Exploring the causal relation between spatial skills and math competence through a game-based spatial skills training: A randomized controlled trial

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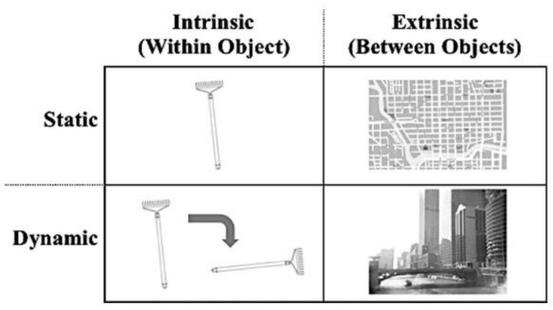
Abstract

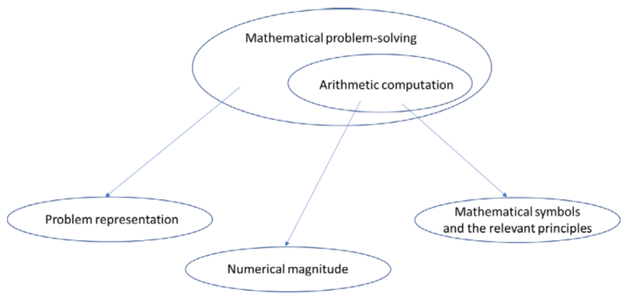
- Recent studies have shown that spatial skills training is effective in terms of improving math competence (Hawes et al., 2022).
- But we have little knowledge about the specificity as well as the mechanisms underlying the causal link between spatial skills and math competence.
- The current intervention study aims to address these issues using **a randomized controlled trial of spatial skills training**.
- A sample of 450 third graders will be randomly assigned to receive one of the five series of **game-based training** (four series of spatial skills training or a vocabulary training). They will be assessed on their spatial skills, reading and math achievement, potential mediators, as well as other potential mechanisms, before and after the intervention.
- The findings will inform us about **whether different spatial skills training benefits math competence through the same mechanisms or contribute to math competence through different mechanisms**.

Introduction

- Spatial skills refer to a range of related abilities that include the mental processing of objects in the environment and within space (Uttal et al., 2013)

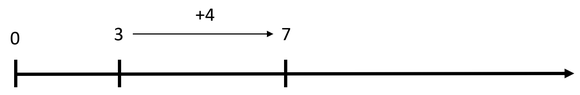


- Spatial skills have been shown to be significantly correlated with (Xie et al., 2020) and causally related to (Gilligan et al., 2019; Hawes et al., 2022) math competence
  - But there is little understanding about the mechanisms (Mix, 2019)
- Spatial skills are proposed to contribute to math competence through three different mechanisms



  - Numerical magnitude

  - Arithmetic operations



  - Word problem representation

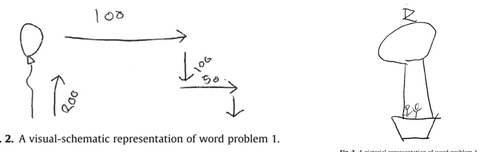


Fig. 2. A visual-schematic representation of word problem 1.

Fig. 3. A pictorial representation of word problem 1.

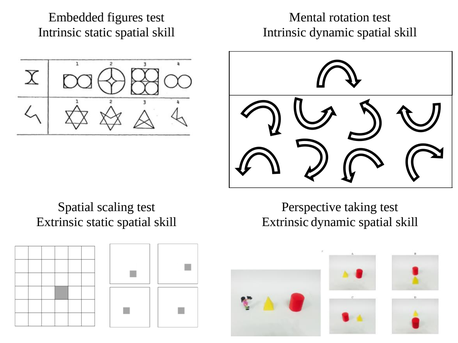
- **Unresolved issues**
  - Not all spatial skills interventions transfer to math (Cornu et al., 2019; Hawes et al., 2015)
  - Existing spatial skills intervention studies focus mainly on mental rotation.
  - Little understanding concerning why the effects of the spatial skills interventions can be generalized to math
    - Specificity of the intervention effects?
    - Mechanisms underlying the transfer?

Method

Participants: 450 third graders, randomly assigned into one of the five intervention groups (4 spatial skills + 1 vocabulary conditions)

Measures:

Spatial skills:

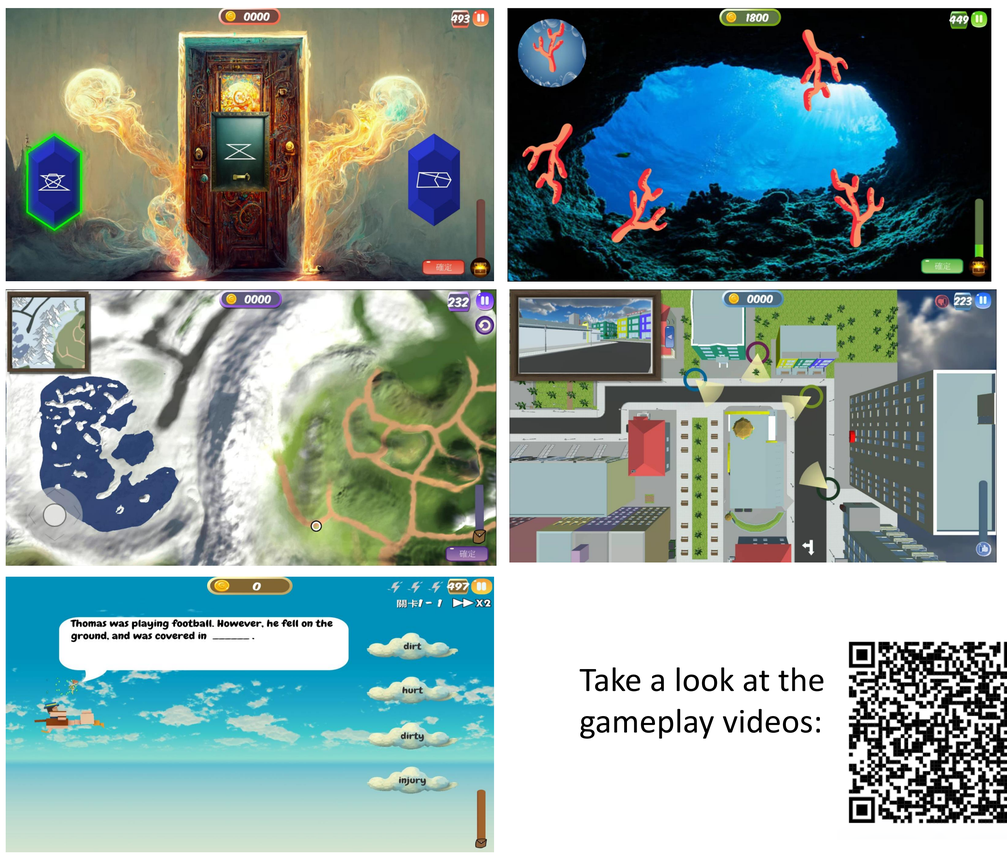


Achievement outcomes:
- Math achievement
- Reading achievement

Potential mediators:
- Numerical magnitude
- Arithmetic principle knowledge
- Word problem representation
- Working memory
- Sustained attention
- Math motivation

Control: IQ

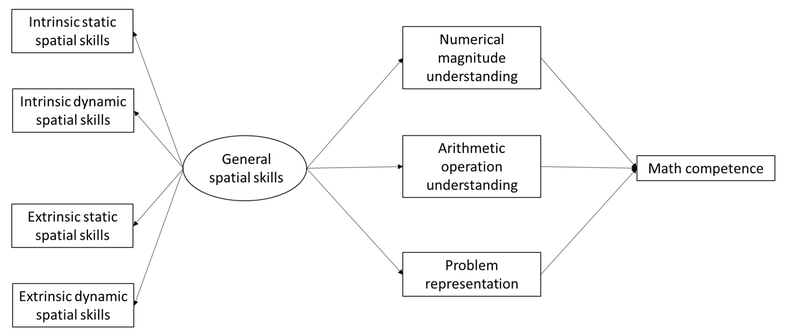
Interventions (Eight 20-minute sessions):



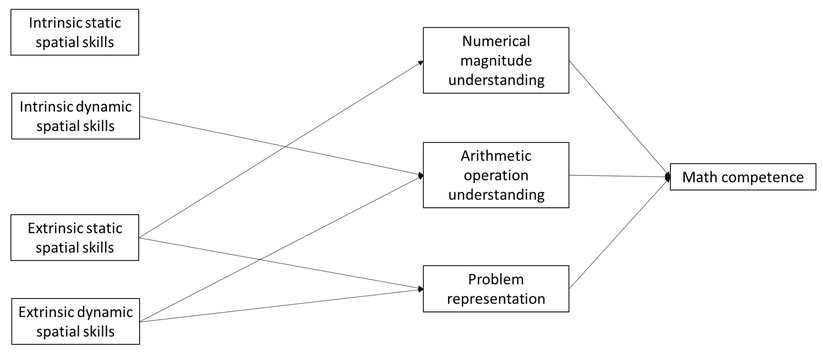
Take a look at the gameplay videos:

Expected results

- If different spatial skills interventions contribute to math through the same mechanisms



- If different spatial skills interventions contribute to math through different mechanisms



Further information

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