

Spatial Reasoning

- The ability to think in terms of spatial information, such as shape and orientation
- Includes
 - Regressing from image to 3D model
 - Representing a concept as a spatial model
 - Manipulating spatial models in the mind

Measuring Spatial Skill

Rotating



A

B

C

D

E

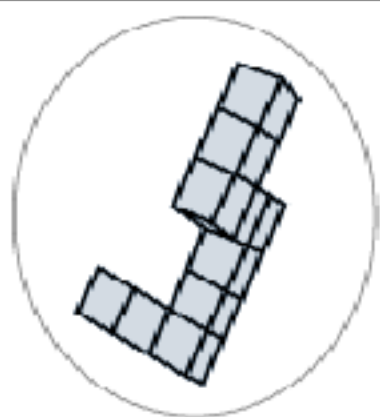
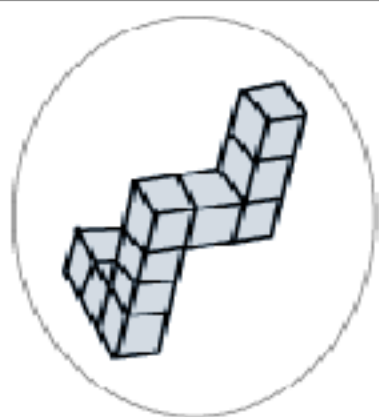
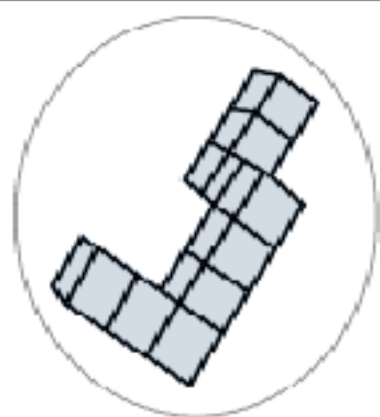
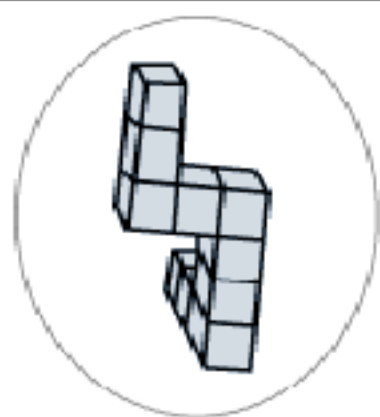
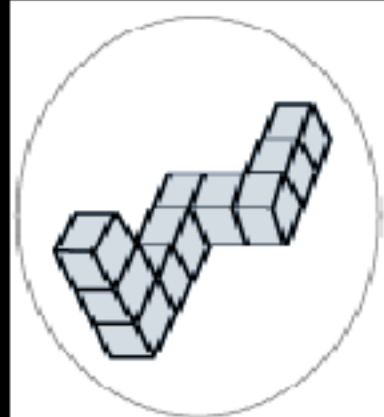
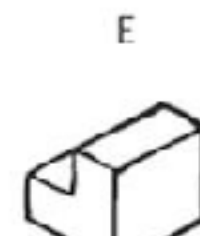
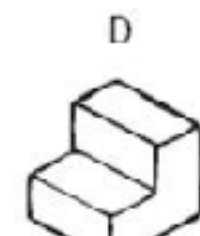
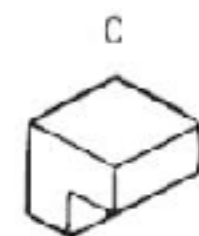
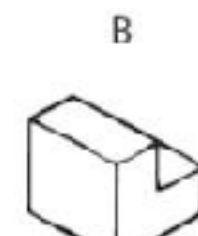
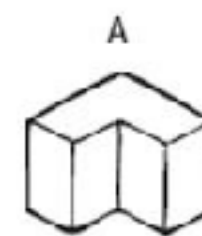


is rotated to



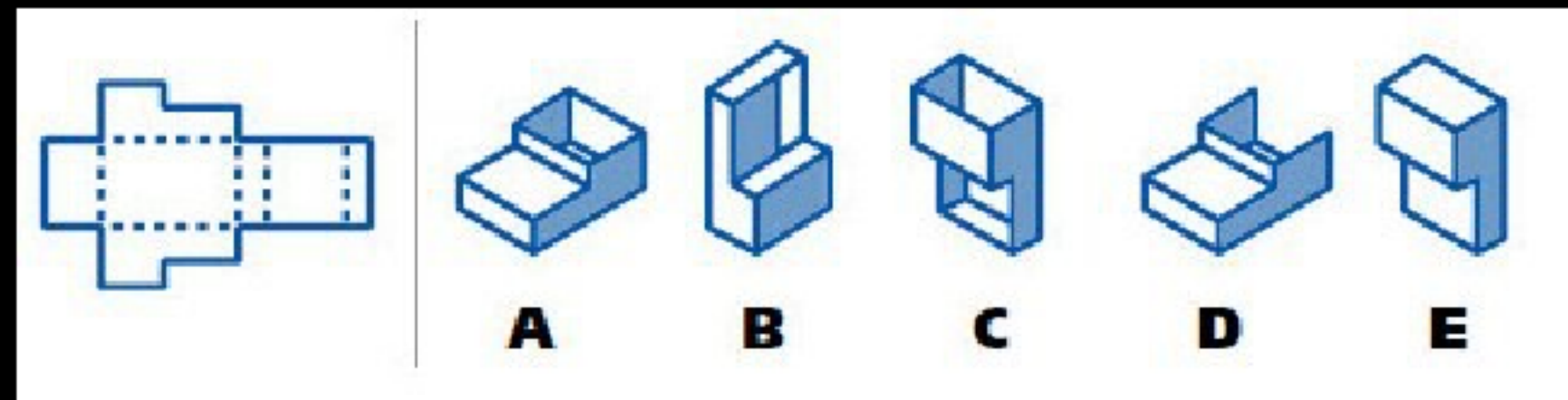
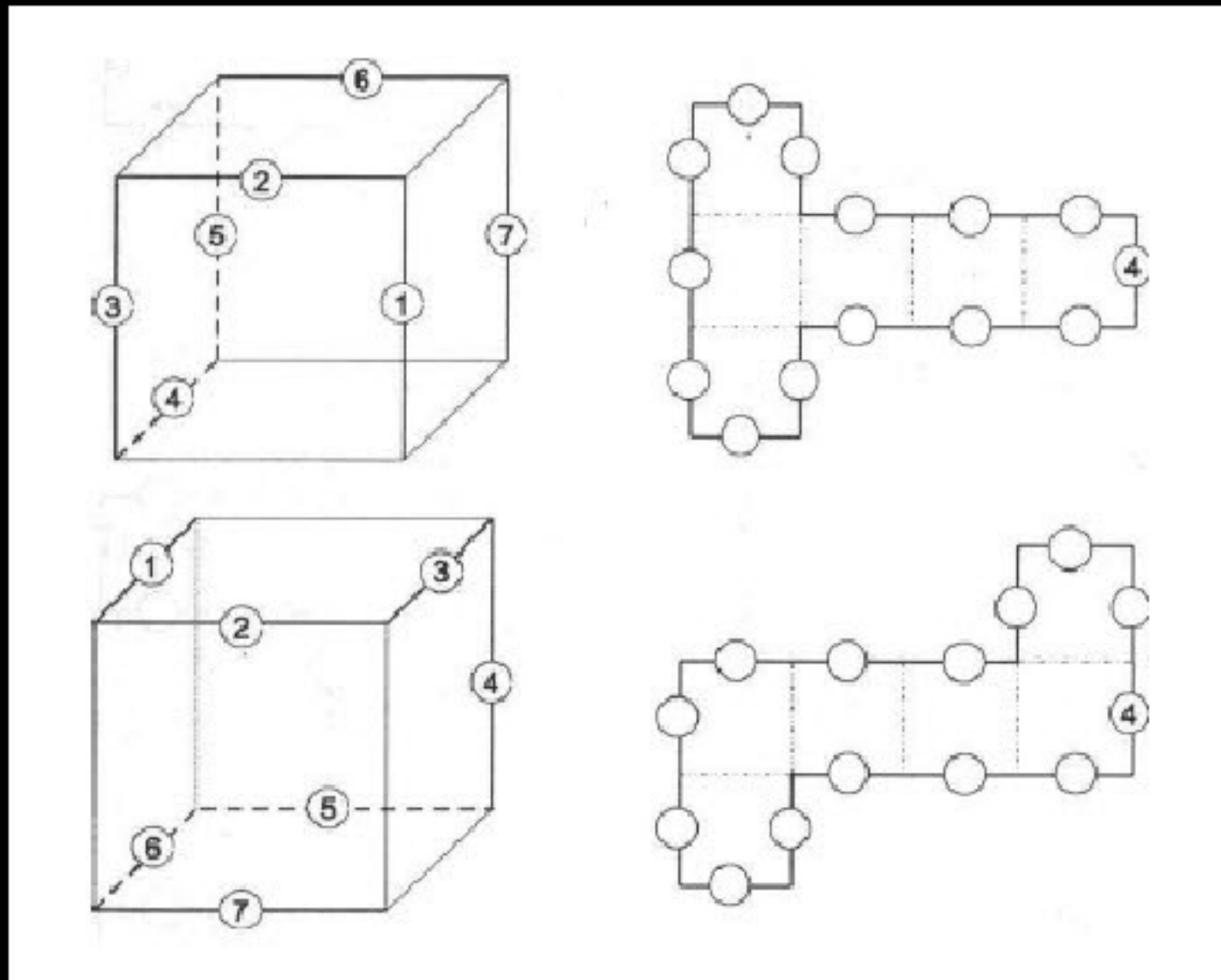
as

is rotated to



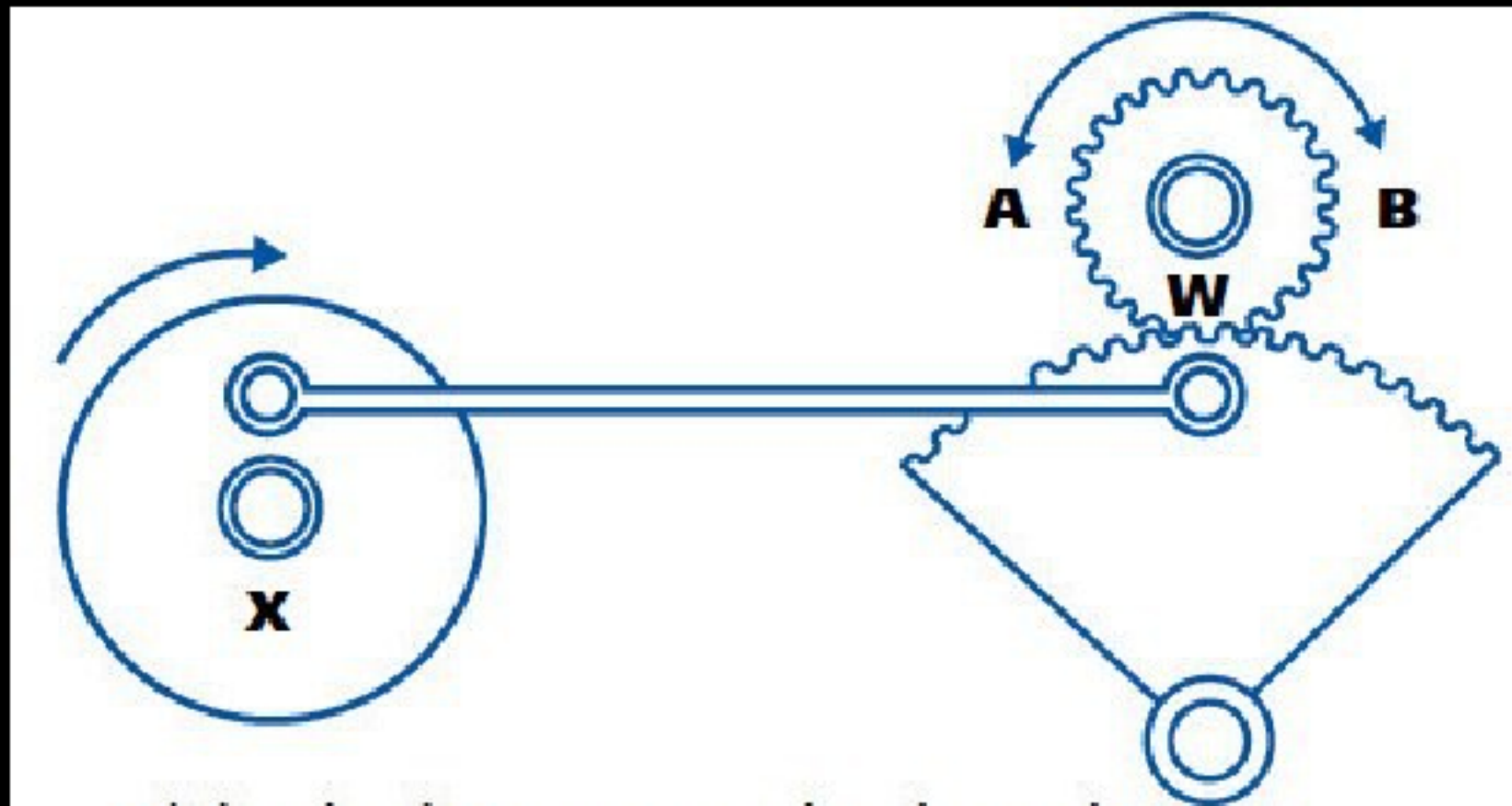
Measuring Spatial Skill

Folding



Measuring Spatial Skill

Mechanisms



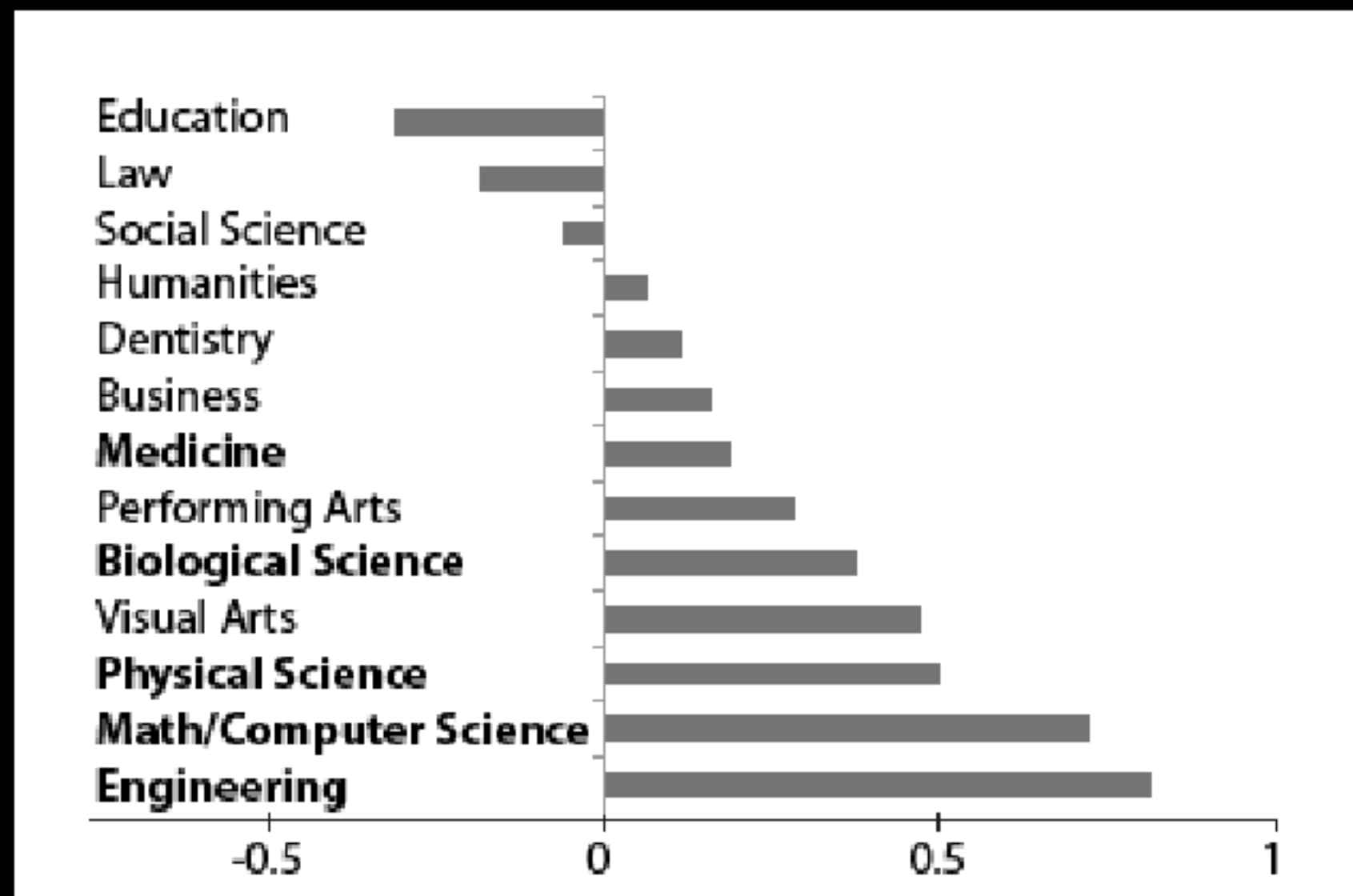
While wheel **X** turns round and round in the direction shown, wheel **W** turns

- A. in direction **A**.
- B. in direction **B**.
- C. first in one direction and then in the other.

On a scale **from 1 to 10**,
where 1 is non-spatial fields like singing
and 10 is highly spatial fields like sculpture,
how spatial is computing?

Spatial Reasoning in CS

- Correlation between HS spatial ability and career choice



Spatial Reasoning Matters

- Correlates with ability in many fields, including **computing**
- Correlation appears **causative** (increasing spatial reasoning skills has been shown to **increase performance** in related fields, including computing courses)

Why Does it Matter?

- Definitive answer not known
- Some ideas:
 - We **teach** concepts visually
 - Variables = boxes, addresses = arrows, ...
 - Computing **terminology** is visual
 - Stacks, trees, threads, flow, branching, nesting, lining up, moving, addresses, ...

Why, continued

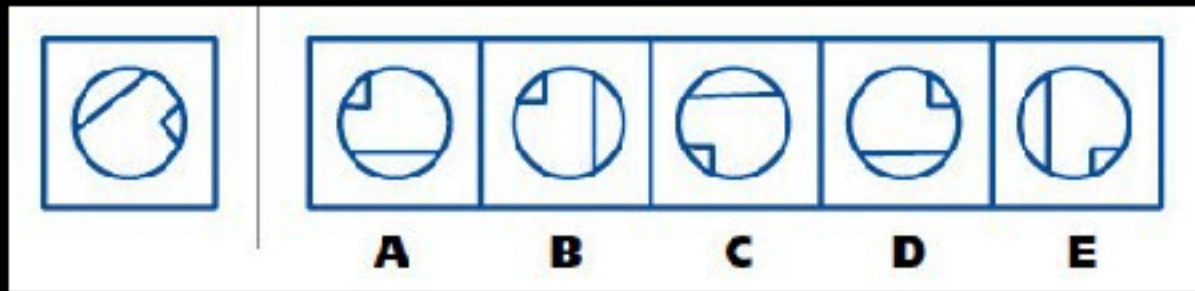
- Challenge: find a **computing concept** that is **not visual** in terminology and that you can explain **without a spatial analogy**

Boys Have the Advantage

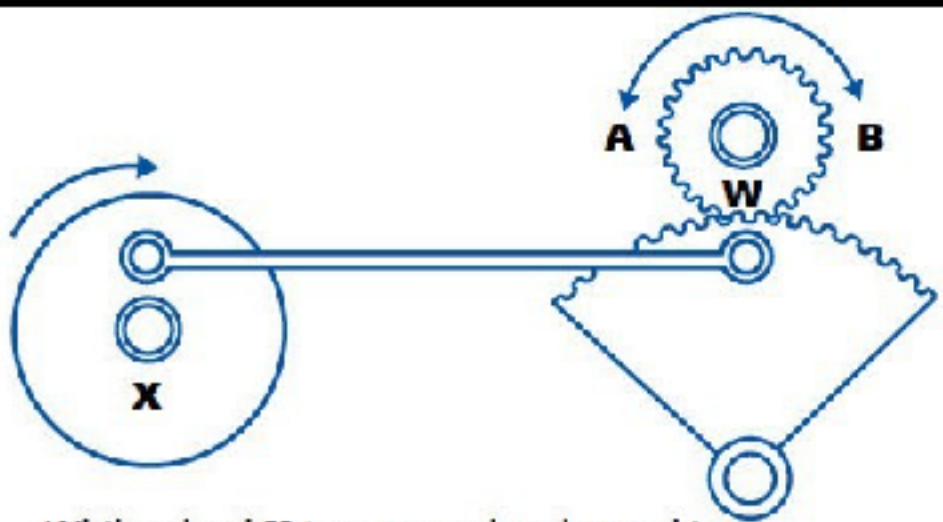
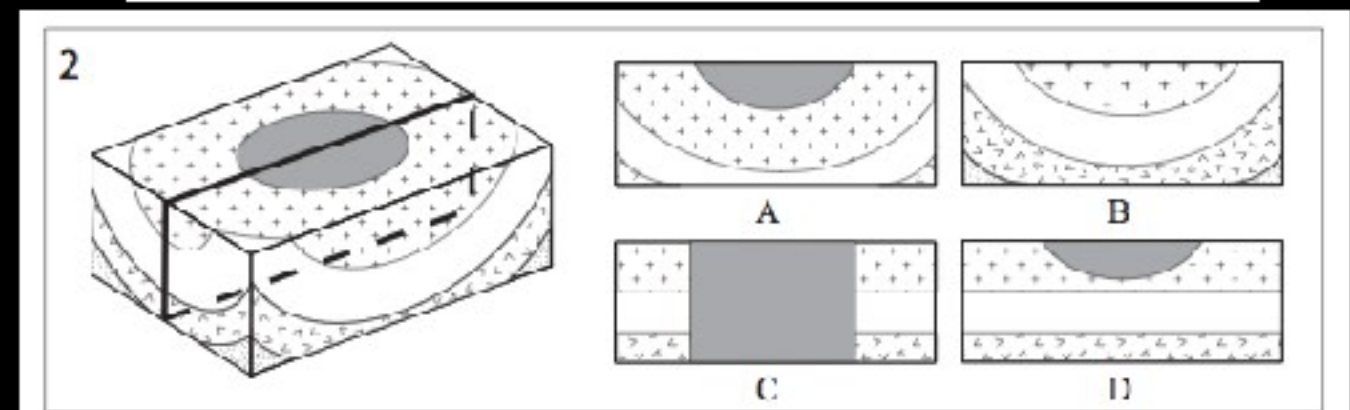
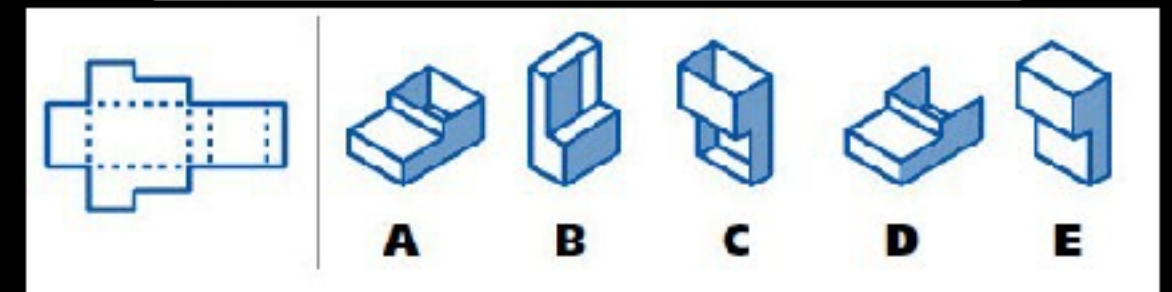
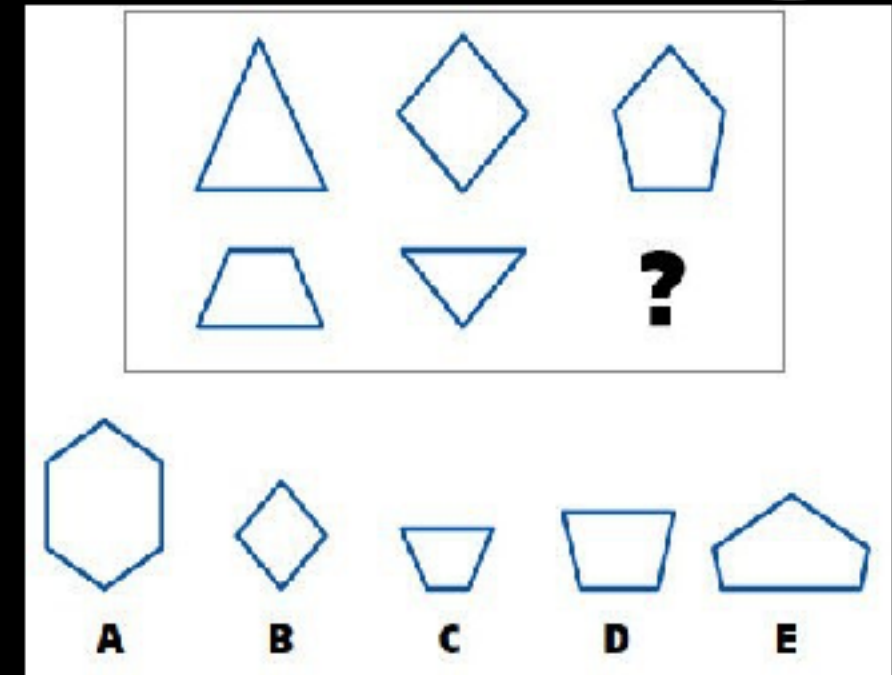
- Taken as a group, boys have more skill at spatial reasoning than girls
 - Better are **rotation** and mechanical reasoning
 - Not better at folding, pattern matching, cross sectioning
 - **Training** can narrow gap

Boys Have Some Advantage

Advantage



No advantage



While wheel **X** turns round and round in the direction shown, wheel **W** turns

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Differences

- Boys better at spatial reasoning at early age
- Higher economic class, more different genders are
- Experience definitely important

Spatial Experience

- Construction toys
- Shop, drafting, mechanics classes
- Some computer games
 - Especially 3D first-person shooters
 - Also geometric ones like Tetris
- Sketching
- Some ball sports, mathematics classes

How do you increase it?

- Provide **exposure**
 - Logic group **activities**
 - Draw when teaching and have them draw
- **Manipulatives**
 - Physical objects in lesson
 - E.g., if variables are boxes, bring in boxes
 - Also good to, e.g., cut the cutting tasks, rotate the rotating tasks, etc.

How do you Increase it?

- **Teach** process (**use-modify-create**)
 - Discuss the process of solving a spatial task
 - Work through a few examples
 - Provide a set of decreasingly similar tasks
- **Interventions**
 - Colleges have had success with 1-credit remedial spatial skills courses

Activities