The Relationship of Mathematical Skills and Spatial Abilities
- Clinical Experience

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Who am I and What do I do?

Integrating Humans’ Nervous System, utilizing noninvasive stimulations.

Develop games and exercises targeted to specific brain networks.

Developmental Delay

Learning Disabilities

Complicated Neurological Disorders

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SPATIAL ORIENTATION SKILL AND MATHEMATICAL PROBLEM SOLVING

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The purpose of this study was to explore the role of spatial orientation skill in the solution of mathematics problems. Fifty-seven tenth-grade students who scored high or low on a spatial orientation test were asked to solve mathematics problems in individual interviews. A group of specific behaviors was identified in geometric settings, which appeared to be manifestations of spatial orientation skill. Spatial orientation skill also appeared to be involved in understanding the problem and linking new problems to previous work in nongeometric settings.

For a long time researchers have attempted to determine why some students learn mathematics or are able to solve mathematics problems better than others do. Some research has focused on the processes used to solve mathematics problems. Other researchers have tried to identify factors and skills related to doing mathematics. Among the skills found to be related to mathematics learning and achievement are spatial skills (Fennema & Sherman, 1977; McGee, 1979).

The literature contains a great deal of discussion about the possible relationship between spatial skills and mathematics. Many studies have found spatial skills to be positively correlated with measures of mathematics performance (Connor & Serbin, 1985; Fennema & Sherman, 1977). But what are spatial skills, and how and why are those skills related to mathematics?

Spatial ability differences between students with a math learning disability and their other normal colleagues

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Abstract

Purpose – This study aims to investigate the differences in spatial ability between students with a math learning disability and their normal peers.

Design/methodology/approach – To investigate these differences two groups, (60 students with a math learning disability) and (60 normal students) from fifth grade with a mean age (10.6 years) were administered with spatial ability test along with an IQ test. Students with a math learning disability were chosen using measures of the following: math learning disability questionnaire developed from learning disability evaluation scale – renormed second edition (LDES-R^2) (McCarney and Arthaud, 2007) and the Quick Neurological Screening Test (Mutti *et al.*, 2012), in addition to their marks in formal math tests in school.

Findings – Comparison between the two groups in four aspects of spatial ability resulted in obvious differences in each aspect of spatial ability (spatial relations, mental rotation, spatial visualization and spatial orientation); these differences were clear, especially in mental rotation and spatial visualization.

Originality/value – This paper contributes to gain more insights into the characteristics of pupils with a math learning disability, the nature of spatial abilities and its effect on a math learning disability. Moreover, the results suggest spatial ability to be an important diagnose factor to distinguish and identify students with a math learning disability, and that spatial ability is strongly relevant to math achievement. The results have significant implications for success in the science, technology, engineering and mathematics domain.

Keywords Neurological screening, Spatial relations, Math learning disability, Mental rotation, Spatial ability, Spatial orientation, Spatial visualization

Paper type Research paper

The developmental relations between spatial cognition and mathematics in primary school children

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Affiliations + expand

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Abstract

Spatial thinking is an important predictor of mathematics. However, existing data do not determine whether all spatial sub-domains are equally important for mathematics outcomes nor whether mathematics-spatial associations vary through development. This study addresses these questions by exploring the developmental relations between mathematics and spatial skills in children aged 6-10 years (N = 155). We extend previous findings by assessing and comparing performance across Uttal et al.'s (2013), four spatial sub-domains. Overall spatial skills explained 5%-14% of the variation across three mathematics performance measures (standardized mathematics skills, approximate number sense and number line estimation skills), beyond other known predictors of mathematics including vocabulary and gender. Spatial scaling (extrinsic-static sub-domain) was a significant predictor of all mathematics outcomes, across all ages, highlighting its importance for mathematics in middle childhood. Other spatial sub-domains were differentially associated with mathematics in a task- and age-dependent manner. Mental rotation (intrinsic-dynamic skills) was a significant predictor of mathematics at 6 and 7 years only which suggests that at approximately 8 years of age there is a transition period regarding the spatial skills that are important for mathematics. Taken together, the results support the investigation of spatial training, particularly targeting spatial scaling, as a means of improving both spatial and mathematical thinking.

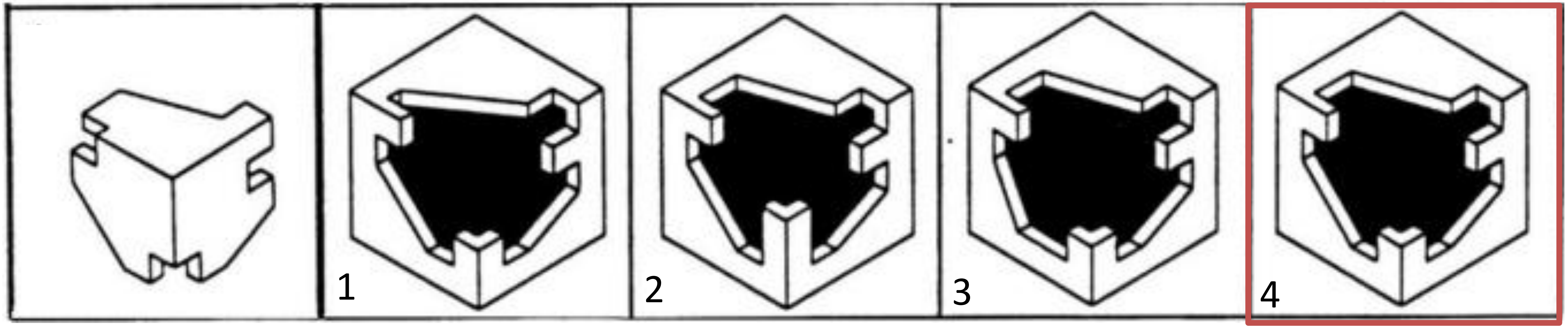
4 Factors of Spatial Ability:

- **Spatial Relationships**
- **Spatial Visualization**
- **Mental Rotation**
- **Spatial Orientations**

Spatial Relationships:

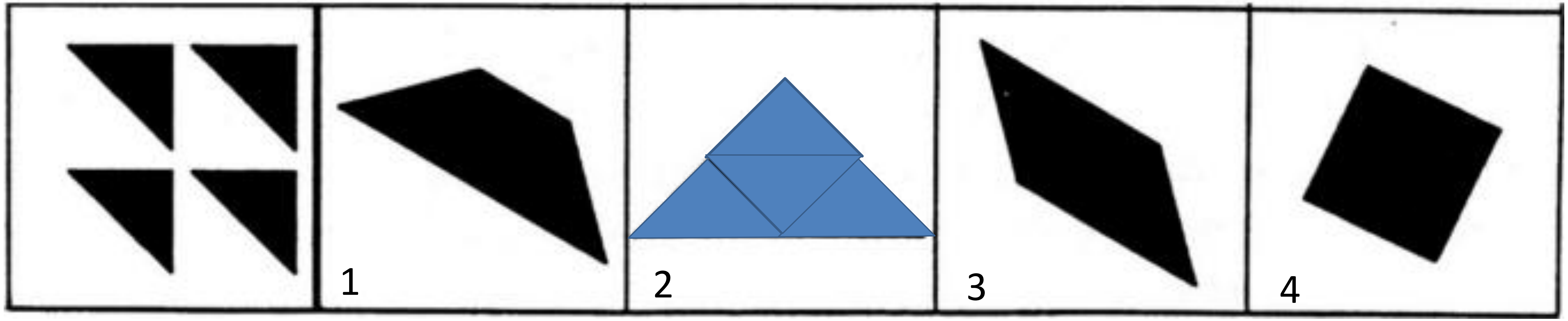
Spatial relationships are the 3D relationships of objects in space, like relative position and distance apart.

This component of spatial ability focuses on realizing 2D and 3D objects in place



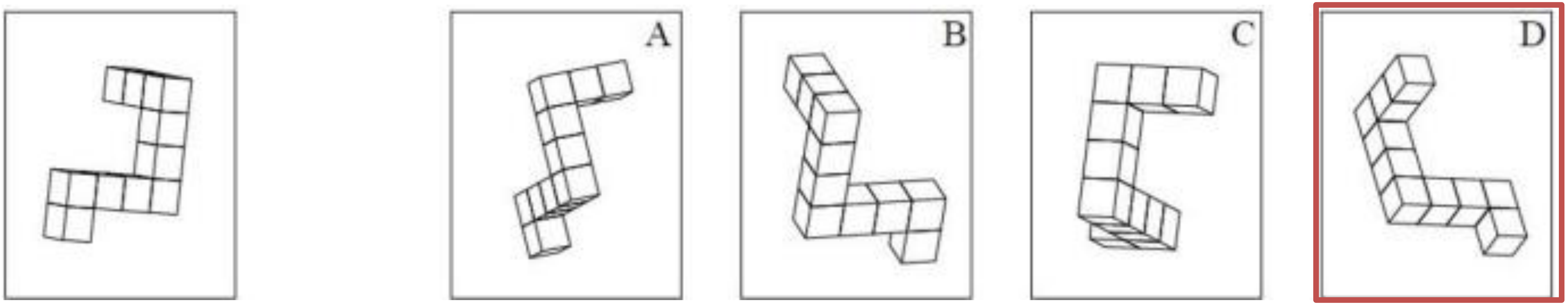
Spatial Visualization:

The ability to think of changes in objects:
changes in position, orientation, or internal relationship



Mental Rotation:

The ability to imagine the rotation of (simple) 2D and 3D objects.



Spatial Orientation:

The ability to find one's way in a 3D space mentally as well as in reality, whereby one has to move around in a spatial arrangement of objects.

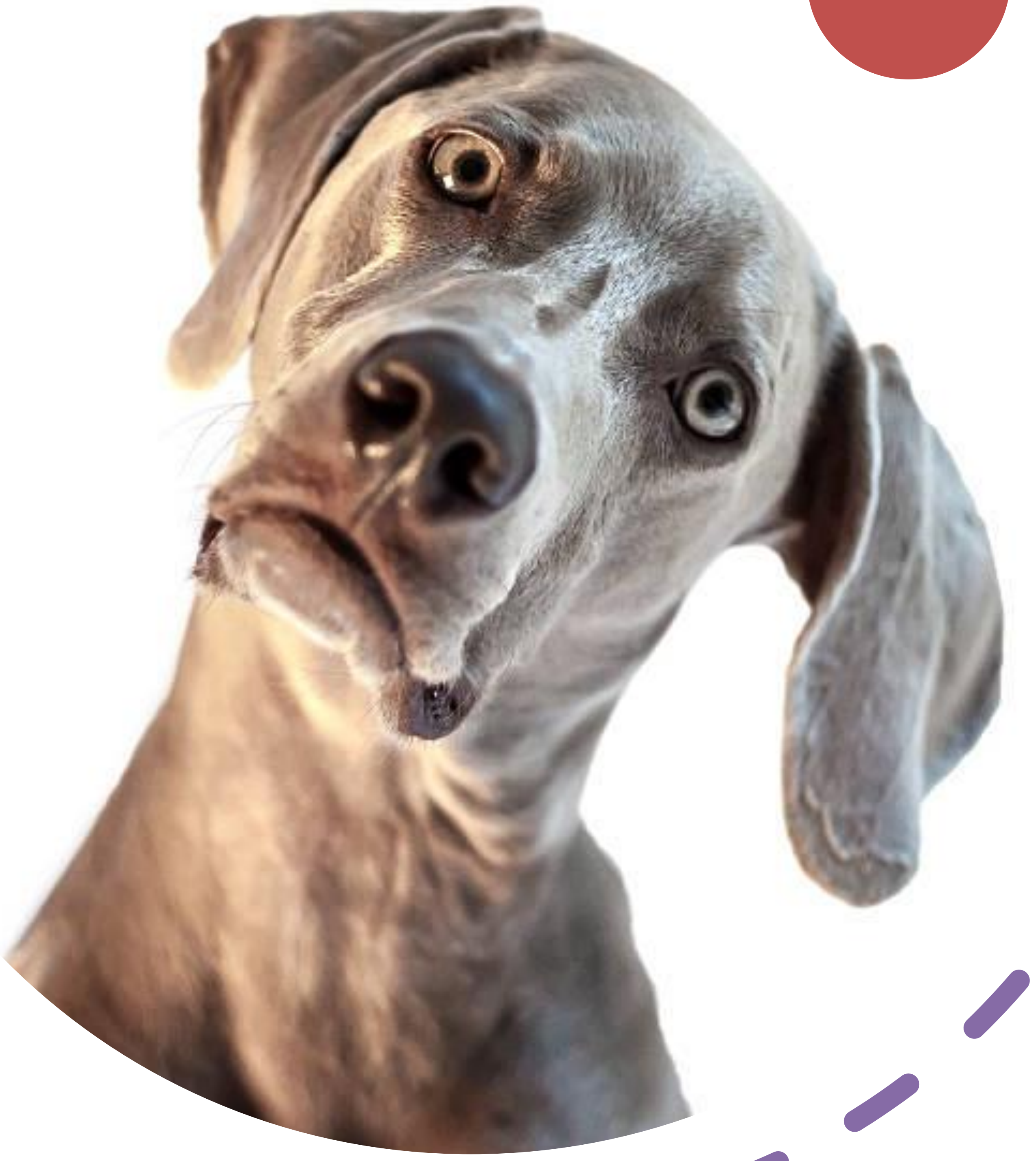
Example:

#POV

Point of View

All these abilities require me to change my point of view

- Can you change your POV?
- Can you walk it somewhere else?
- Can you switch POV with me?

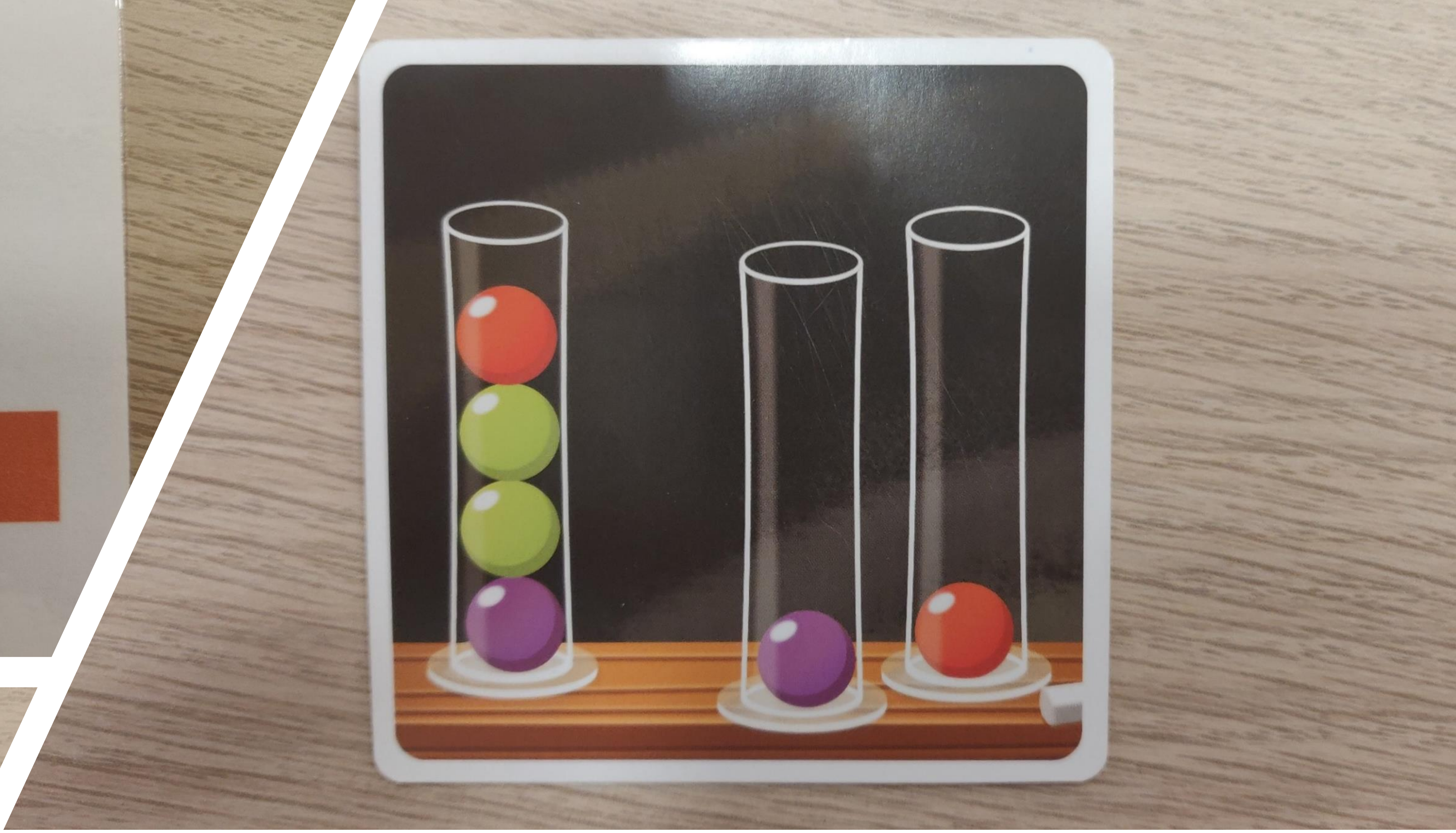


The ability to change POV requires a sense of self, an anker within the body that will serve as a reference point to the outside world.

The ability to change POV requires

Proprioception!

The Test We Developed




A
B
C


A
B
C

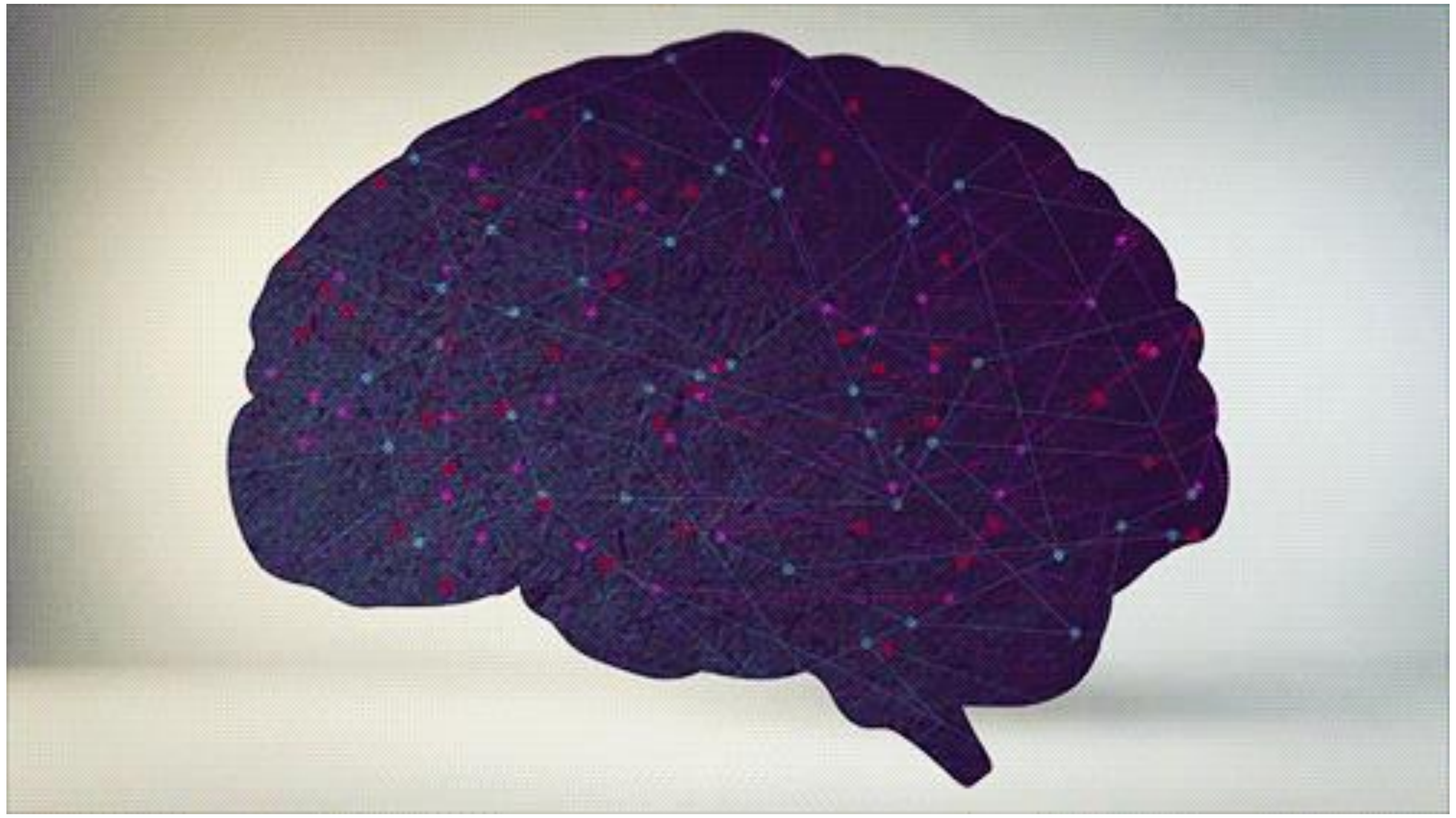
Winter's POV Chair Test


Let’s
Play

We design a program that addresses the foundational components of:

- **Body awareness and Proprioception**
- **Estimation**
- **POV (mental rotation + visualization)**
- **Working Memory**

And designed games to facilitate these components.



Results:

All 20 children benefited from this kind of therapy, all improved their math skills, some to the extent of their grade level (25%) and some needed more tutoring done.

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