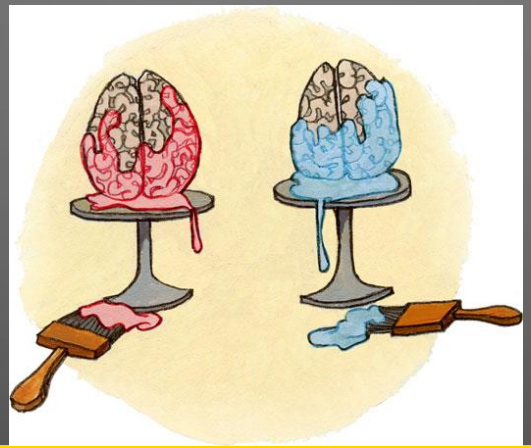
- Silverman and Eals (1992) proposed *Hunter-Gatherer theory of spatial sex differences*
  - Male-bias skills (e.g. mental rotations): orient oneself in relation to prays
  - Female-bias skills (e.g. object-location memory): rapidly remember the content array and location for foraging.

- Geary (1995, p. 291) argued that the gender difference in 3-dimensional spatial ability was a result of sexual selection
  - classroom learning are mostly 2-D and thus gender difference is smaller

Questions

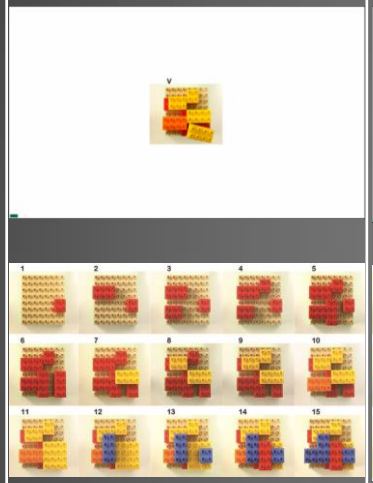
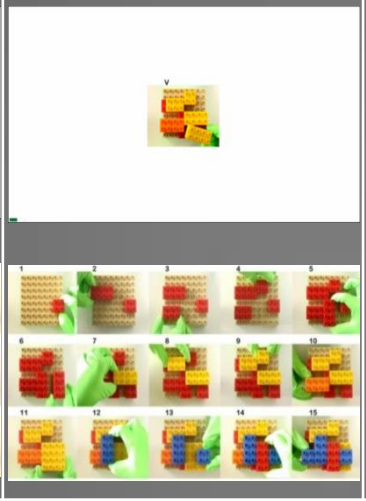
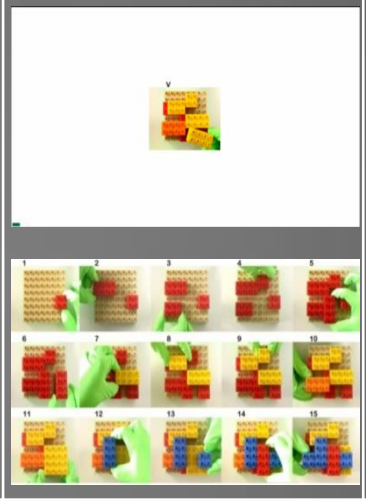
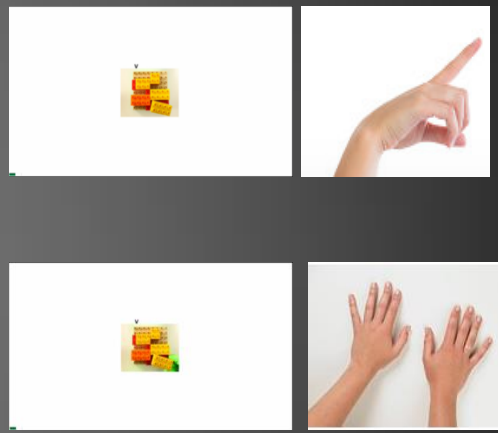
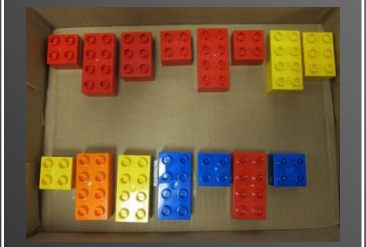
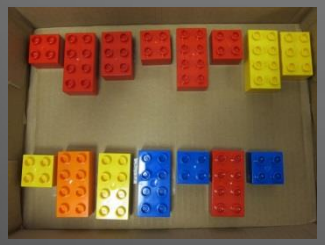
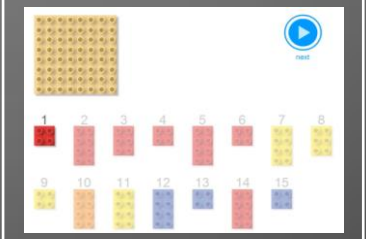
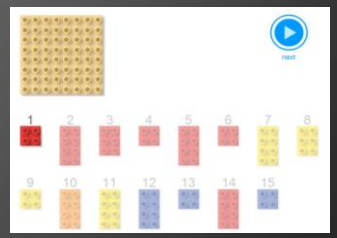
1. Can spatial ability predict learners' performance when learning with instructional animations?

2. Does spatial ability influence the performance of males and females differently when learning with instructional animations?



Empirical evidence

Methodology – Materials & conditions

	Experiment 1	Experiment 2	Experiment 3	Experiment 4
Learning conditions				
Performing conditions				

Methodology – Materials & conditions

Experiment 1	Experiment 2	Experiment 3	Experiment 4

Subjective: Self-rated questionnaire

1. How would you rate your *mental rotation* ability (ie. ability to rotate or flip 2-D or 3-D shape m entally)?

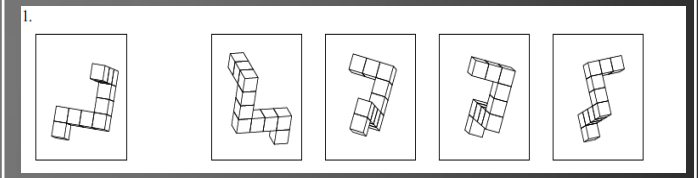
Very Weak ☐ Weak ☐ Fair ☐ Good ☐ Very Good ☐

2. In general, how would you rate your *overall spatial ability*?

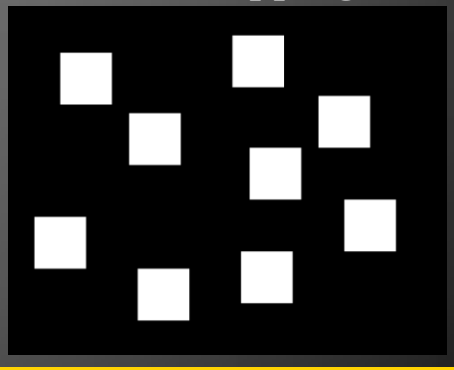
Very Weak ☐ Weak ☐ Fair ☐ Good ☐ Very Good ☐

Objective: Card-rotational test (CRT)

Mental rotations test (MRT)

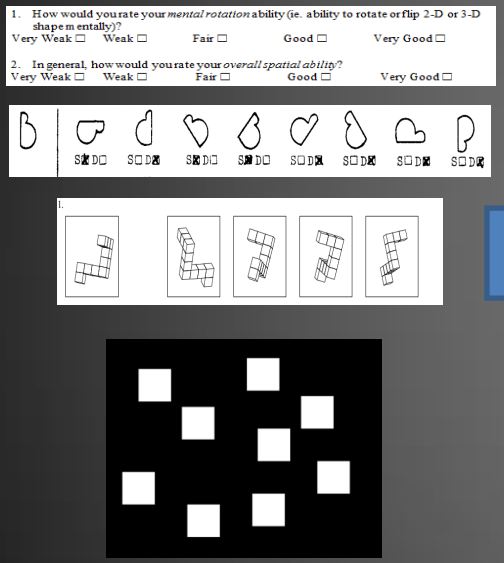


The Corsi Block Tapping test

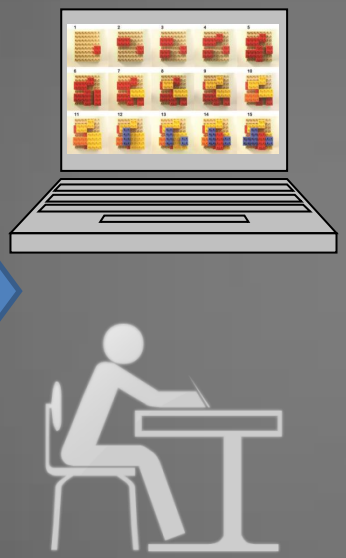


Methodology – Procedure

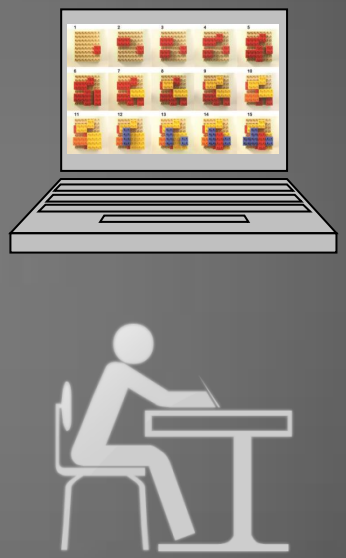
Spatial ability test



Learning 1 + Retention 1 (1st attempt)



Learning 2 + Retention 2 (2nd attempt)



Transfer

Regression Results

Regression

- Dependent variables
  - Performance results: 1st attempt, 2nd attempt and transfer task

- Independent variables (highly correlated with the performance)
  - Animated-static condition
  - Spatial ability results (CRT/MRT/Corsi)
  - Self-reported spatial ability results
  - Frequency learning with animations/static pictures

Results – Experiment 1

Male		Female
Nil	Task 1	1-factor model (p = .081) *Self-perception*
	Task 2	1-factor model (p = .004) *Self-perception*
	Transfer	1-factor model (p = .009) *CRT*

Results – Experiment 2

Male		Female
1-factor model (p = .008) *CRT*	Task 1	Nil
1-factor model (p = .002) *CRT*	Task 2	
3-factor model (p = .040) *CRT + self-perception+ animation-static*	Transfer	1-factor model (p = .068) *animation-static condition*

Results – Experiment 3

Male		Female
Nil	Task 1	1-factor model (p = .039) *animation-static condition*
2-factor model (p = .007) *Self-mental + CRT*	Task 2	Nil
Nil	Transfer	1-factor model (p = .047) *animation-static condition*

Results – Experiment 4

Male		Female
1-factor model (p = .020) *MRT*	Task 1	3-factor model (p < .001) freq with animation+ gesturing + Corsi
1-factor model (p < .001) *MRT*	Task 2	3-factor model (p = .045) *freq with animation+* *freq with picture+* *Corsi*
1-factor model (p = .004) *MRT*	Transfer	1-factor model (p < .001) *freq with picture*

Overall Results

	Task 1	Task 2	Transfer
Exp 1	Nil		
Exp 2	CRT	CRT	CRT + Self-perception + animation
Exp 3	Nil	Self-mental + CRT	Nil
Exp 4	MRT	MRT	MRT

	Task 1	Task 2	Transfer
Exp 1	Self-perception	Self-perception	CRT
Exp 2	Nil		animation-static
Exp 3	animation-static	Nil	animation-static
Exp 4	freq with animation + gesturing + Corsi	freq with animation + freq with picture + Corsi	freq with picture

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Overall Results

	Task 1	Task 2	Transfer
Exp 1	Nil		
Exp 2	Objective	Objective	Objective + Subjective + animation
Exp 3	Nil	Subjective + Objective	Nil
Exp 4	Objective	Objective	Objective

	Task 1	Task 2	Transfer
Exp 1	Subjective	Subjective	Objective
Exp 2	Nil		animation-static
Exp 3	animation-static	Nil	animation-static
Exp 4	freq with animation + gesturing + Corsi	freq with animation + freq with picture + Corsi	freq with picture

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Conclusion

1. Can spatial ability predict learners' performance when learning with instructional animations?

Yes and No

- Predictors for males and females performance are different
  - Males: objective assessments (e.g. CRT & MRT)
  - Females: subjective assessment (self-rated spatial ability) and experience using animations/static pictures

Conclusion

2. Does spatial ability influence the performance of males and females differently when learning with instructional animations?

- Unanswered

  Object-location memory (Corsi) was used in only 1 out of 4 experiments

Discussion

- In many studies (e.g. Castro-Alonso, 2013, 2015): F>M
  - Bias in gender
  - Bias in material used (Lego: Object location memory task)

- Implications
  - Different measures of spatial ability may be required according to gender
  - Experimental setting: balance participants gender and be careful with material design

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THANK YOU AND ANY QUESTIONS?