

Computerized and Adaptable Tests to Measure Visuospatial Abilities in STEM Students

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Outline

- Visuospatial Abilities
- Gender and Visuospatial Abilities
- STEM and Visuospatial Abilities
- Project PAI 82140021
 - Battery of 9 visuospatial tests
- Conclusions

Visuospatial Abilities

- Working memory includes a visuospatial subcomponent⁽¹⁾
- The subprocessor is related to spatial ability⁽²⁾
 - “Skill in representing and transforming symbolic or nonlinguistic information through space.”⁽³⁾

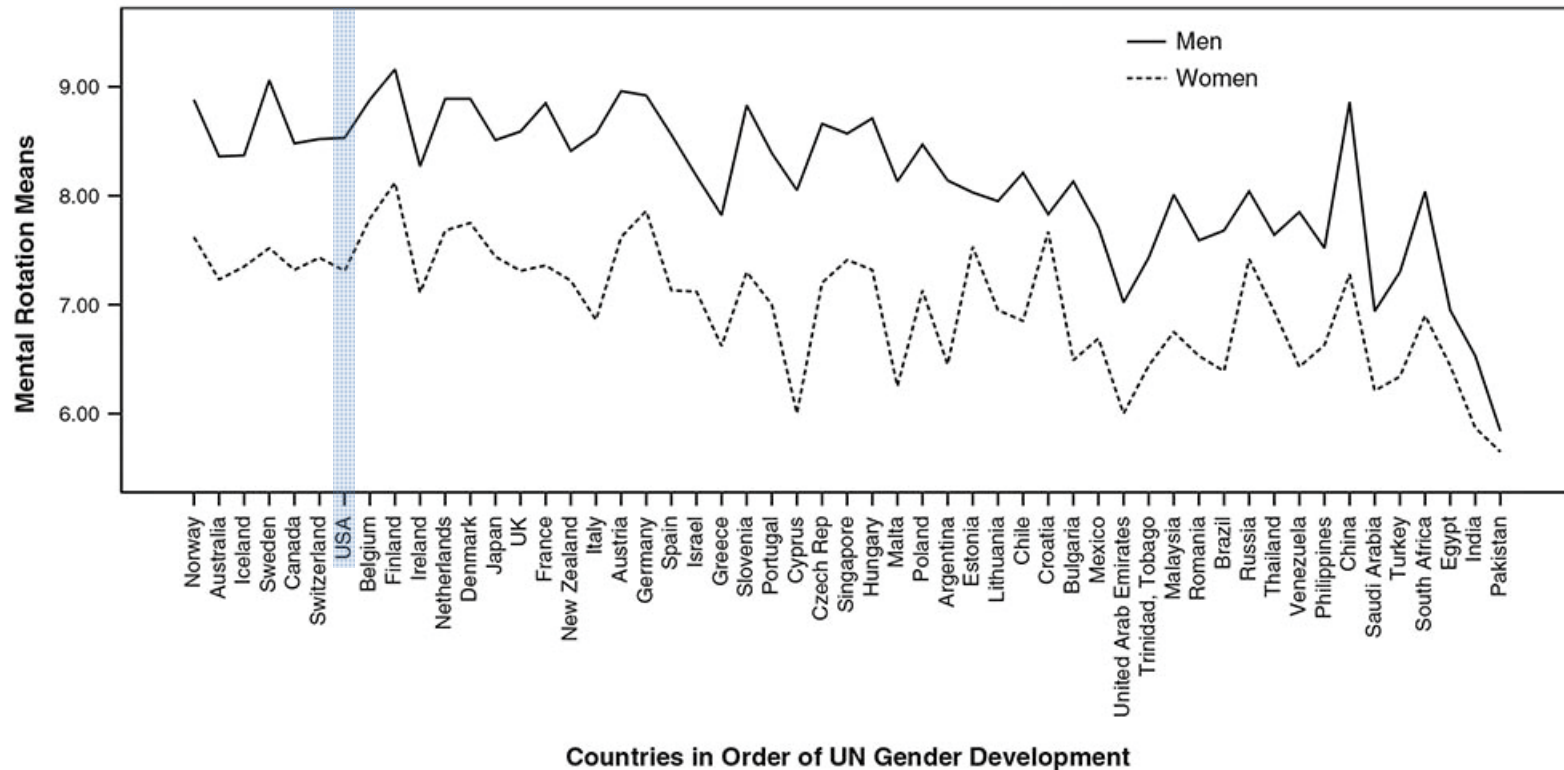
(1) Baddeley, A. (2012). Working memory: Theories, models, and controversies. *Annual Review of Psychology*, 63(1), 1-29. doi: 10.1146/annurev-psych-120710-100422

(2) Salthouse, T. A., Mitchell, D. R. D., Skovronek, E., & Babcock, R. L. (1989). Effects of adult age and working memory on reasoning and spatial abilities. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15(3), 507-516. doi: 10.1037/0278-7393.15.3.507

(3) Terlecki, M. S., & Newcombe, N. S. (2005). How important is the digital divide? The relation of computer and videogame usage to gender differences in mental rotation ability. *Sex Roles*, 53(5-6), 433-441. doi: 10.1007/s11199-005-6765-0

Gender and Visuospatial Abilities

- 53 countries ($N > 200.000$, 2010)⁽¹⁾



(1) Lippa, R. A., Collaer, M. L., & Peters, M. (2010). Sex differences in mental rotation and line angle judgments are positively associated with gender equality and economic development across 53 nations. *Archives of Sexual Behavior*, 39(4), 990-997. doi: 10.1007/s10508-008-9460-8

STEM and Visuospatial Abilities

- STEM learning is aided by spatial ability⁽¹⁾
- Mental rotation
 - Canada ($N > 600$, 1995): STEM students (biology, physics, and engineering) > non-STEM students (arts, social sciences, and humanities)⁽²⁾

(1) Wai, J., Lubinski, D., & Benbow, C. P. (2009). Spatial ability for STEM domains: Aligning over 50 years of cumulative psychological knowledge solidifies its importance. *Journal of Educational Psychology*, 101(4), 817-835. doi: 10.1037/a0016127

(2) Peters, M., Laeng, B., Latham, K., Jackson, M., Zaiyouna, R., & Richardson, C. (1995). A redrawn Vandenberg and Kuse Mental Rotations Test: Different versions and factors that affect performance. *Brain and Cognition*, 28(1), 39-58. doi: 10.1006/brcg.1995.1032

PAI 82140021 Project

- Battery of nine computer instruments
- Improve⁽¹⁾
 - Scoring
 - Modifications
 - Adapt difficulty
 - Customize other variables

(1) Berch, D. B., Krikorian, R., & Huha, E. M. (1998). The Corsi block-tapping task: Methodological and theoretical considerations. *Brain and Cognition*, 38(3), 317-338. doi: 10.1006/brcg.1998.1039

Mental Rotation

- Card Rotations Test

Page 2
Part 1 (3 minutes)

S-1

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Page 3
Part 2 (3 minutes)

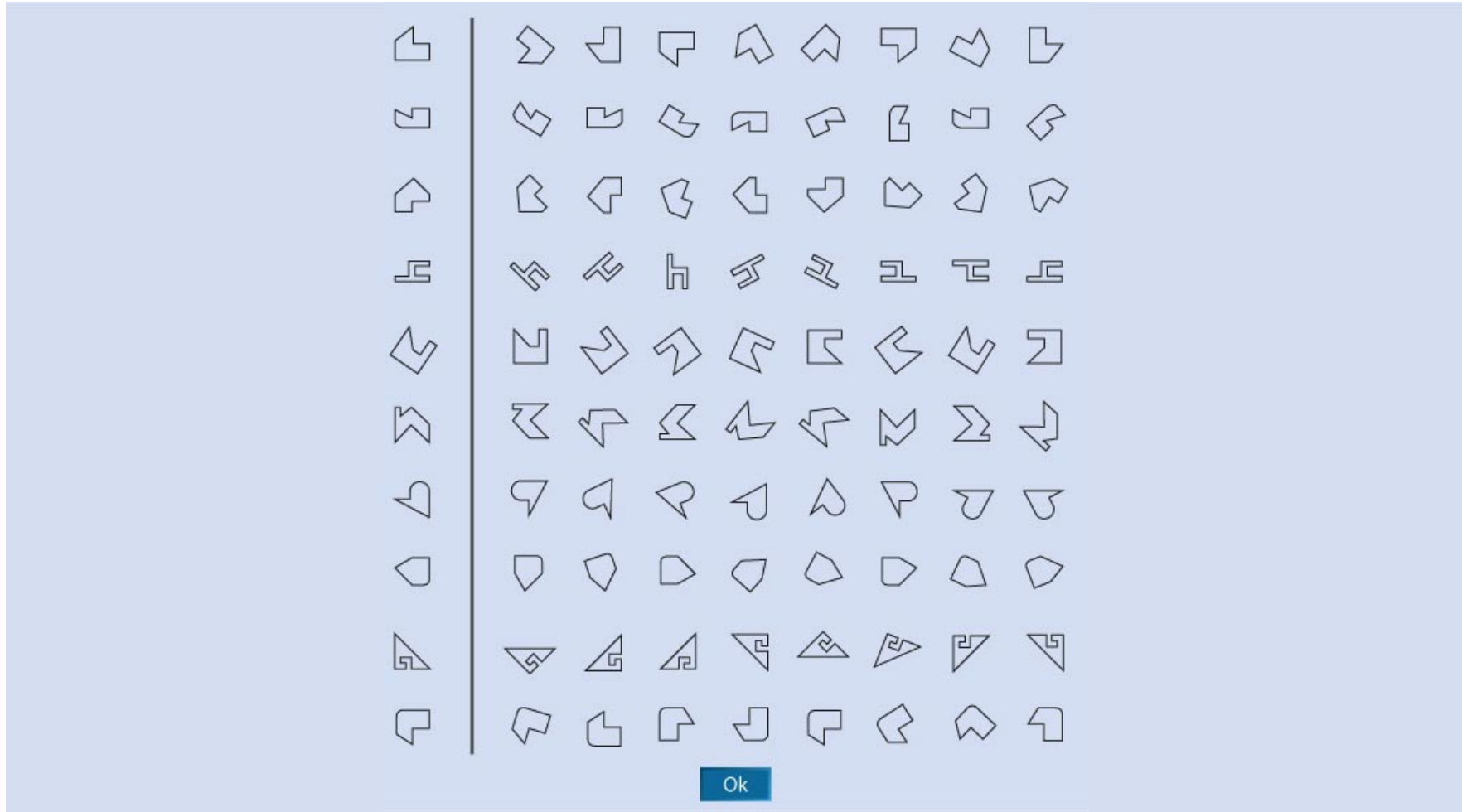
S-1

11.									
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16.									
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17.									
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18.									
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19.									
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20.									
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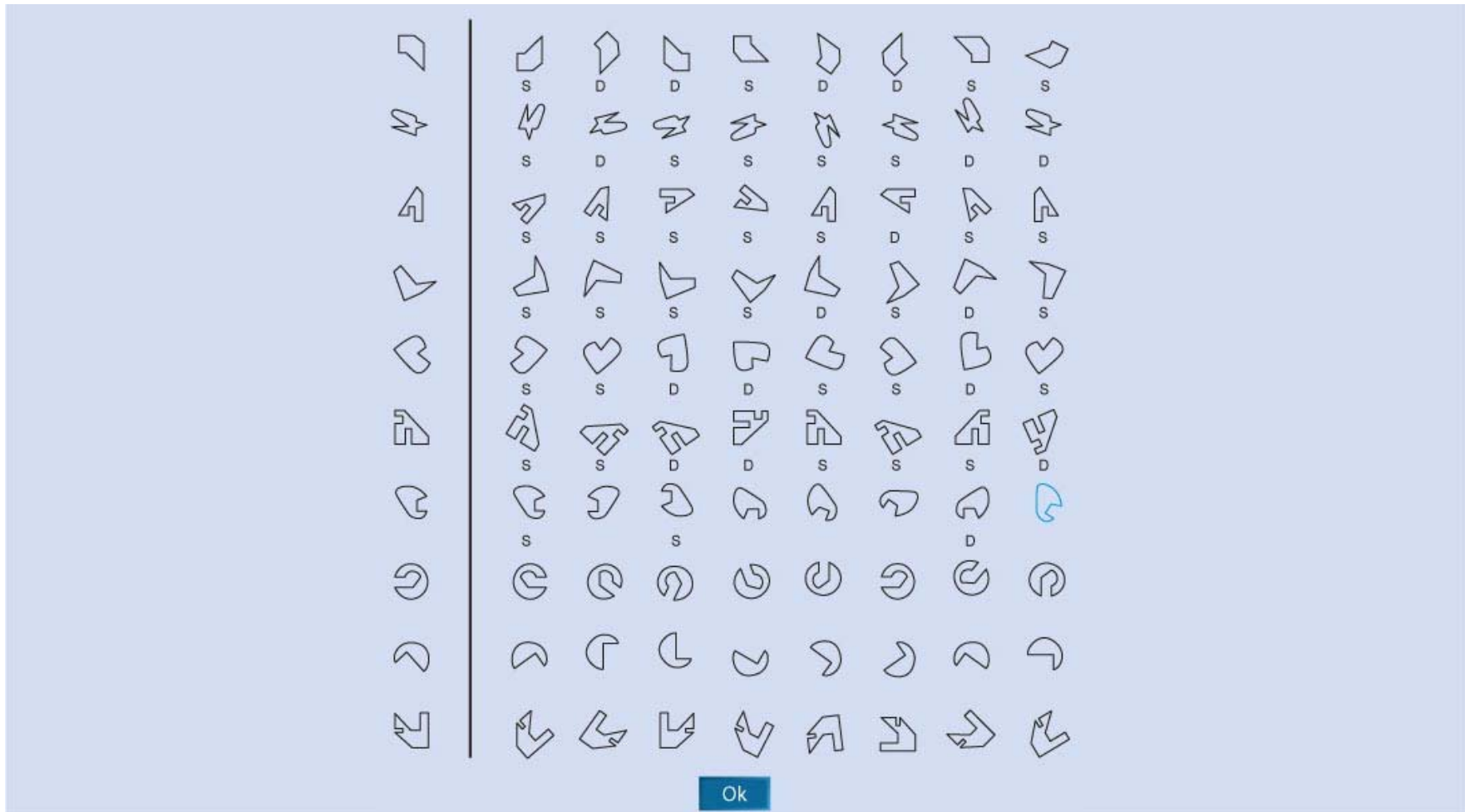
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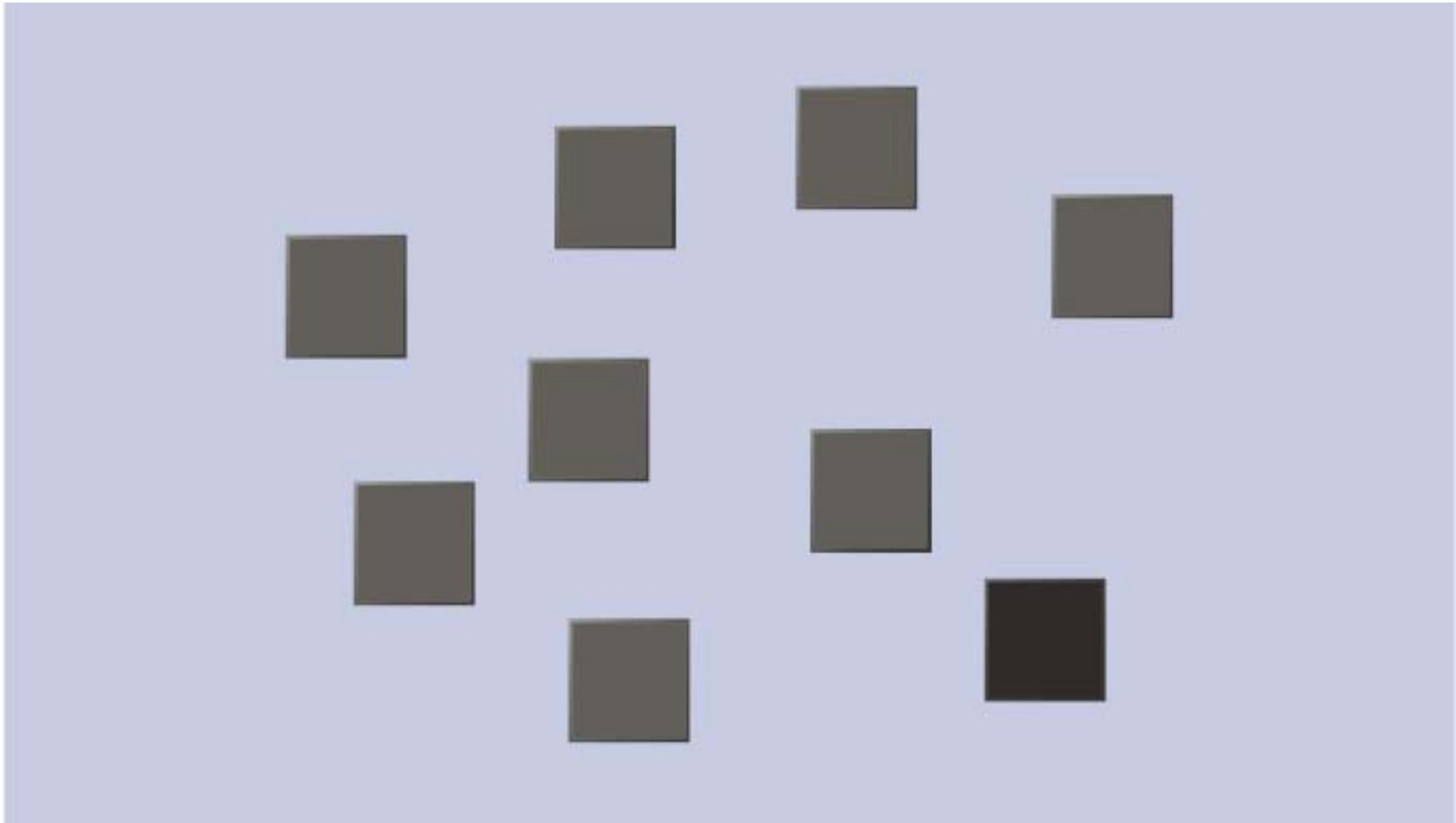
1 - Virtual Card Rotations Test



1 - Novel Virtual Card Rotations Test



2 - Corsi Tapping Test⁽¹⁾

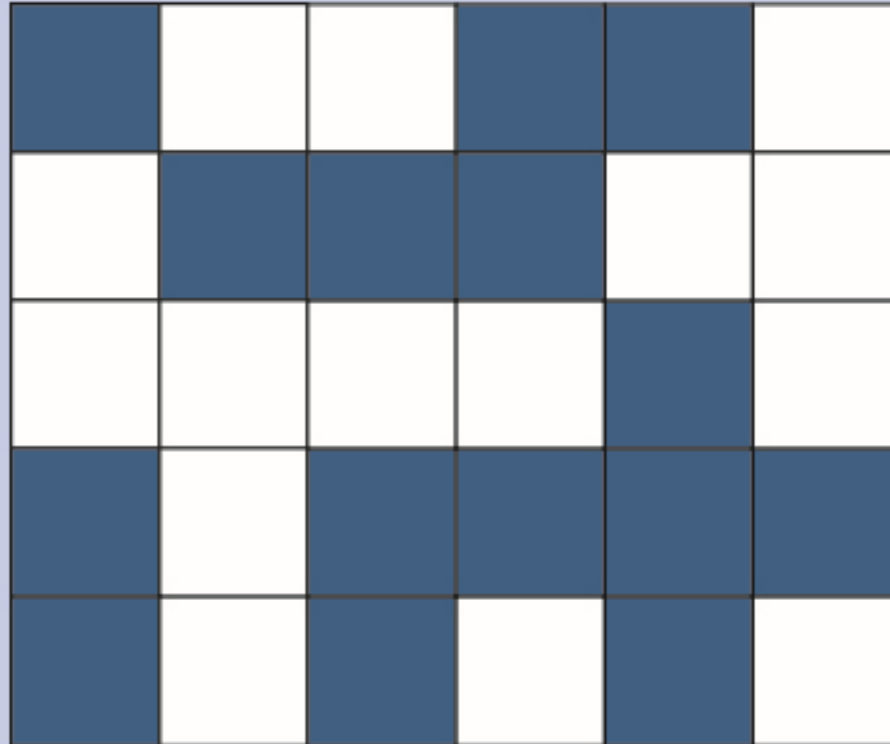


(1) Milner, B. (1971). Interhemispheric differences in the localization of psychological processes in man. *British Medical Bulletin*, 27(3), 272-277.

Corsi Tapping Test

- Other variables
 - Backward test
 - Block positions
 - Block color
 - Display time
 - Sequences
 - Language
 - Instructions
 - Practices

3 - Visual Patterns Test⁽¹⁾



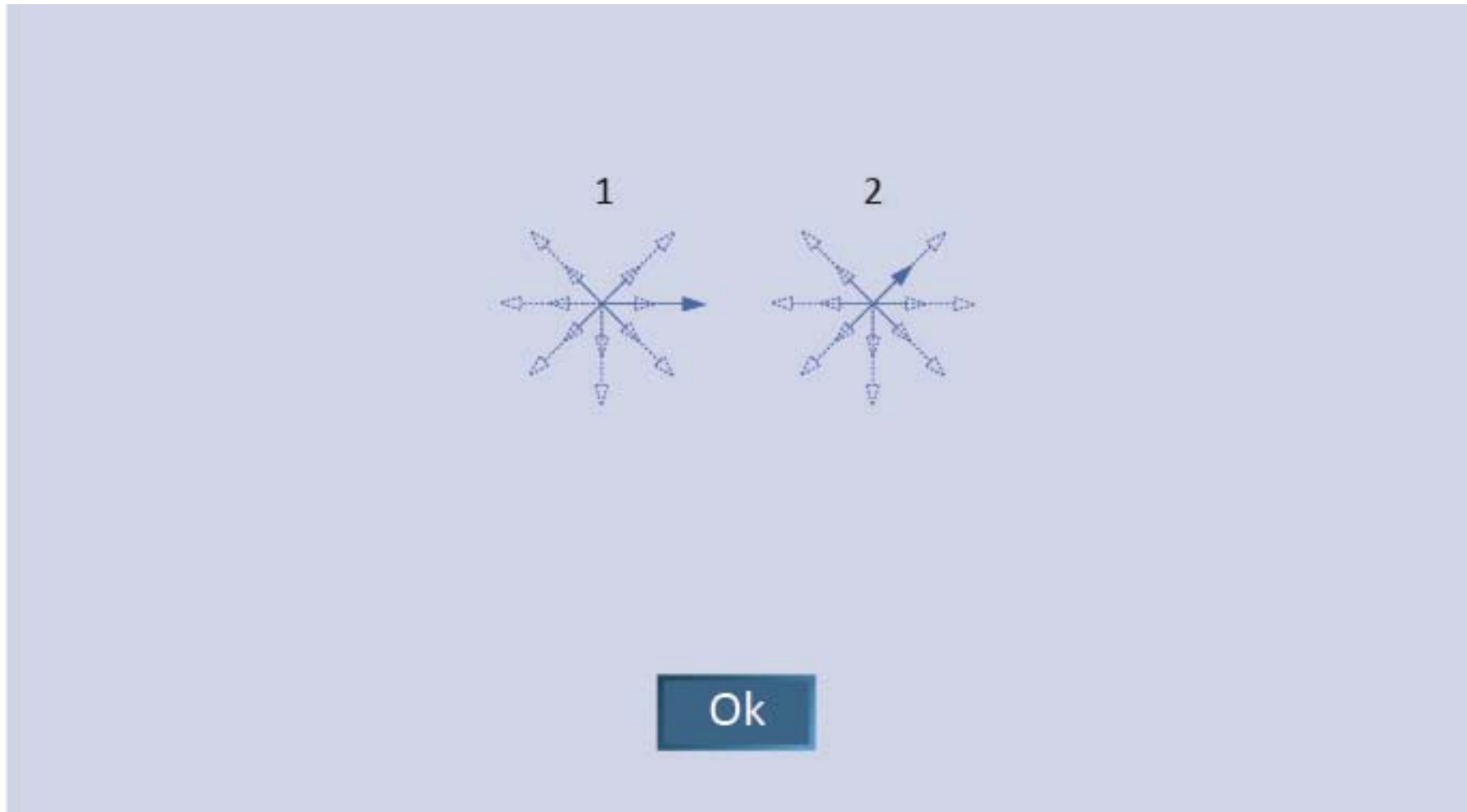
(1) Della Sala, S., Gray, C., Baddeley, A., Allamano, N., & Wilson, L. (1999). Pattern span: A tool for unwelding visuo-spatial memory. *Neuropsychologia*, 37(10), 1189-1199. doi: 10.1016/S0028-3932(98)00159-6

Visual Patterns Test

- Other variables
 - Negative test
 - Display time
 - Interval time
 - Repeats
 - Sounds
 - Language
 - Instructions
 - Practices

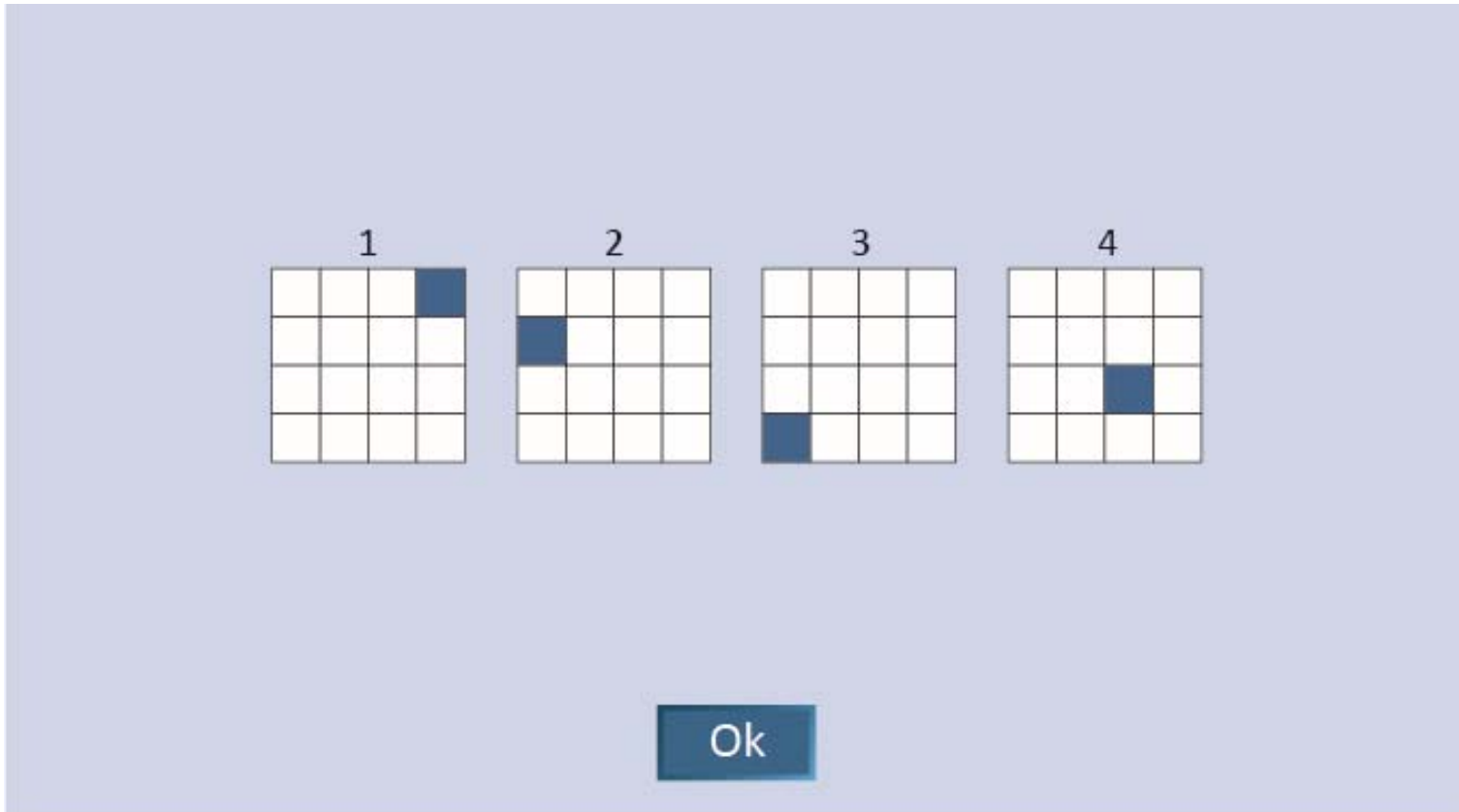
4 - Dual Tasks

- Memory Tasks – Processing (Distracting) Tasks



Dual Tasks

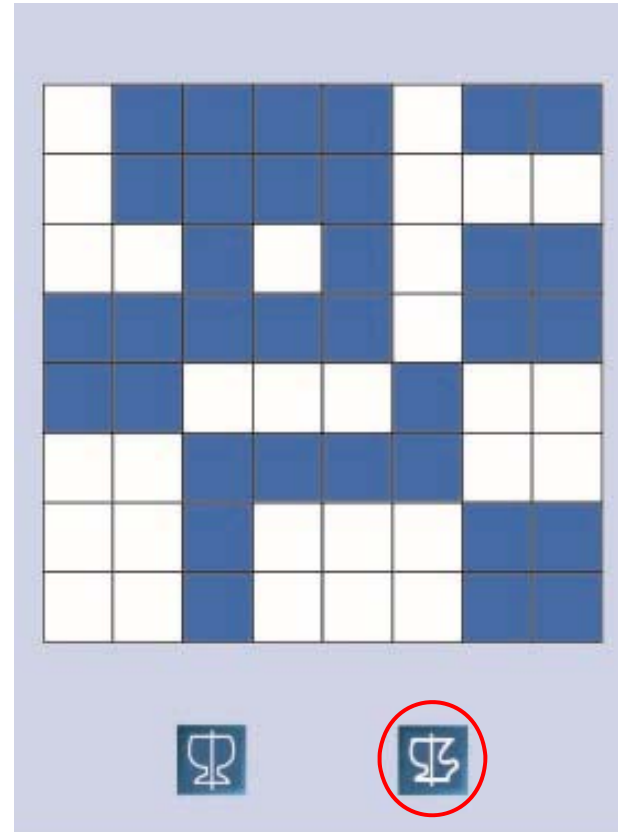
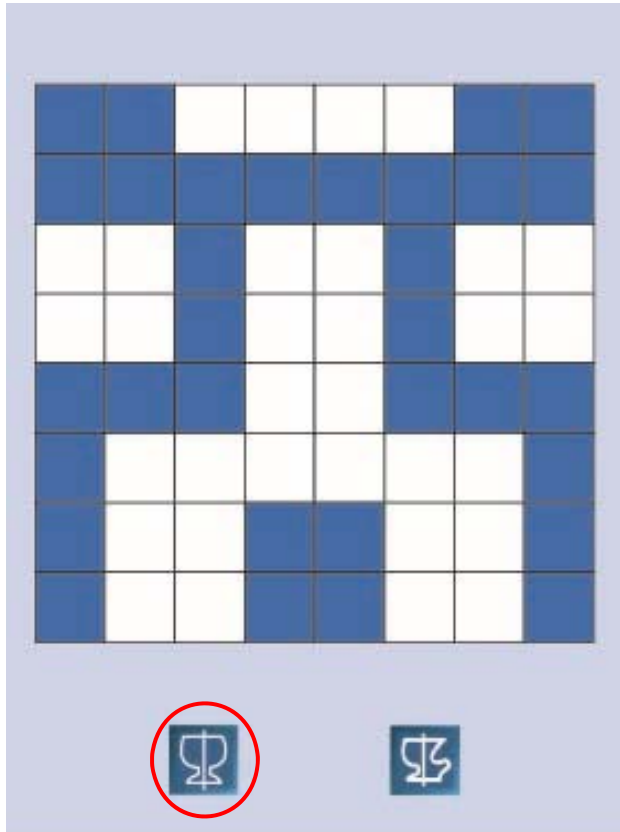
- Memory Task: Matrix Positions⁽¹⁾



- (1) Kane, M. J., Hambrick, D. Z., Tuholski, S. W., Wilhelm, O., Payne, T. W., & Engle, R. W. (2004). The generality of working memory capacity: A latent-variable approach to verbal and visuospatial memory span and reasoning. *Journal of Experimental Psychology: General*, 133(2), 189-217. doi: 10.1037/0096-3445.133.2.189

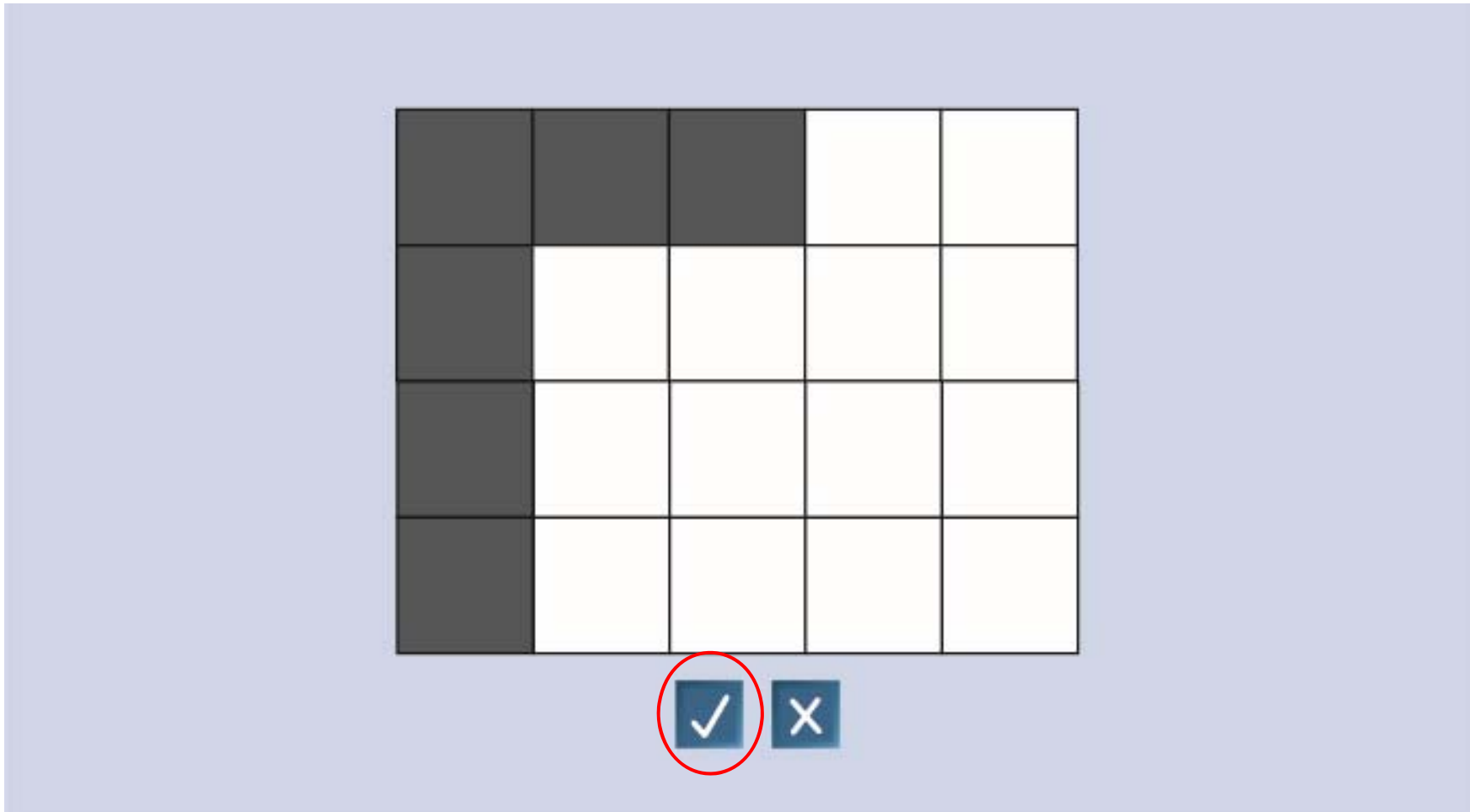
Dual Tasks

- Processing Task: Symmetry Patterns⁽¹⁾



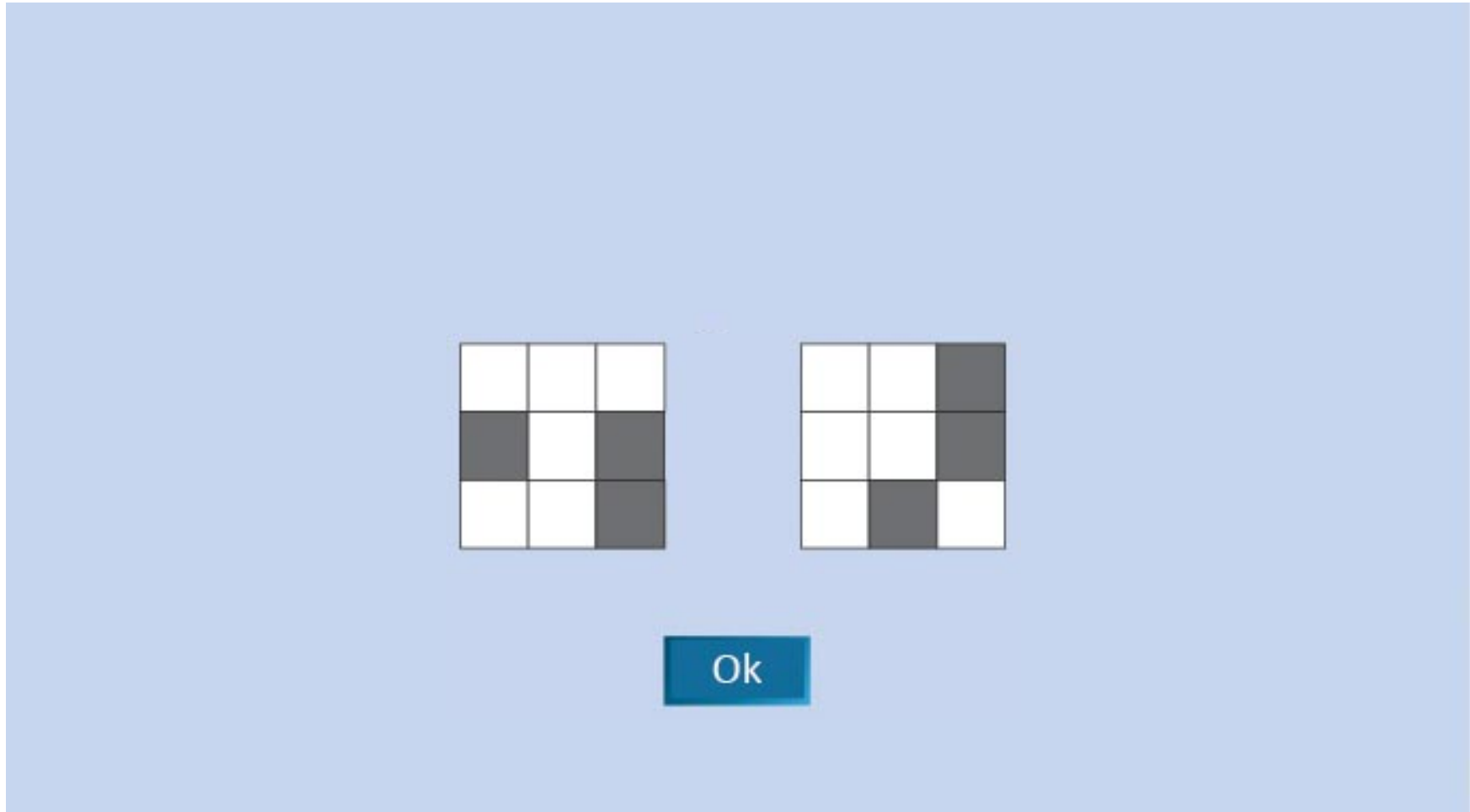
- (1) Blacker, K. J., Curby, K. M., Klobusicky, E., & Chein, J. M. (2014). Effects of action video game training on visual working memory. *Journal of Experimental Psychology: Human Perception & Performance*, 40(5), 1992-2004. doi: 10.1037/a0037556

5 - Spatial N-Back Task⁽¹⁾



(1) Lejbak, L., Crossley, M., & Vrbancic, M. (2011). A male advantage for spatial and object but not verbal working memory using the n-back task. *Brain and Cognition*, 76(1), 191-196. doi: 10.1016/j.bandc.2010.12.002

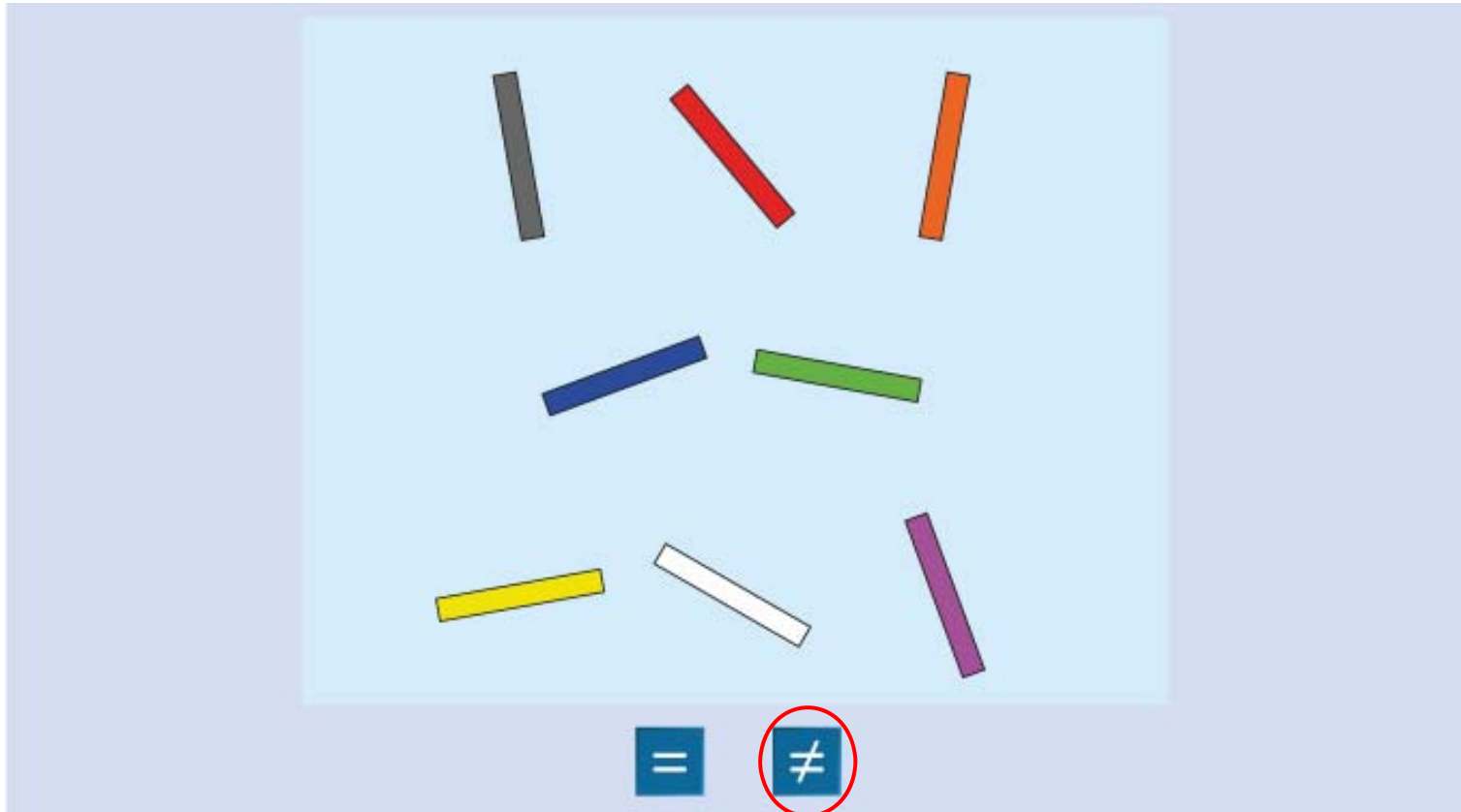
6 - Rotated Patterns⁽¹⁾



- (1) Oberauer, K., Süß, H.-M., Schulze, R., Wilhelm, O., & Wittmann, W. W. (2000). Working memory capacity — facets of a cognitive ability construct. *Personality and Individual Differences*, 29(6), 1017-1045. doi: 10.1016/S0191-8869(99)00251-2

7 - Colored Bars

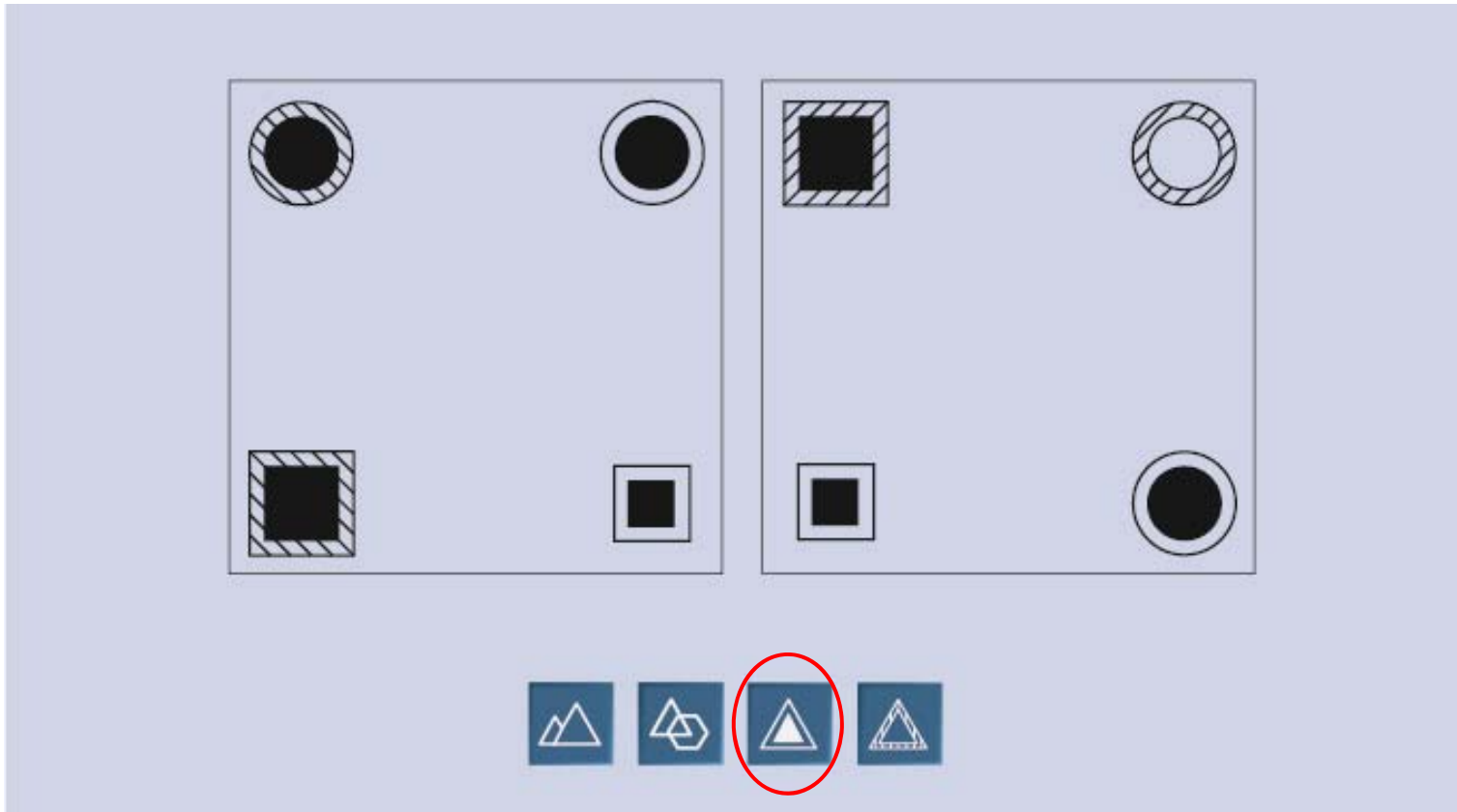
- Changed Color⁽¹⁾



- (1) Harrison, T. L., Shipstead, Z., Hicks, K. L., Hambrick, D. Z., Redick, T. S., & Engle, R. W. (2013). Working memory training may increase working memory capacity but not fluid intelligence. *Psychological Science*, 24(12), 2409-2419. doi: 10.1177/0956797613492984

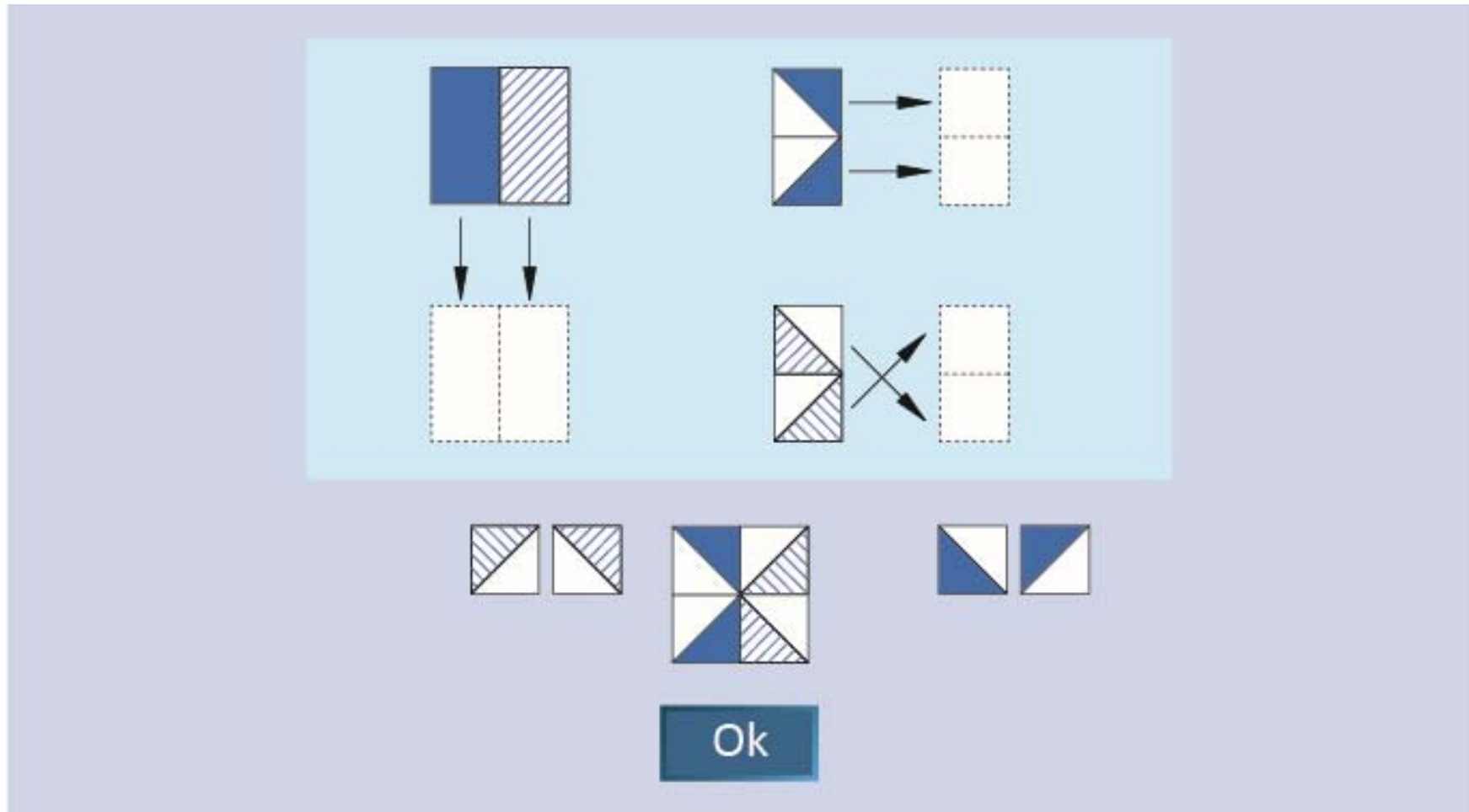
8 - Coordinative Complexity Tasks⁽¹⁾

- Spatial Transformation Task



- (1) Mayr, U., & Kliegl, R. (1993). Sequential and coordinative complexity: Age-based processing limitations in figural transformations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19(6), 1297-1320. doi: 10.1037/0278-7393.19.6.1297

9 - Four Square Ordering⁽¹⁾



(1) Law, D. J., Morrin, K. A., & Pellegrino, J. W. (1995). Training effects and working memory contributions to skill acquisition in a complex coordination task. *Learning and Individual Differences*, 7(3), 207-234. doi: 10.1016/1041-6080(95)90011-X

Conclusions

- Men have been favored in
 - Academic careers in STEM and visuospatial abilities, such as mental rotation
- PAI 82140021 project
 - Developed a battery of 9 computer-adapted visuospatial tests
 - Investigating effects of gender and STEM *versus* non-STEM disciplines

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